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January 30, 2023

Mr. Tony Peterson
Wisconsin Department of Natural Resources
Eau Claire Service Center
1300 W Clairemont Ave
Eau Claire, WI 54701

Subject: Plan of Operation Modification
Phase IV Alma Offsite Ash Disposal Facility
Alma, Buffalo County, Wisconsin
License No. 4126

Dear Mr. Peterson:

On behalf of Dairyland Power Cooperative (DPC), TRC is submitting for the WDNR's review, the attached Plan of Operation (POO) Modification for Initial Permitting of Coal Combustion Residuals (CCR) Landfills for the Phase IV Alma Offsite Ash Disposal Facility (Phase IV Landfill) located in Alma, Wisconsin, License Number 4126. Via e-mail, we are also sending you a link to an electronic (PDF) copy of the POO Modification. Hard copies and electronic copies are disseminated per the attached Distribution List.

The Plan Modification was prepared in accordance with the requirements of Chapter NR 514.045, Wisconsin Administrative Code, following the general submittal requirements of Section NR 500.05 and the updated design requirements of Chapter NR 504.12. To assist in your review, copies of the NR 504 and NR 514.045 completeness checklists have been included, identifying the locations of the required information in the Plan Modification. DPC requests that the Department approves the Plan Modification for Initial Permitting for CCR Landfills for the Phase IV Landfill.

The Department's review fee should be invoiced to Mr. Leif Tolokken at the address indicated in the Distribution List. If you have comments or questions during your review of the Plan Modification, please feel free to contact me at (608) 622-9382 or Leif Tolokken (DPC) at (608) 386-2675.

Sincerely,

TRC

Todd W. Martin

Todd Martin
Principal Project Manager

cc: See attached Distribution List

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Footnotes:

[1] Electronic copies to be sent via an e-mail link.

# Plan Modification for Initial Permitting of CCR Landfills

## Alma Off-site Disposal Facility, Phase IV Landfill (License No. 4126)

January 2023

**Prepared For:**

Dairyland Power Cooperative
3200 East Avenue South
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## Certification Statement

"I, _____, hereby certify that I am a licensed professional engineer in the
Douglas R. Genthe, P.E.
State of Wisconsin in accordance with the requirements of ch. A-E 4, Wis. Adm. Code; that this document has been prepared in accordance with the Rules of Professional Conduct in ch. A-E 8, Wis. Adm. Code; and that, to the best of my knowledge, all information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR 500 to 538, Wis. Adm. Code."

I, _____, hereby certify that I am a licensed professional geologist
Stephen Sellwood, P.G.
in the State of Wisconsin in accordance with the requirements of Chapter GHSS 2, Wisconsin Administrative Code; that the preparation of this document has not involved any unprofessional conduct as detailed in Chapter GHSS 5, Wisconsin Administrative Code; and that, to the best of my knowledge, all information contained in this document is correct and the document was prepared in compliance with all applicable requirements in Chapters NR 500 to NR 538, Wisconsin Administrative Code.

# 1.0 Introduction

Dairyland Power Cooperative (DPC) operates a coal combustion residual (CCR) landfill in the Town of Belvidere, Buffalo County, Wisconsin. The CCR landfill is known as the Phase IV Alma Off-Site Ash Disposal Facility (Landfill) and is licensed under Number 4126. The Plan of Operation Conditional Approval was provided by the Wisconsin Department of Natural Resources (WDNR) on May 15, 2001, indicating that the Landfill was designed in compliance with chs. NR 500-590, Wisconsin Administrative Code. The Landfill is permitted with a design capacity of 3,011,000 cubic yards (cy) within 32 acres. As of 2022, approximately 1.3 million cubic yards of CCR waste have been placed in the Landfill and approximately 20.2 acres have been constructed (Cells 1-3).

DPC owns and operates the permitted Landfill in compliance with the Plan of Operation, Plan of Operation conditions of approval, and subsequent Plan Modifications that have been submitted to, and approved by, the WDNR and their applicable conditions, and the U.S. Environmental Protection Agency's (USEPA) CCR rule, Title 40 Code of Federal Regulations 40 CFR) Parts 257 and 261 Subpart D – "Standards for Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments".

## 1.1 General Site Information

| | |
|---|---|
| **Project title:** | Plan Modification for Initial Permitting of CCR Landfills, WDNR License #4126 |
| **Authorized facility contact:** | Mr. Leif Tolokken, Manager<br>Water and Waste Program<br>Dairyland Power Cooperative<br>3200 East Avenue South<br>La Crosse, Wisconsin 54602 |
| **Consultant:** | TRC Environmental Corporation<br>999 Fourier Drive, Suite 101<br>Madison, Wisconsin 53717<br>Todd Martin, Project Manager<br>(608) 622 9382 |
| **Facility location:** | S2180 State Hwy 35, Alma, WI 54610<br>NE ¼ of the NE ¼ of Section 19 and portions of Sections 18 and 20, T21N, R12W, W ½ of the NE ¼, Section 23, T26N, R7E, Town of Belvidere, Buffalo County, Wisconsin |
| **Date of Feasibility Determination:** | September 10, 1999 |
| **Date of Plan of Operation Approval:** | May 15, 2001 |
| **Liner Construction To Date (approval date):** | Cell 1 (May 2002), 2A (May 2007), 2B (March 2008), 3A (March 2013), and 3B (November 2015) |
| **Final Cover Events To Date (approval date):** | Cover Event 1 (January 2010), Cover Event 2 (January 2012), Cover Event 3 (March 2017) |

## 1.2 Purpose

The WDNR recently updated Chapters NR 500-520, Wisconsin Administrative Code, to incorporate the requirements of the Federal CCR rule (Title 40 Code of Federal Regulations Parts 257 and 261 Subpart D) into the Wisconsin solid waste regulations. The goal of these updates is for the WDNR to oversee CCR requirements for Wisconsin landfills as part of the state permitting program. Revisions to chs. NR 500-520 went into effect on August 1, 2022. As part of the revisions, owners/operators of new or existing CCR landfills that were licensed or constructed prior to August 1, 2022, are required to submit a plan of operation modification to the WDNR meeting the requirements of s. NR 514.045.

The purpose of this Plan of Operation Modification is to provide the necessary information required by the WDNR to show compliance with the revised requirements of ch. NR 500-520, Wisconsin Administrative Code. The following sections will detail compliance with s. NR 514.045. In addition, this Plan of Operation Modification will detail the Landfill's compliance with CCR operational requirements. The appendices include the WDNR ch. NR 514.045 and ch. NR 504 Completeness Checklists identifying the location of required information in this plan modification, along with the required CCR plans and supporting documentation and drawings to demonstrate compliance.

**Appendix A** includes the completed NR 514.045 and NR 504 checklists. Only the applicable sections of the NR 504 checklists were completed. **Appendix B** includes the prior approvals associated with the Landfill.

# 2.0 Locational Criteria and Performance Standards Demonstrations

## 2.1 Performance Standards

According to s. NR 514.045(1)(b), all phases of the CCR landfill are to meet performance standards specified under s. NR 504.04(4)(a),(b), and (c). The performance standards are addressed as follows:

1. **A significant adverse effect on wetlands as provided in ch. NR 103:** Wetlands were evaluated during preparation of the Feasibility Report (RMT, 1997). At that time, wetlands were not mapped in the Wisconsin Wetland Inventory Maps in the area of the Landfill. Based on an updated desktop review of the Landfill limits of waste, three wetlands classified as too small to delineate, one wetland indicator soil, and one NRCS wet spot were observed within the Landfill (Study Area) on the Wisconsin Department of Natural Resources (WDNR) Surface Water Data Viewer (SWDV). The wetland indicator soil and NRCS wet spot were observed in the southern portion of the Study Area. The mapped indicator soil as reported by the USDA Natural Resources Conservation Service (NRCS) Web Soil Survey, Northbend-Ettrick silt loams, 0 to 3 percent slopes, frequently flooded, consists of 36 percent of the soil map unit classified as hydric.

   Based on prior and ongoing construction activities occurring at the Landfill, the information reflected on the SWDV may not be representative of the current site condition of aquatic resources. The wetlands reflected on the SWDV are unlikely to be present; therefore, no adverse impacts to wetlands are anticipated as a result of the continuation of operations at the Landfill. The SWDV map is provided in **Appendix C**.

2. **A taking of an endangered or threatened species in accordance with s. 29.604, Stats:** The Feasibility Report dated September 1997 (RMT, 1997) noted that the Natural Heritage Inventory data files contained no occurrence records of Endangered, Threatened, or Special Concern species or natural communities, nor of any State Natural Areas within the Landfill area. Since the 1997 Feasibility Report, an updated endangered resources review was conducted to evaluate the existing Landfill area. The Endangered Resources (ER) Review request was submitted to the WDNR on December 21, 2022. The WDNR finalized the ER Review on January 13, 2023 (ERR Log # 22-859).

   WDNR ER Review letter (ERR Log # 22-859) indicated records of 12 state-listed threatened and endangered species and three state listed special concern species. The list of threatened and endangered species included seven fish species, two mussel species, and one snail species. WDNR requires that erosion control measures shall be implemented to protect the species located downstream from the Landfill. The Landfill includes a stormwater management system that is designed to minimize erosion and sediment transport off-site. The storm water management system was designed to the 100-year, 24-hour storm event at the time of the 2000 Plan of Operation and continues to meet the 25-year, 24-hour storm event design requirements, as detailed in Section 3.4.

   Temporary stormwater infrastructure and best management practices are used during construction and during intermediate phases of the Landfill's operation to manage storm water and sediment at the site. Through the continued implementation of these practices, adverse impacts to the identified species are not expected. The storm water management

system is detailed in Section 3.4. Additional requirements needed in order to not adversely impact the species noted in the ER Review letter are detailed in Section 2.4.

3. **A detrimental effect on any surface water:** During the Initial Site Inspection for the Landfill, inspection to determine whether the ephemeral waterways that were located the Landfill were navigable. During this inspection, it was determined that the ephemeral waterways were non-navigable. Therefore, the development and future development of this Landfill did not impact any navigable streams. No existing ponds, flowages, or floodplains were identified within the area occupied by the Landfill. The Site Inspection Letter is provided in **Appendix C**.

   In addition to not impacting existing surface water features, the existing Landfill has been designed with sedimentation structures that limit the release of soil from the proposed facility in accordance with the applicable soil erosion and/or storm runoff regulations. The Landfill proposed two sedimentation basins that would be used to manage storm water following placement of the final cover. In addition, diversion berms, downslope flumes, perimeter ditching, and culverts were proposed to manage surface/storm water at the site as it is conveyed to the sedimentation basins. As of 2022, the larger of the sedimentation basins has been constructed, the remaining sedimentation basin is to be constructed with Cell 4B. The storm water design is further detailed in Section 3.4.

## 2.2 Locational Criteria

According to s. NR 514.045(1)(c), all phases of the CCR landfill are to meet locational criteria specified under s. NR 504.04(3)(g),(h), and (i). The locational criteria are addressed as follows:

1. **Within 200 feet of a fault that has had displacement in Holocene time:** Subsurface investigations performed and reported in the Feasibility Report (RMT, 1997) included rock coring. Faulting was not observed in the rock cores. Additionally, the USGS Quaternary Earthquake Fault Map submitted in the latest Location Restrictions Demonstrations report (TRC, 2018) does not map faults occurring in the past 1.6 million years in the region of the Landfill. An updated Earthquake Fault Map for 2022 was evaluated and no faults occurring in the past 1.6 million years are noted in the area of the Landfill.

2. **Within seismic impact zones:** The American Society of Civil Engineers (ASCE) 7 seismic hazard tool maps website (ASCE, 2022) indicated an adjusted peak ground acceleration of 0.029g. This design peak ground acceleration is below the 0.1g lower limit for seismic impact zones; therefore, the site is not located in a seismic impact zone.

3. **Within unstable areas:** Risks presented by unstable areas caused by soil conditions, geologic or geomorphologic features, and human made features were evaluated for compliance with state regulations. An analysis was performed as part of the Location Restrictions Demonstrations report (TRC, 2018) which determined that the geotechnical exploration performed for the Feasibility Report (RMT, 1997) and landfill design performed by a professional engineer observed and documented no unstable foundation conditions. Soils within the footprint were found to consist of silt and lean clay overlaying medium to dense silty sand with evidence of highly weathered sandstone or dolomite in some areas to depths of 152 feet below ground surface. The observations did not suggest geologic conditions that are seen as unstable. Global stability calculations were performed as part of the Plan of Operations to evaluate the safety factors for the designed critical slopes (RMT, 2000). The analysis indicated acceptable factors of safety for the designed landfill.

Additionally, construction of the Landfill subgrade was performed under the observation of an engineer's representative and according to project specifications. Since the start of construction of the Landfill and as of today, no evidence of differential settlement impacting the foundation conditions have been observed. As no changes have created new unstable areas within the Landfill, this report satisfies the requirements of the s. NR 504.04(3)(i).

The Location Restrictions Demonstrations for the Landfill, dated May 2018, is provided in **Appendix D**. The updated supporting information detailed above supersedes the supporting information contained within the May 2018 document.

## 2.3 Floodplain Demonstrations

The FEMA floodplain map for the Landfill indicates the permitted area is not within a floodplain. The nearest floodplain boundary is along the western side of Highway 35, approximately 0.75 miles southwest of the southernmost limits of waste. The Landfill is in Zone X, which are areas of 0.2% annual chance of flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

The flood elevation of the floodplain nearest to the Landfill is about 670 feet (NAVD 1988). Subbase elevations within the Landfill range from approximately 780 feet above mean sea level (msl) in the southern portion and 862 feet msl in the northern portion of the Landfill (USGS mean sea level, 1929 adjustment) and final grades elevations up to approximately 966 feet msl. Because the Landfill's elevations are significantly higher than the flood elevation of the nearest floodplain and the Landfill is not located inside the floodplain, the facility nor its operations are not expected to restrict the flow of the regional flood, reduce the temporary water storage capacity of the floodplain, or result in washout of solid waste so as to pose a hazard to human life, wildlife, or land or water resources.

## 2.4 Endangered Species or Critical Habitats Demonstrations

The Landfill Study Area was submitted to the Wisconsin Department of Natural Resources (WDNR) along with an Endangered Resources (ER) review request to review of the Wisconsin Natural Heritage Inventory (NHI) database. A review of the U.S. Fish and Wildlife Service (USFWS) Information for Planning and Conservation (IPaC) website was conducted to identify state and federally listed species occurrences within or near the Alma Off-Site Disposal Facility.

The WDNR ER Review letter (ERR Log # 22-859) indicated records of 12 state-listed threatened and endangered species and three state listed special concern species. The list of threatened and endangered species included seven fish species, two mussel species, and one snail species. The DNR is requiring erosion control measures to avoid and minimize potential impacts to the fish and mussel species. DPC will continue to utilize erosion control BMPs in accordance with DNR Technical Standards as required by state statues to manage potential erosion and control sediment release from the Landfill during land disturbance activities. In addition, DPC's storm water management system is designed to manage erosion and sediment transport during the Landfill's operation. The storm water management system will continue to be maintained and is detailed in Section 3.4.

The DNR is also requiring habitat surveys for the snail species. Prior to disturbing areas where potential snail habitat occurs during liner construction activities, DPC will have a qualified individual perform a habitat survey for snail habitat. If habitat is found and would need to be impacted, DPC will contact the WDNR Endangered Resources Utility Liaison to discuss how to avoid impacts or to apply for an Incidental Take Permit, as per the requirement listed in the ER review letter.

The ER review letter also makes recommendations to avoid and minimize impacts to three state listed special concern fish species. This includes installing erosion control measures. Given that erosion control measures are required for state listed threatened and endangered fish and mussel species, DPC would follow this DNR recommendation. By following state requirements and recommendations, no adverse impacts on state listed special concern, threatened, or endangered species are anticipated.

The U.S. Fish and Wildlife Service (USFWS) Information for Planning and Conservation (IPaC) Official Species List indicated the potential presence of one endangered mammal, the Northern Long-eared Bat (*Myotis septentrionalis*), two endangered clams, Higgins Eye (*Lampsillis higginsii*) and Sheepnose Mussel (*Plethobasus cyphyus*), and one candidate insect species, the Monarch butterfly (*Danaus plexippus*). Included below are descriptions of potentially suitable habitat areas within the Landfill Study Area.

- Northern long-eared bat: Potential suitable woodland habitat was observed in the Study Area. If no clearing of forest or woodland habitat is expected to be needed, potentially suitable northern long-eared bat roost habitat will not be adversely affected by the Project and a no effect determination may be concluded. During previous construction events, tree clearing for Cells 4A and 4B was substantially completed. Therefore, if constructed, additional tree clearing would be minimal, and time of year tree clearing restrictions would be followed as needed. Tree clearing restrictions include conducting tree removal activities outside of the northern long-eared bat pup season (June 1 to July 31) and/or the active season (April 1 to October 31). This will minimize impacts to pups at roosts not yet identified (USFWS).

- Higgins Eye and Sheepnose Mussel: Suitable habitat is not present for the Higgins Eye and Sheepnose Mussel clam species. Streams providing suitable habitat for the listed mussel species are not present within the Study Area, therefore, no impacts to these species, including destruction or modification of their critical habitat are expected. Additionally, erosion control measures will be implemented to control for erosion and sediment release to waterways where the mussel may occur.

- Monarch Butterfly: Suitable flowering plant and milkweed habitat is not expected to be present in the Study Area, therefore, no destruction or adverse modification of critical habitat is anticipated. As of the date of this Plan Modification, the monarch butterfly is a candidate species only and no state or federal regulations for the species or their habitat are required to be followed, however, protection of identified habitat is encouraged by USFWS.

Results from the USFWS IPaC Official Species List are provided in **Appendix E.**

# 3.0 Design Demonstrations

The design of the Landfill was originally presented in the Plan of Operation, dated October 2000 (RMT, 2000) and modified with subsequent plan modifications submitted since 2001. The Plan of Operation was approved on May 15, 2001 by the WDNR. Applicable information previously provided in the Plan of Operation has been included in **Appendix F**.

As of January 2023, five liner construction events and three final cover construction events have been completed at the Landfill. During each of the construction events, an on-site quality assurance representative observed the construction and completed compliance testing. A summary of the construction activities along with the results of the compliance testing were submitted to the WDNR following construction for review and approval. All liner and final cover construction events have been approved by the WDNR. The approval letters for each construction event are included in **Appendix B**.

The following subsections will provide details pertaining to the design of the Landfill which also apply to the future construction at the landfill, summarizing information provided in previous submittals, supporting information or excerpts from previous submittals will be provided in the appendices as needed.

## 3.1 Accepted Waste Types

The Landfill only accepts CCR-related materials approved with the Plan of Operation or approved in subsequent Plan Modifications. These approved materials originated from DPC's Alma site which included Alma Station (Units 1 – 5) and John P. Madgett Generating Station (JPM) and DPC's Genoa Station No. 3 and include:

- Fly ash,
- Bottom ash,
- Sludge from the wastewater treatment plants for the Alma and Genoa power generating facilities,
- Asbestos generated from renovations at the power generating stations,
- Genoa Station No. 3 flue gas desulfurization (FGD) (similar to Sherco #3 FGD),
- Dry Sorbent Injection (DSI) – JPM Power Plant only,
- Activated carbon injection, JPM and Genoa
- Selective catalytic reduction – JPM Power Plant only, and
- Selective non-catalytic reduction - Genoa Power Plant only.

Throughout the Landfill's operating life, the waste stream sources have decreased as facilities have been decommissioned. Waste streams originating from Alma Generating Station (Units 1 - 5) and Genoa Station No. 3 have halted due to the decommissioning of these power plants.

## 3.2 Liner Design

Five liner construction events have been completed at the Landfill, which include Cells 1, 2A, 2B, 3A, and 3B. During each of the construction events, an on-site quality assurance representative working under the direction of a professional engineer licensed in the State of Wisconsin observed the construction and completed compliance testing. A summary of the construction activities along with the results of the compliance testing were submitted to the WDNR following construction for review and approval. The liner and cover construction events have been approved by the WDNR and their approval letters are included in **Appendix B**. Construction of future Cells 4A and 4B are expected to follow similar construction procedures as the previous liner construction events.

A revised existing conditions map, **Plan Sheet 1**, has been provided to detail the current conditions of the Landfill. Additional drawings associated with the site are included in **Appendix F**. Per s. NR 504.12(3)(a), a new or lateral expansion of a CCR landfill shall be designed, constructed, operated, and maintained with a composite liner and leachate collection and removal system. The following subsections detail the design of the CCR landfill for future potential expansions, which include Cells 4A and 4B.

### *3.2.1 Subbase grades*

Subbase grades were designed to provide a minimum separation distance of 10 feet from the seasonal high groundwater table and the top of bedrock surface. In addition, 40 CFR 257.60 indicates that the Landfill (lateral expansions) must be located with a base that is no less than 5 feet above the upper limit of the uppermost aquifer.

The site water table, based on water level elevations measured in April 1996, is shown on the engineering cross sections from the Plan of Operation (**Appendix F.2)**. The separation between the water table and the subbase grades on the engineering cross sections is typically 30 to 40 feet and is greater than 25 feet throughout the footprint of the Landfill. Water levels changes since 1996 have ranged from a decrease of approximately 1 foot (W-100/W-100R) to an increase of approximately 17 feet (W-104); therefore, the minimum 5-foot separation between the subbase grades and groundwater elevations has been maintained for the entire Landfill footprint.

Subbase grades within the Landfill slope from north to south, following the overall site's topography, mimicking the base grades detailed in Section 3.2.2. Interior perimeter berms are designed and constructed at a 3:1 slope. The floor slopes are designed to exceed the minimum 2% requirement for liner slopes.

### *3.2.2 Base Grades and Liner System*

Base grades at the Landfill are designed to be raised a minimum 2 feet above subbase grades and follow the subbase grades slope from north to south. The base grades (and subbase grades) are designed in a herringbone configuration. This configuration increases the efficiencies of the leachate collection system as leachate is directed to designated low spots where the leachate can be removed from the landfill footprint.

The base grades within Cells 4A and 4B are designed with a 4% slope along the leachate collection line. These slopes exceed the minimum 0.5% requirement in s. NR 504.06(5)(b). The ridges in the herringbone configuration are designed to meet or exceed the minimum liner slope

requirements toward the leachate collection liner of 2%, in accordance with s. NR 504.06(2)(d). Liner slopes within Cell 4A and 4B range from 2% to 10%, exceeding the minimum requirement of s. NR 504.06(2)(d).

In general, the herringbone design of the Landfill does not exceed the maximum leachate flow distance requirements of 130 feet, except in two small areas in Cell 4. An exemption had been previously granted for the two exceedances, which are located in the southwestern corner of Cell 4A and along the eastern wall of Cell 4B. In Cell 4A the flow length exceeds the requirement by an average of 19 feet, and an average of 12 feet in Cell 4B. Due to the relatively steep base slopes (6% and 10% respectively) in these areas, the WDNR approved the exemption request in 2001 (**Appendix B**). Liner slopes within Cell 4A and 4B range from 2% to 10%, exceeding the minimum requirement of s. NR 504.06(2)(d). The base grades from the Plan of Operation, which are consistent with the constructed area grading and grades for Cells 4A and 4B, are provided in **Appendix F.2**.

A composite liner system for the Landfill is designed to be installed along the base and interior sidewalls of the entire Landfill. The composite liner consists of a geosynthetic clay liner (GCL), and a 60-mil high-density polyethylene (HDPE) geomembrane liner installed over a low-permeability layer soil layer as allowed by s. NR 504.06(7).

#### 3.2.2.1 Low Permeability Soil Layer

Per s. NR 504.06(7)(c), the GCL in a composite liner system is to be underlain by a soil barrier layer that is a minimum 2 feet thick and meets the specifications of s. NR 504.07(4)(a)(12-17). Per s. NR 504.07(4)(12) the soil barrier layer (known hereby referenced as the low permeability soil layer) consists of soil types with the Unified Soil Classification System (USCS) classes of ML, CL, CH, SM, or SC or dual-classification of these soils. Condition 7a of the Plan of Operation approval noted that material in the upper 1 foot of the low permeability soil layer is required to consist of the soil types listed above, with a maximum particle diameter less than 1 inch and have at least 80% by weight pass the No. 60 screen and a P200 content of 40% of greater.

The soil that has historically been utilized for the low permeability layer is obtained from on-site material excavated during subbase construction. This is anticipated to be consistent for the future construction of Cells 4A and 4B. The on-site soil borrow for the low permeability layer has consisted of silty clay, silt, or lean clay with Unified Soil Classification System (USCS) symbols of ML, ML-CL, and/or CL, as noted in the liner construction documentation reports. This material has been in conformance with the requirements and specifications of the low permeability soil.

If Cells 4A and 4B are constructed, the material excavated during development of the subbase grades is anticipated to meet the low-permeability soil requirements, consistent with the previous construction events, and would be placed to a minimum 2-foot-thickness above the subbase grades. If additional soil material is needed, an off-site borrow source or commercial source would be utilized to supplement the soil volume requirements. Soil samples would be obtained during liner construction and tested both in the field (moisture-density testing) and in the laboratory (moisture content, dry density, grain size, and Atterberg) to show compliance with the material specifications.

Placement of the low-permeability soil layer will comply with the requirements of s. NR 504.07(4)(a)(12-17) and is detailed in Section 4.6.1 of the 2000 Plan of Operation text

excerpt provided in **Appendix F.1** and the Construction Quality Assurance (CQA) Plan included in **Appendix G**.

### 3.2.2.2 Geosynthetic Clay Liner

#### *3.2.2.2.1 Geosynthetic Clay Liner Design*

A GCL is designed to be placed directly above the low permeability soil layer along the base and sidewalls. The GCL consists of a layer of pure sodium bentonite encapsulated between two geotextiles. The bentonite barrier component of the GCL contains an expanding clay that absorbs water and swells to form low-permeability material. The liquid flow rate through the GCL layer is designed to be no greater than the liquid flow rate through 2 feet of compacted clay meeting the hydraulic conductivity requirement in s. NR 504.06(2)(a)(2). The liquid flow rate comparison is included in **Appendix H.1**.

GCL used in construction at the Landfill is required to be meet the requirements detailed in the CQA Plan (**Appendix G**). Previously used GCLs consist of either Bentomat ST or GSE BentoLiner NSL, both reinforced GCLs consisting of a layer of granular sodium bentonite clay encapsulated between a two geotextiles fabrics (upper – nonwoven; lower – woven) needle-punched together. The GCLs are certified as needle free. These or similar materials will be used during the liner construction of Cells 4A and 4B.

If Cells 4A and 4B are constructed, placement of the GCL will comply with the requirements of s. NR 504.07(4)(a)(1-11) and is detailed in Section 4.6.3 of the 2000 Plan of Operation text excerpt provided in **Appendix F.1** and the CQA Plan included in **Appendix G**.

#### *3.2.2.2.2 Geosynthetic Clay Liner Compatibility Testing*

Throughout Landfill operations, GCL compatibility testing has been completed per the requirements in the 2001 Plan of Operation Conditional Approval. As summarized below, the testing has not found a significant increase in the permeability of the GCL. Operations that would take place in Cells 4A and 4B would be consistent with existing operations and waste acceptance. Therefore, these findings summarized below can be applied to Cells 4A and 4B.

In 2006, a trend analysis for the GCL compatibility testing was completed and submitted to the WDNR. During this evaluation it detailed that the primary factor in the swelling of the bentonite component of the GCL is due to sodium ions present in the clay. The permeability of a GCL increases if a significant fraction of these sodium ions exchange with calcium ions in solution. Based on historic leachate samples taken through 2005, it was calculated that the overall increase in hydraulic conductivity of the GCL was approximately 2.3 percent. This increase is insignificant due to the order of magnitude of the GCL permeability being $10^{-9}$ cm/s (Cell 3B GCL hydraulic conductivity was reported as $1.23 \times 10^{-9}$ cm/s). The resultant hydraulic conductivity of the GCL material would continue to be calculated to an order of $10^{-9}$ cm/s.

The most recent compatibility testing was completed in April 2009 when FGD waste was proposed to be accepted at the Landfill. Based on the study, it was expected that the disposal of the FGD material may cause a slight increase in the liner permeability, but the permeability of the liner is expected to stay well below $1 \times 10^{-7}$ cm/s because the variability of the FGD waste is less than what was seen for the fly ash and Sherco scrubber material that was currently disposed of at the Landfill. The FGD material was approved for disposal in December 2009. The FGD approval

letter and 2009 leaching potential and GCL compatibility analysis is provided in **Appendix B** and **Appendix H.2.1**, respectively.

In November 2013, a subsequent plan modification (**Appendix H.2.2**) was submitted to the WDNR for the inclusion of several waste sources from the Alma and Genoa power generating facilities to the Landfill. These waste sources included DSI, which is currently one of the primary waste sources disposed at the Landfill. DSI residual material is similar to the FGD residual material generated at the Genoa facility, except that there is a higher sodium content and lower calcium content. As noted in the 2006 trend analysis, it is the presence of calcium ions (divalent ions) and their exchange with sodium ions that tends to cause an increase in GCL permeability. The decrease in calcium content in the waste source would presumably decrease the potential of this ion exchange.

As noted in the submitted 2013 Plan Modification, the annual results of the previous compatibility testing from 2003 through 2007 were reviewed along with the recent laboratory testing performed on the sodium bicarbonate samples from the JPM baghouse. Based on this review and the similarities in the leaching characteristics between the lime-based and sodium bicarbonate-based materials, it was not anticipated that a significant increase in permeability of the GCL would occur. Approval of these waste sources was provided to the Landfill from the WDNR in December 2013. The approval letter is provided in **Appendix B**.

#### 3.2.2.3 Geomembrane Liner

The upper component of the composite liner system consists of a nominal 60-mil high density polyethylene (HDPE) geomembrane liner. The geomembrane liner located within the landfill base will consist of a smooth geomembrane, while the geomembrane on the sideslopes will be textured for added stability. HDPE geomembrane liners have historically been included in the design and construction of nonhazardous waste facilities. Testing of the compatibility of the HDPE geomembrane with the leachate generated from this type of facility has been previously performed by geomembrane manufacturers, suppliers, and industry users. These test results, provided from the 2000 Plan of Operation, indicate that the leachate from a typical nonhazardous waste disposal facility will not adversely affect the performance of the HDPE geomembrane liner and are included in **Appendix F.3**.

The geomembrane will be deployed above the GCL. Minimum geomembrane liner property requirements will comply with those presented in the CQA Plan. The geomembrane will be seamed with the previously installed geomembrane as to create a continuous seal. If Cells 4A and 4B are constructed, placement of the geomembrane will comply with the requirements of s. NR 504.06(3)(a-k) and is detailed in Section 4.6.4 of the 2000 Plan of Operation text excerpt provided in **Appendix F.1** and the CQA Plan included in **Appendix G**.

#### 3.2.2.4 Geotextile Cushion

The leachate collection drainage layer, detailed in Section 3.2.3, is designed to require placement of geotextile on an as-needed basis for areas outside the leachate collection trenches. A minimum 12 ounce per square yard (oz/sy) of nonwoven geotextile is to be installed within the leachate collection trench following geomembrane installation to provide additional protection to the geomembrane from the pipe bedding materials. Material specified for use of the leachate collection drainage layer does not exceed particle sizes of ¼ inch in diameter; therefore, the geotextile would not be required outside the trenches. If the leachate collection drainage layer

includes particles exceeding 1/4 inch in diameter, geotextile should be placed over the entirety of the Landfill base grade, in accordance with s. NR 504.06(5)(t). The geotextile cushion would be secured in place via the anchor trench.

The geotextile in Cells 4A and 4B will be deployed above the geomembrane within the leachate collection drainage trenches, at a minimum. Minimum material specifications are presented in the CQA Plan. Placement of the geotextile is detailed in Section 4.6.6 of the 2000 Plan of Operation text excerpt provided in **Appendix F.1** and the CQA Plan included in **Appendix G**.

### *3.2.3 Leachate Collection System*

The primary function of the leachate collection system was to maintain the average leachate head on the liner system to less than 12 inches per s. NR 504.12(3)(a)(1). The leachate collection system design for the Landfill consists of a minimum 1-foot-thick leachate collection drainage layer, leachate collection piping traversing north to south across the landfill base, and leachate conveyance piping between landfill cells and the leachate tank located outside the limits of waste. The leachate collection piping is outfitted with cleanouts to provide access for maintenance and jetting of the pipes throughout the operational and post-closure periods of the Landfill.

The leachate collection tank was previously installed during the Cell 1 liner construction event. Leachate collection and conveyance piping along with the drainage layer and cleanouts have been installed systematically as cells were developed at the Landfill. Construction of Cells 4A and 4B would include the installation of the remaining portions of the drainage layer, collection piping, cleanouts, and head wells.

Per s. NR 504.12(3)(a), a new or lateral expansion of a CCR landfill shall be designed, constructed, operated, and maintained with a composite liner and leachate collection and removal system. The following subsections will summarize the leachate collection system design presented in the Plan of Operation, which is consistent for the future potential expansion Cells 4A and 4B. Excerpts from the Plan of Operation are provided in **Appendix F.1**, details relating to the leachate collection system from the Plan of Operation plan set are provided in **Appendix F.2**.

#### 3.2.3.1 Leachate Collection Drainage Layer

The leachate collection drainage layer consists of a minimum 1-foot thick of select granular fill that is placed over the geomembrane on the base and sidewalls of the Landfill. The leachate collection layer will have a minimum hydraulic conductivity of 1 x $10^{-2}$ cm/s, not exceed ¼ inch in size, and meet the specifications detailed within the CQA Plan (**Appendix G**).

The material that has been utilized for the select granular fill has primarily been obtained from an off-site commercial source. The select granular fill utilized for the leachate collection drainage layer did the not exceed the particle size requirements in s. NR 504.06(5)(t) which would have required geotextile atop the geomembrane outside the leachate collection trenches. In addition, hydraulic conductivities met the minimum requirement as specified in s. NR 504.06(5)(tm).

Aggregate material is used for bedding material for the leachate collection piping. The pipe bedding will have a uniformity coefficient of less than 4, maximum particle diameter of 1.5 inches, maximum of 5% of the material passing the number 4 sieve and consist of either rounded or subangular gravel. A minimum of 4 inches of bedding material is to be placed below the perforated collection pipe in the leachate collection trenches. The aggregate material is also to

be placed around the leachate collection pipe and mounded at least 1 foot above the pipe. The material that has been utilized for the select aggregate fill has been obtained from an off-site commercial source. The aggregate material has been in general conformance with the material specifications in NR 504.06(5)(e).

Material for the leachate collection drainage layer and aggregate pipe bedding material in Cells 4A and 4B would continue to be obtained from this or a comparable off-site commercial source and confirmation testing would be completed to determine that it met the required specifications.

The leachate collection drainage layer is designed to provide a soil filter for filtering the select aggregate fill material. However, if the soils obtained during construction do not meet that graded design, a 6-inch-thick layer of select graded fill will be placed over the bedding material as needed to maintain the soil filter to minimize migration of the select granular fill into the pipe bedding material. The use of select graded fill has been used periodically during the previous liner construction, depending on the characteristics of the granular and aggregate fill obtained.

Soil filter calculations have been completed previously as part of the Plan of Operation and continued to be completed as part of the liner construction documentation reports to confirm that the leachate collection drainage layer and pipe bedding material met the requirements for the graded filter design. The soil filter calculation utilized the DPC material specifications to show that the leachate collection drainage layer and the pipe bedding material met the requirements of a graded filter so clogging is not anticipated for the site. As noted above, if the materials obtained for construction show the potential for movement, a graded fill is installed to maintain the soil filter design.

The soil filter piping and permeability calculations from the Plan of Operation are provided in **Appendix F.4**. The assumptions made in these calculations are generally valid, with exception the uniformity coefficient of the average pipe bedding which exceed the requirements. Material used during construction have met the specifications in CQA Plan and the soil filter calculations from the two most recent liner construction events are included in **Appendix I.1 and I.2**. The soil filter design will be able to be maintained with the off-site commercial materials with Cells 4A and 4B.

Calculations have also been performed during the 2000 Plan of Operation to confirm that the average leachate head on the liner is limited to 1 foot or less, this calculation is provided in **Appendix F.5**. Assumptions made in these calculations are valid as the slope of the liner cover the most critical conditions encountered for the entire Landfill, which includes Cell 4, and the leachate generation rate in ch. NR 512 is consistent. Therefore, as designed and installed, the Landfill (on average) is expected to maintain a leachate head on the liner to 1 foot or less in accordance with s. NR 504.12(3)(a)(1). Because the leachate collection lines are 1,200 feet or less and are considered extended lines, the requirements under s. NR 514.07(8)(c)(3)(b) were not considered.

The leachate collection drainage layer will be placed within 30 days of completing geomembrane installation and quality assurance testing. To minimize the potential for large wrinkles in the geomembrane, the drainage layer will be placed during cooler temperatures when possible. Wrinkles in the geomembrane that are higher than they are wide, will be smoothed or cut out and repaired prior to placing the drainage layer. Initial lifts of the select granular fill will be approximately 2 to 3 feet thick to allow for vehicular traffic over the geomembrane component for material hauling. A minimum of 2 feet of material will be placed prior to operating tracked vehicles

and flotation tire–equipped vehicles, while a minimum of 3 feet of material will be placed prior to operating trucks and other wheeled hauling equipment. These initial lifts will be graded down to the 1-foot minimum design with the use of low ground pressure tracked vehicles, meeting the requirements of NR 504.06(3)(h). To protect this layer, DPC will place a minimum 2-foot layer of bottom ash or ash from the JPM Station over the select granular fill.

#### 3.2.3.2 Leachate Collection Piping, Sumps, and Manholes

The leachate collection piping, cleanout risers, and head wells are designed to consist of HDPE piping. HDPE materials have historically been utilized within solid waste facilities, both for municipal and industrial applications. Based on the EPA 9090 Chemical Compatibility study between CCR materials and HDPE and VLDPE, the HDPE materials did not have any changes in the polymer structure or original performance of the polymer's characteristics. In addition, HDPE has been tested to show satisfactory chemical resistance properties to chemical attack from compounds associated with CCR materials as noted in the Ineos's Chemical Resistance Guide **(Appendix I.3)** per s. NR 504.12(3)(a)(2)(a).

Leachate collection piping consists of 6-inch-diameter perforated SDR 17 HDPE pipes placed in minimum 18-inch-deep vee-trenches constructed in the valleys of the herringbone base grades. The vee-trenches sideslopes have a maximum slope of 3:1, per s. NR 504.06(5)(d) and contain a geotextile placed underneath the pipe bedding material. The geotextile is detailed in Section 3.2.2.4. The perforated collection piping includes a maximum 1/2-inch diameter holes set 45 degrees from center, consistent with piping installed within the previous liner construction. This is also permissible per the piping and permeability calculations. The leachate collection piping is designed to gravity flow to the south through liner penetrations (detailed below) to the leachate conveyance system.

Pipe joints will be butt-fusion–welded in accordance with the manufacturer's recommendations. The leachate collection piping will be flushed following construction.

An exemption request has previously been approved by the WDNR in the 2001 to allow for horizontal pipe penetrations through the southern liner sideslope to allow leachate to gravity drain to the leachate collection tank south of the Landfill. The leachate collection lines transition into dual encased transfer piping that penetrates the liner sideslope, and ultimately combine via manholes into a single transfer pipeline that is routed to the existing leachate tank. The penetrations were designed to prevent leachate from leaving the liner system. Section 3.8.4 of the Plan of Operation included in **Appendix F.1** details the design of these penetrations. Drawing details are provided in the Plan of Operation Plan Set in **Appendix F.2**. These penetrations are included in leachate removal design for Cells 4A and 4B, and their construction will be consistent with those in Cells 1 through 3.

The leachate collection pipes are outfitted with perimeter cleanouts at the end of each leachate collection pipe. Midline cleanouts are included in Cells 3 and 4 along the longest collection lines to maintain pipe cleanout lengths of 1,200 feet or less. The cleanout risers and midline risers consist of 6-inch nonperforated SDR 17 HDPE pipe. The cleanout risers will be placed up the sidewalls of the Landfill, daylighting atop the perimeter berm or in manholes with a locking cap. A minimum 2-foot-thick (vertically) of select granular fill is be placed above cleanout risers on the sideslopes of the Landfill.

Pipe strength calculations were conducted during preparation of the 2000 Plan of Operation. The calculations indicated that the proposed loading from waste placed above the pipes would not adversely impact strength characteristics of the pipes. The strength parameters (diameter, SDR, material) for piping currently installed at the Landfill are consistent or stronger than those included in the Plan of Operation. Similar strength material will continue to be used for the construction of Cells 4A and 4B. No changes to the height of proposed waste have been proposed in subsequent plan modifications. Minimal changes to the final cover configuration have occurred since the Plan of Operation. These have included reverting back to the 3-foot final cover system approved by WDNR instead of the 5--foot cover system presented in the WDNR Plan of Operation Approval letter. This final cover system is more consistent with the loading presented in the pipe strength calculations provided in the Plan of Operation. These pipe strength calculations are included in **Appendix F.6**.

#### 3.2.3.3 Leachate Conveyance and Storage Tank

The leachate collection pipe transitions into a non-perforated pipe prior to penetrating the liner system as detailed in Section 3.8.4 of the Plan of Operation text excerpt included in **Appendix F.1**. At the liner penetration, the leachate piping transitions from single walled pipe to dual-encased pipe in accordance with s. NR 504.06(5)(L) for pipelines location outside the limits of waste/ash. The leachate transfer piping is designed to gravity drain from the northern side of the Landfill to the existing leachate tank located south of Sedimentation Basin 1.

The dual-encased transfer piping has been previously installed at the Landfill and consists of 6-inch non-perforated SDR 17 HDPE pipe encased within a 10-inch diameter nonperforated SDR 11 HDPE pipe. Outside the limits of waste/ash, seven concrete manholes were designed to provide locations for changes in piping direction, for piping to manifold into a single transfer pipe, cleanout access, and to monitor interstice between the casing and carrier pipes.

The seven previously proposed transfer leachate manholes were installed during the previous liner construction events. An additional manhole located between the tank and loadout station to monitor volume of leachate extracted from the tank was also installed during a previous liner construction event. The concrete manholes were installed as the perimeter berms were constructed. During construction of Cell 3A, two leachate transfer pipelines were preemptively installed from Manhole 7 (located south of Cell 4A) to the construction limits of Cells 4A to allow for the future leachate collection piping connections.

Due to the additional construction that occurred during the Cell 3A liner construction event, additional dual-encased transfer piping and leachate transfer manholes are not anticipated to be installed during liner construction events for Cells 4A and 4B.

The leachate collection tank was installed during the construction of Cell 1 per the requirements of the Plan of Operational approval. The tank consists of a double-walled, fiberglass-coated, steel reinforced Duraglass Type I storage tank that was bedded on clean sand and secured with deadman anchors. Double wall steel reinforced tanks tend to be resistant against structural failure and both internal and external corrosion. These types of tanks are generally used for both municipal and industrial applications. The existing tank has been in service at the Landfill for over 20 years and has not experienced failures due to the interactions between the leachate and the tank. Leachate from the tank is pumped via dual encased piping to the processing facility or loadout station. The leachate generated, once extracted, is used as approved in the Plan of

Operation or hauled off-site for disposal and treatment. Use of the generated leachate for dust control, as previously presented in the 2000 Plan of Operation, is detailed in Section 5.1.

#### 3.2.3.4 Leachate Collection System Maintenance, Monitoring, and Operation

The Landfill leachate system is designed with leachate head wells that are used to monitor the hydraulic head of the leachate within the Landfill. Two leachate head wells are to be installed within each cell of development, totaling in eight head wells for the entire Landfill. Six head wells are currently installed at the Landfill. Construction of Cells 4A and 4B would complete the installation of the remaining 2 head wells.

The head wells consist of a 3-inch-diameter Schedule 120 non-perforated PVC piping with a 5-foot screen and installed at a level grade toward the toe of the perimeter berm sidewall with surface access at the top of the perimeter berm. The head wells will be placed over the geomembrane, within the select granular fill drainage layer at a constant elevation. A minimum of 2-feet of select granular fill will be placed above the head well along the base and sidewall of the Landfill. General fill will be mounded around the head well piping at the termination at the top of the berm for support. During final cover construction, the mounded general fill will be replaced with final cover material. Drawing details of the head wells are included in **Appendix F.2**.

DPC measures head levels on a monthly basis per their environmental monitoring plan. If elevated head levels are discovered, DPC evaluates the potential causes and attempts to lower the levels in a timely fashion. These measures include completing additional leachate collection pipe jetting to confirm that they are clear and televising the line on a more frequent basis. The most recent leachate line video inspection was performed in June 2022 in which the lines were found to be in good working condition with no significant problems encountered during the post-jetting video inspection (DPC, 2022).

Due to the properties of the CCR material disposed of at the facility, precipitation that contacts the active area of the Landfill and becomes leachate is prone to runoff from the higher elevations and to concentrate in lower areas of the waste mass surface causing temporary ponding of leachate. DPC has implemented the practice of constructing vertical leachate drains out of bottom ash in areas prone to ponding to more efficiently route leachate to the leachate collection system.

## 3.3 Final Cover System

Final grades at the Landfill consist of 4H:1V sideslopes from the high point to the top of the perimeter berm. The final grades, in conjunction with the final cover system and surface water management system, promote surface water runoff, effectively reducing infiltration of precipitation and thereby reducing the quantity of leachate generated.

As of January 2023, three final cover construction events have been completed. During each of the final cover construction events, an on-site quality assurance representative, working under the direction of a professional engineer licensed in the State of Wisconsin, observed the construction and completed compliance testing. A summary of the construction activities along with the results of the compliance testing have been submitted to the WDNR for review and approval. The final cover construction events have been approved by the WDNR, approval letters are included in **Appendix B**.

Per s. NR 504.12(4), a new or existing CCR landfill or lateral expansion of a CCR landfill shall be designed and constructed with a final cover system that meets the requirements under s. NR 504.07. A new or existing CCR landfill or a lateral expansion of a CCR landfill may also propose an alternative final cover system design in accordance with s. NR 504.10. The approved final cover system complies with the requirements for an alternative final cover system design.

### *3.3.1 Final Cover System Design*

In 2004, DPC submitted a Plan of Operation Modification (**Appendix J.1**) to modify the final cover presented in the conditional Plan of Operation approval. The final cover system presented the Plan of Operation Conditional Approval required the following:

- 2-foot soil barrier layer,
- GCL,
- 40 mil very flexible polyethylene (VFPE) geomembrane,
- 1-foot granular drainage layer,
- 1.5-foot general fill rooting layer, and
- 6-inch topsoil layer.

The 2004 Plan of Operation Modification presented a modified final cover system, which has been used in the previous three final cover construction events. This modified final cover system consists of the following components (from bottom to top):

- 2-foot moisture-conditioned and compacted “select” fly ash (i.e. mixture containing a minimum of 40 percent of the more reactive J.P. Madgett fly ash),
- 40-mil geomembrane,
- 1-foot-thick sand drainage layer,
- 1.5-foot-thick general soil cover layer, and
- 6-inch-thick topsoil layer.

The 2004 Plan of Operation Modifications was subsequently approved by the WDNR on March 4, 2004 (**Appendix B**). Both the Plan of Operation Approval final cover design and the modified final cover design are approved for use at the Landfill. If the Plan of Operation final cover design is used for future cover events, additional details pertaining to the cover system tie-in will be prepared. A plan modification will be prepared if alternate materials for the “select fly ash” layer need to be used or an alternative cover system is proposed.

The modified final cover system effectively utilizes the moisture-conditioned and compacted “select fly ash” as the capping layer/barrier layer in s. NR 504.07. As noted in the 2004 Plan of Operation Modification, ash mixtures of at least 40 percent JPM ash have resulted in a compacted hydraulic conductivity ranging from $1x10^{-9}$ cm/s to $8x10^{-7}$ cm/s; however, an assumed hydraulic conductivity of $1x10^{-6}$ cm/s was used as a conservative approach in the 2004 Plan of Operation Modification. The material has previously been used to construct low-permeability ash and ash-

slurry containment berms for the Phase I-III Landfills, and was found to be “extremely dense, durable, and have a low permeability once compacted and cured.” (TRC, 2004)

Percolation modeling via the HELP model was used to justify the performance of the modified final cover system and resulted in a similar efficiency as the final cover system presented in the Plan of Operation Approval. The use of the moisture-conditioned select fly ash along with the geomembrane was shown to provide comparable reductions in infiltration into the waste mass as s. NR 504.07(4) materials and provides a lower hydraulic conductivity than $1x10^{-5}$ cm/s or an effectively equivalent hydraulic conductivity as the base liner in accordance with s. NR 504.12(4)(b)(1-2).

The geomembrane component consists of a minimum 40-mil linear low density polyethylene (LLDPE) geomembrane that is placed in direct contact with the select fly ash material. Minimum geomembrane liner specifications are to comply with those presented in the CQA Plan (**Appendix G**). The geomembrane will be seamed with the previously installed geomembrane as to create a continuous seal and barrier over the final waste grades of the Landfill.

A drainage and rooting zone layer is included in the modified final cover system. The drainage system is included to provide lateral drainage away from the capping layer of the final cover system. The drainage layer is located immediately above the capping layer and consists of 1-foot of sand that has a minimum hydraulic conductivity of $1x10^{-3}$ cm/s. Previously utilized materials were obtained from off-site commercial sources and had hydraulic conductivity between $1.7x10^{-2}$ cm/s and $8.4x10^{-2}$ cm/s, meeting the minimum requirements in s. NR 504.07(6)(a). This is expected to continue for the remaining cover events. Demonstration that the surface water head on the final cover is contained within the drainage layer as required by s. NR 504.07(6)(a) is provided in **Appendix J.2**.

Surface water that enters the drainage layer will be collected in 4-inch-diameter perforated, corrugated polyethylene collection pipes located below diversion berms installed as part of the final cover system. The design of the drain pipe is provided in the Section 3.11.4 of Plan of Operation text excerpt included in **Appendix F.1**. Drawing details from the Plan of Operation are included in **Appendix F.2**.

The drain pipes are designed to be placed at a minimum 1 percent slope to an outlet pipe. The respective outlet for the drain pipes is dependent on its location on the final cover and is detailed in the provided text excerpt. The drain pipes will be constructed within a select aggregate fill pipe bed enveloped with a geotextile to mitigate migration of the sand drainage layer into the pipe bedding material.

The rooting zone layer is to be a minimum 1.5-foot thick, this in conjunction with the drainage zone meet the 2.5 foot thick drainage and rooting zone requirement in s. NR 504.07(6). The rooting zone will consist of general fill that is placed above the drainage layer. The general fill has previously been obtained from on-site sources. This is expected to continue for the remaining cover events. If insufficient volumes are available on-site then off-site commercial sources will be utilized.

The rooting zone will provide protection to the geomembrane, provide a rooting zone for vegetation, and protect the capping layer from freeze-thaw and desiccation. The drainage layer and rooting zone provide area for infiltration to occur and be managed prior reaching the capping

layers of the final cover system. In addition, this layer provides additional protection against erosion impacting the capping layer of the final cover.

A 6-inch topsoil layer, in accordance with s. NR 504.07(7), is located above the rooting zone. The topsoil has previously been obtained from on-site borrow sources for the previous final cover construction events. This is expected to continue for the remaining cover events. If insufficient volumes are available on-site then off-site commercial sources will be utilized. Following placement, the topsoil will be seeded, mulched, and fertilized, as required. Seed mixes have consisted of Minnesota DOT #35-221 (formerly Minnesota DOT #340) and a temporary grass mixture of Minnesota DOT #25-121 (formerly Minnesota DOT #240) applied at 1-2 pounds per 1,000 square feet. Fertilizer will be placed at the appropriate rate, per specifications, to establish dense, thick vegetative growth on the final cover.

This final cover design is generally consistent with the typical s. NR 504.07 final cover design and accommodates settling and subsidence. Additionally, DPC's practices of moisture conditioning ash prior to depositing it in the landfill and compacting the waste during placement help to create a dense and stable waste mass. These practices further ensure that the final cover will not be negatively impacted by differential settlement. The overall stability of the Landfill final cover system has been previously evaluated in the Plan of Operation, resulting in sufficient factors of safety. Though changes in the final cover design have occurred, the previous analysis included additional geosynthetic materials, making it a more critical section. In addition, interface stability analysis has been conducted as part of the previous final cover construction events and the factor of safety against internal sliding has ranged from 1.7 to 2.8 which exceed the minimum requirement of 1.3. The interface stability calculation from the 2A cover construction report is included in **Appendix J.3.** The global stability analysis from the Plan of Operation is provided in **Appendix F.7**.

### *3.3.2 Final Cover System Construction*

The final cover system will be constructed as specified in NR 504.07, the CQA Plan, Plan of Operation, subsequent Plan Modifications, and conditions from the WDNR. Construction will be generally consistent with the practices implemented during the previous final cover events. Installation of the geomembrane will be conducted in a similar fashion as detailed in Section 3.2.2.3. Below contains a summary of the construction of the final cover system, detailed information on the placement of the drainage layer, rooting zone, and topsoil is provided in Sections 4.6.5-4.6.8 of the 2000 Plan of Operation (**Appendix F.1**), and preparation of the condition select fly ash layer is detailed in the 2004 Plan of Operation Modification (**Appendix J.1**).

The conditioned and compacted ash layer will be placed in stages as the landfill filling progresses. The fly ash mixture containing a minimum of 40 percent JPM ash will be conditioned with 5 to 15 percent moisture and transported to the landfill where it will be placed, spread and compacted in maximum 12-inch-thick lifts to a minimum overall thickness of 2 feet. Once the conditioned and compacted ash layer is brought to final waste grades, the remaining portion of the final cover design will be placed.

Prior to geomembrane placement, the surface will be fine-graded and smooth drum-rolled and inspected. Field testing the ash component is not practicable as the material hardens as a low-permeability concrete-like mass as detailed in the 2004 Plan Modification. Therefore, operational

procedures that have historically been used to achieve the hydraulic conductivity properties will continue at the site.

Following certification of the select ash barrier layer, the geomembrane will be placed. Following a Plan Modification approval in 2011, the leak location testing requirement for final cover geomembranes was eliminated for future final cover construction events. The select granular fill will be placed as soon as practicable after geomembrane is installed to provide protection to the geomembrane. Geomembrane will be covered within 30 days following completion of geomembrane installation and quality assurance testing. Placement of the select granular fill will be consistent with the placement methods for the leachate collection drainage layer detailed in Section 3.2.3.1. Construction of the surface water drain pipes is detailed in Section 3.11.4 of the Plan of Operation (**Appendix F.1**). The rooting zone layer will be placed above the drainage layer in a single lift, followed by the topsoil layer.

Quality assurance testing will be completed as specified in the CQA Plan (**Appendix G**).

## 3.4 Storm Water Management System

Per 40 CFR 257.81 and s. NR 504.12(2), CCR landfills are required to have a storm water run-on control system that prevents flow onto the active portion of the CCR unit during the peak discharge from a 24-hour, 25-year storm event and a run-off control system from the active portion of the CCR unit to collect and control at least the water resulting from a 24-hour, 25-year storm event.

In addition, as a part of the initial permitting of the site, the Landfill was designed with a storm water management system to manage and convey stormwater at the site in accordance with s. NR 504.09. The design of the storm water system, as detailed in the Plan of Operation, is provided in Section 3.13 in **Appendix F.1**. Both temporary and permanent storm water system features were designed to a 100-year, 24-hour storm event (6.1 inches) at the time of the design in the Plan of Operation. This design rainfall event exceeds the current 25-year, 24-hour storm event (5.4 inches) as required by s. NR 504.12(2) and 40 CFR 257.81.

Designed run-on control features include diversion ditches, diversion berms, downslope flumes, sedimentation basins, culverts, and temporary controls. These features were designed to divert off-site surface water and on-site non-contact water away from the active fill areas. Permanent features are maintained at the site during operation and will be maintained throughout the post-closure period. These permanent features are constructed as liner and final cover construction progresses in order to continue to minimize off-site surface water from running onto the active portions the of the Landfill.

Designed run-off control features include the leachate handling system, in conjunction with cell delineation berms and perimeter berms. These features are used to limit contact surface water run-off from the active portions of the Landfill. This contact surface water is treated as leachate and is handled via the leachate collection and removal system.

The Run-on and Run-off Control System Plan details these features with respect to s. NR 504.12(2). The Run-on and Run-off Control System Plan is included in **Appendix K**.

# 4.0 Groundwater Monitoring System and Sampling Requirements

## 4.1 Regional Geology Summary

The site is located within the Western Upland physiographic region of South-Central Wisconsin adjacent to the Mississippi River (**Figure 1**). This area of Wisconsin was not glaciated during the most recent glacial advance and is known as the "Driftless Area" and is characterized by a significant amount of topographic relief. The facility is situated within a valley surrounded by steep slopes.

The thickness of unconsolidated soils beneath the Landfill ranges from approximately 15 to 60 feet. The predominant soil type includes fine- to coarse-grained silty sand, poorly graded sand with gravel, and/or poorly graded gravel with sand. The sandy soils range in thickness from 20 to 60 feet beneath the Landfill and are interpreted to be the result of fluvial deposition and in-situ weathering of underlying sandstone bedrock. In some areas beneath the Landfill, silts and clays ranging in thickness from a few feet to 40 feet overlie the sandy soils. The silt and clay soils were associated with loess deposits and, to a lesser degree, isolated lacustrine sediments.

Bedrock in the area is composed of the Prairie du Chien Group dolomite overlying Cambrian sandstone units. However, the Prairie du Chien group is absent beneath the Landfill due to erosion, so the sandy soil is directly underlain by Cambrian sandstone. The Cambrian sandstones were described as fine-grained, fissile, friable, and glauconitic with interbedded lenses of dark brown sandstone and calcareous shaley partings in boreholes performed during the Landfill's initial siting.

The uppermost aquifer beneath the Landfill resides in the sandy soil and the underlying Cambrian sandstone. The saturated thickness of the aquifer ranges from 10 to 20 feet in the sandy soil. The Cambrian sandstone in the region is estimated to be approximately 400 feet in thickness (Young and Borman, 1973). Well drilling logs (WGNHS 2003 and WDNR 2015) in the vicinity of the Landfill present sandstone thicknesses of 338 feet to 435 feet. Precambrian igneous and metamorphic rock underlies the Cambrian sandstone.

## 4.2 Groundwater Monitoring System

The current groundwater monitoring system consists of 14 monitoring wells and piezometers:

| Well | DNR ID | Type | Formation |
|---|---|---|---|
| W-42 | 17 | Water Table | Sand and gravel |
| P-42A | 18 | Piezometer | Sandstone |
| P-42B | 19 | Piezometer | Sandstone |
| W-100R* | 40 | Water Table | Sandstone |
| W-100AR* | 42 | Piezometer | Sandstone |
| W-101* | 23 | Water Table | Sandstone |
| W-101A | 24 | Piezometer | Sandstone |
| W-102R* | 44 | Water Table | Sandstone |
| W-102AR | 46 | Piezometer | Sandstone |

| Well | DNR ID | Type | Formation |
|---|---|---|---|
| W-104 | 27 | Water Table | Sandstone |
| W-104A | 28 | Piezometer | Sandstone |
| W-105* | 29 | Water Table | Sandstone |
| W-106* | 30 | Water Table | Sandstone |
| W-107* | 31 | Water Table | Sandstone |

Note:

* Designated as a CCR well.

Six water table monitoring wells and one piezometer are proposed for designation as CCR wells in accordance with NR 507.15(3). Three of the water table wells are upgradient (i.e. "background") wells (W-102R, W-101, and W-107). The four downgradient monitoring wells are W-100R, W-100AR, W-105, and W-106. Well locations are shown on **Figure 2**. Well construction information for the seven CCR wells is included in **Appendix L**.

The rationale for the selection of each monitoring point is discussed below:

- **Upgradient Monitoring Points** – Three upgradient water table monitoring wells (W-101, W-102R, and W-107) were selected to represent background groundwater quality. These three wells are completed in the sandstone bedrock.
- **Downgradient Monitoring Points** – Groundwater flow beneath the Landfill is generally to the south. Three water table wells (W-100R, W-105, and W-106), and one piezometer (W-100AR) are located downgradient of the Landfill, and each of these wells will be included in the CCR monitoring program. Wells W-100R and W-100AR are centrally located downgradient of the Landfill, with the majority of the groundwater channeled through the valley toward these points. Downward vertical gradients present in the aquifer support sampling in both shallow and deep portions of the aquifer using the W-100R/W-100AR well nest. Monitoring wells W-105 and W-106 are downgradient of the limits of existing or future waste placement.

## 4.3 Environmental Monitoring and Sampling Plan

### *4.3.1 Baseline Groundwater Monitoring*

Eight rounds of baseline groundwater monitoring were completed for each of the CCR wells between September 2015 and June 2017. This baseline monitoring included the parameters listed in NR 507 Appendix I, Tables 1A and 3, except for alkalinity, hardness, nitrate plus nitrite as nitrogen (nitrate+nitrite-N), copper, manganese, silver, zinc, field conductivity, and field temperature. Previous site sampling included alkalinity, hardness, nitrate+nitrite-N, and field conductivity. DPC is in the process of completing the required baseline groundwater monitoring for copper, manganese, silver, zinc, and field temperature in the CCR wells. At this time two rounds have been completed (10/26/2022 and 11/28/2022). Baseline groundwater monitoring results for these parameters will be submitted when the eight rounds have been completed. The baseline groundwater quality data from 2015 through 2017 are included in **Appendix M**.

### *4.3.2 Detection Groundwater Monitoring*

The current detection groundwater monitoring program includes analysis of groundwater samples collected semiannually from the 14 site monitoring wells and piezometers for field conductivity, field pH, field temperature, alkalinity, dissolved boron, hardness, sulfate, and dissolved selenium, and measurement of groundwater elevation. This meets the requirements of NR 507, Appendix I, Table 2, for non-CCR wells, except for chemical oxygen demand (COD). DPC requests that COD analysis not be required for non-CCR wells because it is not required at the CCR wells and COD analysis generates mercury laboratory waste.

For CCR wells, the parameters listed in NR 507 Appendix I, Table 1A, are required to be measured or analyzed on a semiannual basis. To meet this requirement, calcium, chloride, fluoride, and total dissolved solids (TDS) are proposed for addition to the detection monitoring program for the CCR wells. In addition, total boron rather than dissolved boron will be analyzed at CCR wells. The monitoring program is described in the Environmental Sampling and Analysis Plan included in **Appendix N**.

### *4.3.3 Applicable Standards*

Detection groundwater monitoring results for CCR wells, and if required, assessment monitoring results, will be compared to NR 140 standards, except for radium, which will be compared to the federal maximum contaminant level (MCL). In accordance with NR 140, well-specific PALs will be calculated for substances that do not have published NR 140 standards. In addition, well-specific alternative concentration limits (ACLs) will be calculated for substances whose background concentrations exceed published NR 140 standards.

#### 4.3.3.1 Indicator Parameters

Well-specific PALs were previously established for the site CCR wells in accordance with NR 140.20(2) for field conductivity, alkalinity (except at W-107), and hardness. These approved PALs are included in **Appendix B**. Additional well-specific PALs will be calculated in accordance with NR 140.20(2) for field pH, field temperature, alkalinity (at W-107), calcium, TDS, and lithium. Proposed PALs will be included in a future addendum when all baseline groundwater data have been collected.

#### 4.3.3.2 Alternative Concentration Limits

Well-specific ACLs were previously established for nitrate+nitrite-N at CCR wells W-100R, W-100AR, and W-107. These approved ACLs are included in **Appendix B**. ACLs were not required for nitrate+nitrite-N at the other CCR wells because background concentrations were less than the NR 140 PAL.

Based on a review of baseline groundwater data collected at the CCR wells between September 2015 and June 2017, the following substances were not detected in groundwater samples from the CCR wells at concentrations exceeding NR 140 standards, and therefore, ACLs are not required: boron, chloride, fluoride, sulfate, antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, lead, mercury, molybdenum, radium, selenium, and thallium. DPC is currently in the process of collecting baseline data at CCR wells for copper, manganese, silver, zinc. The need for ACLs for these substances will be assessed once eight rounds of baseline data have been collected.

### *4.3.4 Leachate Monitoring*

Leachate collected at the leachate tank will be monitored on a semiannual (March/September) basis for the parameters listed in NR 507, Appendix I, Table 4 for landfills accepting fly or bottom ash. DPC requests that COD analysis not be required for leachate samples because COD analysis generates mercury laboratory waste. The leachate tank will be sampled annually for semi-volatile organic compounds (NR 507, Appendix IV).

DPC will maintain records of leachate pumped. Leachate analytical results, volumes, and elevations will be reported to the WDNR on a semiannual basis. Results will be reported in accordance with NR 507.

# 5.0 Coal Combustion Residuals Plans

Per s. NR 514.045(1)(g), several operating plans are required to be included in the Plan of Operation Modification for CCR Landfill Initial Permitting. These plans include the following: Fugitive Dust Control Plan, Run-on and Run-off Control System Plan, Closure Plan, and Long-Term Care Plan (also known as a Post-Closure Plan). These are included in the appendices in their entirety and briefly summarized in the sections below.

## 5.1 Fugitive Dust Control Plan

Per s. NR 514.07(10)(a), the CCR Fugitive Dust Control Plan details the dust control measures the owner or operator will use to minimize CCR from becoming airborne at the facility. The Landfill published an Initial Fugitive Dust Control Plan on October 14, 2015, with the latest revision completed on December 30, 2022.

The fugitive dust control plan describes the dust control procedures for short-term CCR storage, the CCR landfill, and the facility roads. Short term storage management includes the use of CCR silos for backup storage of fly ash. Dust is controlled during the off-loading process by a filter system on the storage silos. In addition, when loading into trucks for placement in the Landfill, the CCR is conditioned (wetted) to reduce dusting. Use of covers and conditioning at the source location also assist in minimizing the generation of dust during transport.

In addition to conditioning the CCR material, additional measures are used (as applicable) during placement and operations to reduce dusting at the Landfill. These include reducing the active open areas to the extent practicable, wetting the CCR material during placement as needed, controlling dust during operations by spraying the working face, and stopping unloading operations when dust cannot be controlled.

Within the lined area of the Landfill, the use of generated leachate is proposed to be used for dust control in addition to pond water and river water. The use of leachate for this process was previously presented in the 2000 Plan of Operation. Care will be taken to monitor the spraying of leachate so that it does not leave the lined area of the Landfill.

The access road leading to the Landfill is paved with asphalt and access roads around the perimeter of the landfill are paved with crushed stone. Water is sprayed on the access roads during non-freezing weather conditions as needed to reduce airborne dust, no leachate or pond water will be utilized for this purpose. Paved roads are cleaned by a sweeper/vacuum truck as needed and trucks/vehicles are cleaned prior to leaving the Landfill area through the use of track out pads.

These dust control applications are typical for the industry and appropriate considering the conditions of the site. The applications are compatible with the current operations and can be initiated quickly to minimize and prevent fugitive dust at the site.

The Fugitive Dust Control Plan is provided in **Appendix O**.

## 5.2 Run-on and Run-off Control System Plan

A Run-on and Run-off Control System Plan was initially created for the Landfill in October 2016 with a 5-year revision completed in October 2021. The Run-on and Run-off Control System Plan was developed in accordance with 40 CFR 257.81, which is substantially consistent with s. NR 514.07(10)(b). Discussion of construction procedures and schedule of the run-on and run-off control system components is detailed below. As noted in Section 3.4, the storm water management system was designed to a 100-year, 24-hour storm event at the time of design. The design exceeds the current 25-year, 24-hour storm event required by s. NR 504.12(2)(a).

The run-on and run-off control system components are constructed incrementally as the Landfill is constructed and final cover is placed. The currently constructed components were built to the site specifications with construction oversight directed by a professional engineer licensed in the State of Wisconsin during the previous liner and final cover construction events. Construction documentation reports associated with these construction events were prepared, submitted to the WDNR, and approved by the WDNR (**Appendix B**). Because the timing of construction events is based on the filling rate of the Landfill, a definitive schedule for the construction of the system components is not practicable. Construction of these components will be consistent with the previous construction at the Landfill. These system components are summarized below:

- The run-on control system for the Landfill consists of perimeter berms, diversion berms, downslope flumes, ditching, sedimentation basins and culverts designed and constructed to control surface water during both the operational and post-closure periods of the Landfill. Run-on controls have been designed to divert off-site surface water away from the active fill areas. On-site water is routed to sedimentation basins, except surface water in contact with active fill areas which is treated as leachate.

  The run-on control system components are constructed incrementally during both the liner construction and final cover construction. Temporary systems are used at the limits of the construction event to assist in the run-on control system until the remainder of the component is completed. The entirety of the run-on control system components will not be completed until Cell 4B is constructed and final cover has been placed over the Landfill. With the construction of Cell 4B, the final sedimentation basin will be developed along with the remainder of the perimeter berms and ditches. Final cover system components (diversion berms, downslope flumes, etc.) will continue to be installed as the final cover is constructed.

- The run-off control system consists of the leachate collection and handling system in conjunction with cell delineation berms and perimeter berms designed to prevent contact surface water run-off from the active portions of the Landfill. Contact surface water is managed as leachate. The leachate collection system transfers leachate from the active cells to an underground leachate storage tank located near the ash processing facility, where it is transferred into tanker trucks and transported to a licensed wastewater treatment facility.

  The run-off control system components are constructed with the development of the individual landfill cell liners. The remaining portions to be constructed are associated with the leachate collection system located within Cells 4A and 4B.

The Run-on and Run-off Control System Plan is provided in **Appendix K**.

## 5.3 Closure Plan

The Closure Plan for the Landfill was created in October 2016 and revised in December 2022. The Closure Plan details how the Landfill will be closed and the steps required to close the Landfill while satisfying the regulations set forth by s. NR 514.07(10)(c), and applicable portions of s. NR 506.083. The Closure Plan is provided in **Appendix P**. Closure of the Landfill is briefly summarized below and detailed in Section 3.3 of this Plan Modification.

Closure of the Landfill will occur by leaving the waste in place. The Landfill will be closed using the composite final cover system as detailed in Section 3.3.1. This design was approved by WDNR in 2001 Plan of Operation Conditional Approval with a modified design approved through the 2004 Plan of Operation Modification (TRC, 2004). This design satisfies the final cover system requirements of s. NR 504.12(4).

The final cover will be installed in phases as portions of the Landfill reach the design top of waste grades. The largest of these phases is approximately 12.4 acres per the phasing plan presented in the 2000 Plan of Operation. Closure costs, updated in 2019, reflect this closure scenario.

The Landfill will be closed in a manner that controls post-closure infiltration of liquids into the waste, releases of waste, and leachate or contaminated run-off to groundwater or surface water and preclude the probability of impoundment of water, sediment, or slurry. Measures will be included that provide slope stability which will prevent movement of the final cover system during closure and post-closure. The closure of the Landfill will be completed within 6 months of commencing closure activities as required by s. NR 506.83(3). It is currently anticipated that that closure will be initiated in 2057, as detailed in the Closure Plan. This closure date is subject to change based on potential changes in volume of CCR accepted at the Landfill.

**Appendix P** includes the detailed description of the closure implementation as well as a detailed schedule estimate for completing closure once it is initiated. The closure schedule satisfies the requirements of s. NR 514.07(10)(c)(6).

## 5.4 Post-Closure Care Plan

A Post-Closure Care Plan (also known as a long-term care plan) was previously developed in October 2016 for the Landfill, and has been revised in conjunction with this Plan Modification. The Post-Closure Care Plan details the plans to maintain and monitor the Landfill after closure. The plan was revised to satisfy the requirements for the long-term care period of 40 years, per s. NR 506.084(2)(a). The plan covers the requirements for inspection, monitoring, maintenance, and post-closure use for the Landfill. The Post-Closure Care Plan satisfies the requirements set forth by s. NR 514.07(10)(d). The Post-Closure Care Plan is included in **Appendix Q.**

The long-term care cost estimate revised in 2019 has been updated following the revisions to chs. NR 500 to 520 for inclusion of the CCR monitoring requirements and is included in **Appendix R**.

# 6.0 Operations

General site operations to be employed for efficient site performance, in accordance with chs. NR 506, 507, and 514 were detailed it the 2000 Plan of Operation Section 5.

Per s. NR 514.07(10), the Plan of Operation will be updated every 10 years during the active life of the landfill to comply with regulations in place at the time of the update. These updates will be submitted to the WDNR as plan modifications.

In addition to those operating procedures currently initiated at the Landfill, DPC will also comply with the CCR related updates contained within ch. NR 506 and 507. These primarily include updated record keeping and inspection and reporting requirements for CCR Landfills.

## 6.1 Record keeping

Record keeping will be the responsibility of DPC and will be performed in accordance with s. NR 506.17(2). DPC will maintain a written operating record at their main office located at 3200 East Avenue South, La Crosse, WI 54601 throughout the operating life and long-term care period. The written operating record contains the plan of operation, plan modifications, construction documentation, department approvals, annual reports, inspection records, monitoring and corrective action records, notifications to the WDNR, and records of public comments received during a public comment period. These documents are placed in the written operating record as they become available and can be submitted to the WDNR if requested. Key landfill operations personnel working at the Alma Off-Site facility have electronic access to the written operating record.

In addition, DPC personnel will keep records of various activities and operations occurring at the site, including but not limited to performance of final cover, performance of scheduled maintenance activities, leachate quantities, and placement of final cover.

In addition to the written operating record, DPC also maintains a publicly accessible internet site titled “CCR Rule Compliance Data and Information.” (https://dairylandpower.com/ccr-rule-compliance-data-and-information). Information posted to the internet site is made available for at least 5 years following the date on which the information was first posted and is posted within 30 days from placing the information within the operating record. Following approval of this Plan Modification, this document will be placed on the internet site. Construction documentation for new/lateral expansions for the existing CCR landfill will be placed on the site once completed. In addition, the documentation detailed in s. NR 506.17(3)(d)(3-11) will be maintained on the internet site as applicable.

## 6.2 Notifications

Notifications as required by ch. 507 or 508 will be sent to the WDNR before the close of the business day that the notification is required to be completed. Other notifications required in ch. 506 will be sent to the WDNR within 30 days of placing the notification in the written operating record.

## 6.3 Inspections and Reporting

DPC inspects the Landfill on a weekly basis as required by s. NR 506.20(1), and after storm events when rainfall volumes exceed 1 inch within 24 hours. DPC completes inspections of the Landfill for appearances of actual or potential structural weaknesses or other conditions that may disrupt the operation or safety of the landfill. Fugitive dust inspections are detailed in the Fugitive Dust Control Plan (**Appendix O**). The results of the periodic inspections are logged in the electronic operating record at the Landfill and will be maintained for a period of at least 5 years. As required by 40 CFR 257.84(b), annual inspections by a professional engineer are and will continue to be completed at the Landfill. The inspection will be in accordance with 40 CFR 257.84(b) and s. NR 506.20(2).

An annual report will be developed for the Landfill prior to January 31 of each year. This report will include the annual fugitive dust control report, as detailed in **Appendix O**, the annual inspection report by a professional engineer, the annual groundwater monitoring and corrective action report, and the leachate pipe cleaning and inspection report as required by s. NR 506.07(5)(g).

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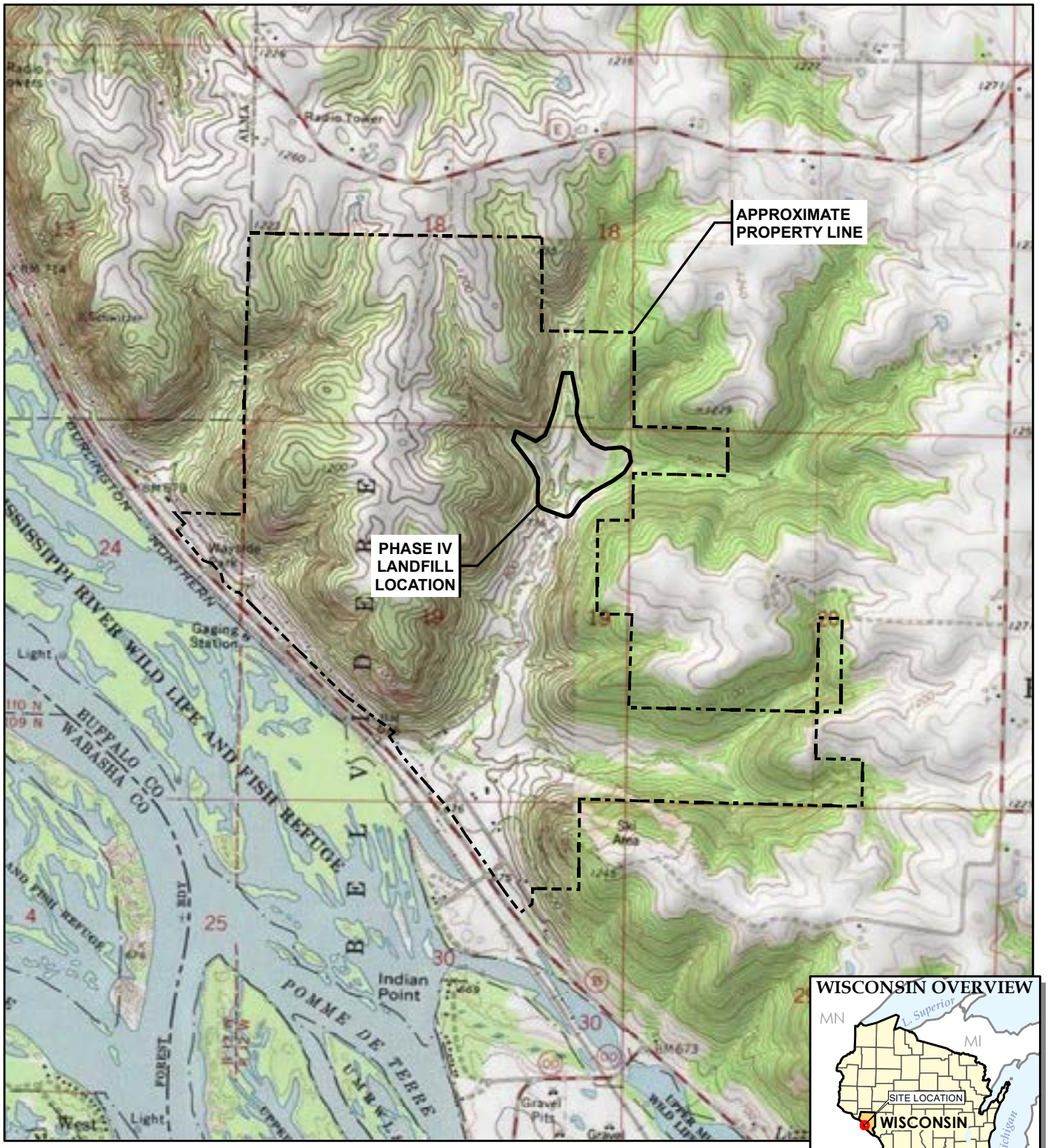


BASE MAP FROM USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE SERIES.

N

1 " = 2,000 '
1:24,000

0 2,000 4,000 FEET

TRC

708 Heartland Trail
Suite 3000
Madison, WI 53717
Phone: 608.826.3600

TRC - GIS

PROJECT:

**DAIRYLAND POWER COOPERATIVE**
**ALMA OFF-SITE DISPOSAL FACILITY, PHASE IV LANDFILL**
**BUFFALO COUNTY, WISCONSIN**

TITLE:

**SITE LOCATION MAP**

| | |
|---|---|
| DRAWN BY: | R. SUEMNICHT |
| CHECKED BY: | S. EDWARDS |
| APPROVED BY: | S. SELLWOOD |
| DATE: | JANUARY 2023 |
| PROJ. NO.: | 469888.0001 |
| FILE: | 469888-001slm.mxd |

**FIGURE 1**

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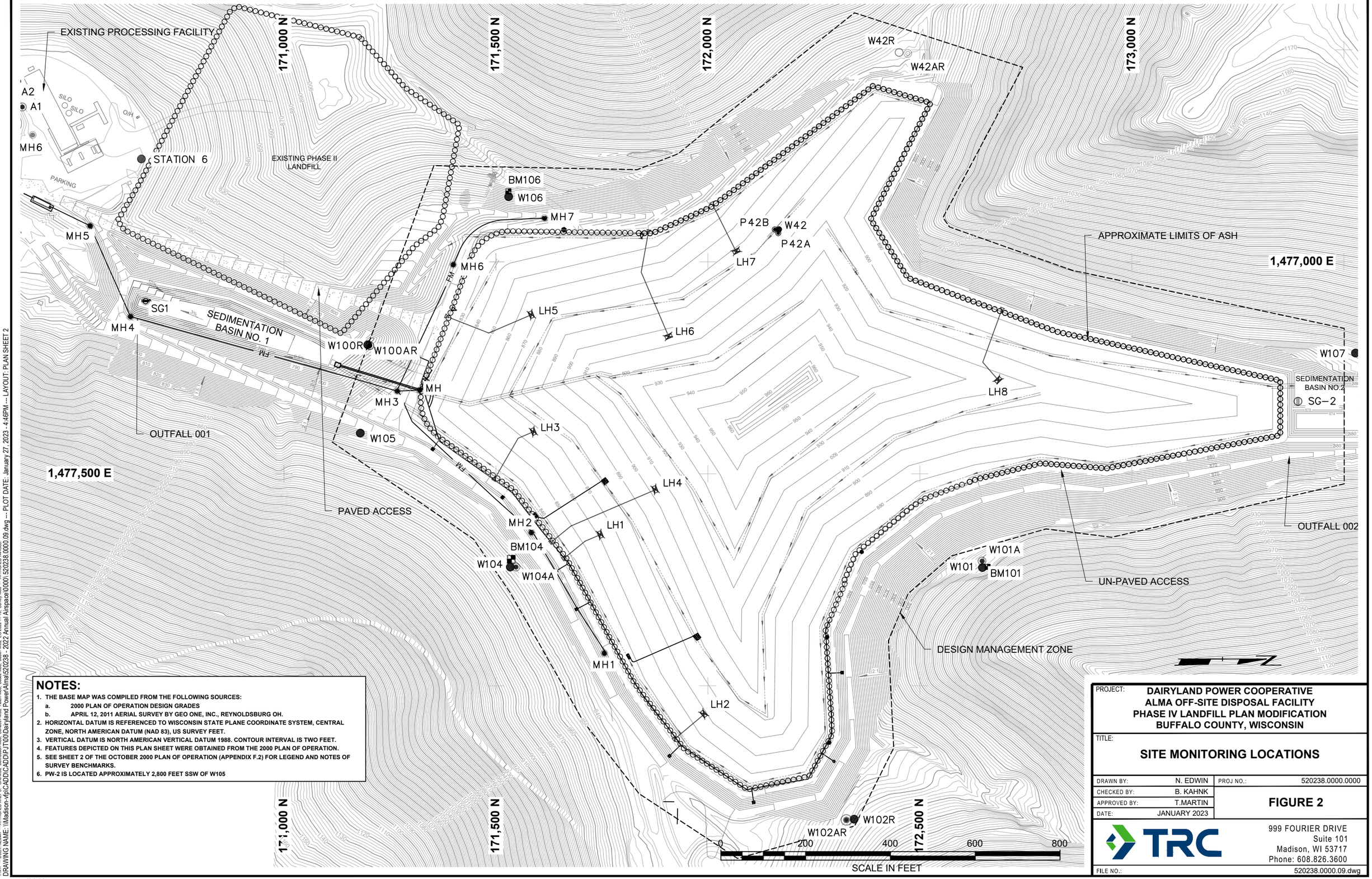



## NOTES:

1. THE BASE MAP WAS COMPILED FROM THE FOLLOWING SOURCES:
   a. 2000 PLAN OF OPERATION DESIGN GRADES
   b. APRIL 12, 2011 AERIAL SURVEY BY GEO ONE, INC., REYNOLDSBURG OH.
2. HORIZONTAL DATUM IS REFERENCED TO WISCONSIN STATE PLANE COORDINATE SYSTEM, CENTRAL ZONE, NORTH AMERICAN DATUM (NAD 83), US SURVEY FEET.
3. VERTICAL DATUM IS NORTH AMERICAN VERTICAL DATUM 1988. CONTOUR INTERVAL IS TWO FEET.
4. FEATURES DEPICTED ON THIS PLAN SHEET WERE OBTAINED FROM THE 2000 PLAN OF OPERATION.
5. SEE SHEET 2 OF THE OCTOBER 2000 PLAN OF OPERATION (APPENDIX F.2) FOR LEGEND AND NOTES OF SURVEY BENCHMARKS.
6. PW-2 IS LOCATED APPROXIMATELY 2,800 FEET SSW OF W105

PROJECT: DAIRYLAND POWER COOPERATIVE
ALMA OFF-SITE DISPOSAL FACILITY
PHASE IV LANDFILL PLAN MODIFICATION
BUFFALO COUNTY, WISCONSIN

TITLE: SITE MONITORING LOCATIONS

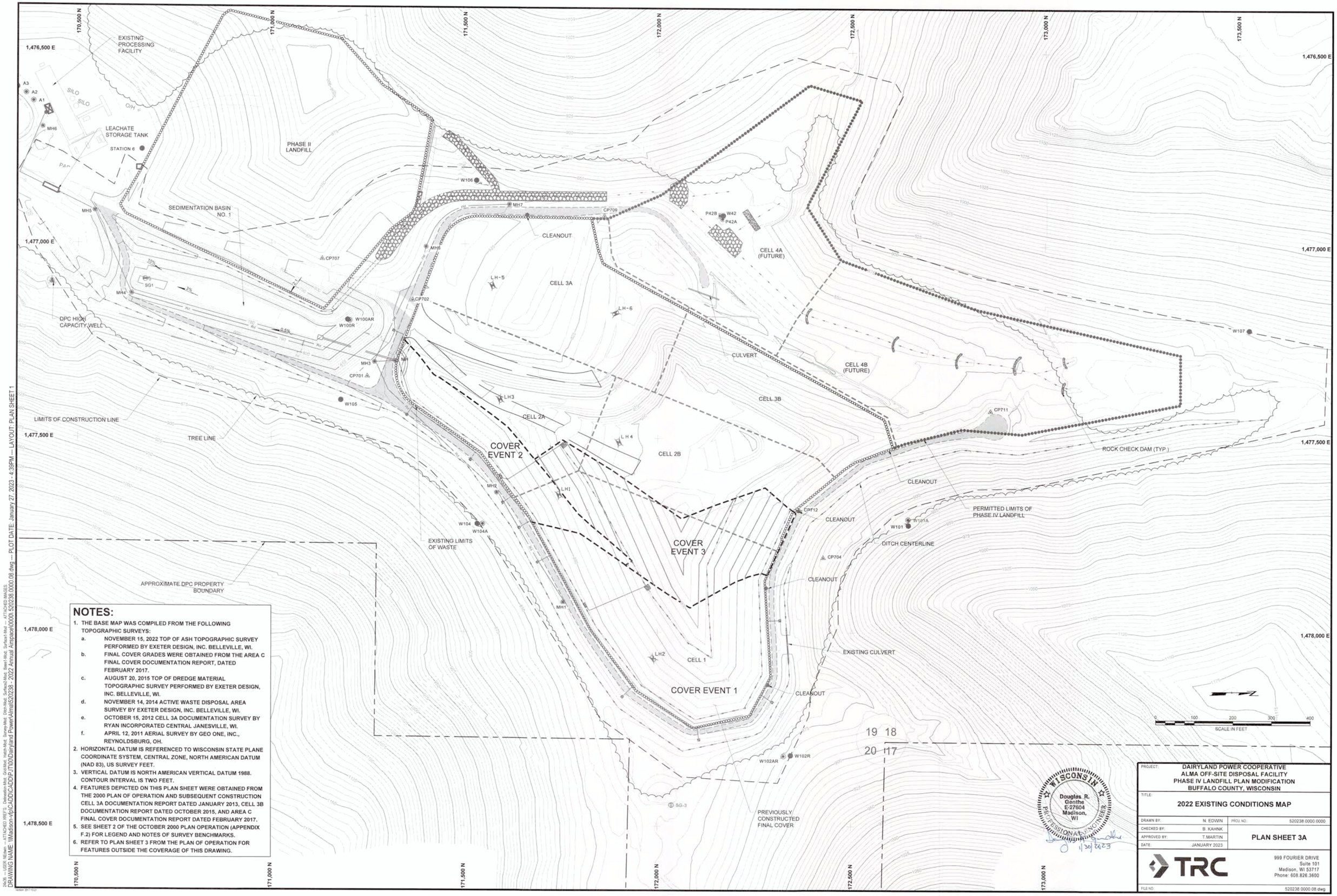
| | | | |
|---|---|---|---|
| DRAWN BY: | N. EDWIN | PROJ NO.: | 520238.0000.0000 |
| CHECKED BY: | B. KAHNK | | FIGURE 2 |
| APPROVED BY: | T.MARTIN | | |
| DATE: | JANUARY 2023 | | |

TRC
999 FOURIER DRIVE
Suite 101
Madison, WI 53717
Phone: 608.826.3600

FILE NO.: 520238.0000.09.dwg

11x17 - USER: NEdwin - ATTACHED XREFS: GeoMod; Datasets-Mod; Subpot-Mod; Hatch-Mod; Bapd-Mod; Bapd-Mod; EG 2022-11-15; Surveyed - ATTACHED IMAGES:
DRAWING NAME: \\Madison-sfp\CADD\CADD\PJT900\Dairyland Power\Alma\520238 - 2022 Annual Airspace\0000\520238.0000.09.dwg -- PLOT DATE: January 27, 2023 - 4:46PM -- LAYOUT: PLAN SHEET 2
Version: 2017-10-21

## Plan Sheet 3A: 2022 Existing Conditions Map




## NOTES:

1. THE BASE MAP WAS COMPILED FROM THE FOLLOWING TOPOGRAPHIC SURVEYS:
   a. NOVEMBER 15, 2022 TOP OF ASH TOPOGRAPHIC SURVEY PERFORMED BY EXETER DESIGN, INC. BELLEVILLE, WI.
   b. FINAL COVER GRADES WERE OBTAINED FROM THE AREA C FINAL COVER DOCUMENTATION REPORT, DATED FEBRUARY 2017.
   c. AUGUST 20, 2015 TOP OF DREDGE MATERIAL TOPOGRAPHIC SURVEY PERFORMED BY EXETER DESIGN, INC. BELLEVILLE, WI.
   d. NOVEMBER 14, 2014 ACTIVE WASTE DISPOSAL AREA SURVEY BY EXETER DESIGN, INC. BELLEVILLE, WI.
   e. OCTOBER 15, 2012 CELL 3A DOCUMENTATION SURVEY BY RYAN INCORPORATED CENTRAL JANESVILLE, WI.
   f. APRIL 12, 2011 AERIAL SURVEY BY GEO ONE, INC., REYNOLDSBURG, OH.
2. HORIZONTAL DATUM IS REFERENCED TO WISCONSIN STATE PLANE COORDINATE SYSTEM, CENTRAL ZONE, NORTH AMERICAN DATUM (NAD 83), US SURVEY FEET.
3. VERTICAL DATUM IS NORTH AMERICAN VERTICAL DATUM 1988. CONTOUR INTERVAL IS TWO FEET.
4. FEATURES DEPICTED ON THIS PLAN SHEET WERE OBTAINED FROM THE 2000 PLAN OF OPERATION AND SUBSEQUENT CONSTRUCTION CELL 3A DOCUMENTATION REPORT DATED JANUARY 2013, CELL 3B DOCUMENTATION REPORT DATED OCTOBER 2015, AND AREA C FINAL COVER DOCUMENTATION REPORT DATED FEBRUARY 2017.
5. SEE SHEET 2 OF THE OCTOBER 2000 PLAN OPERATION (APPENDIX F.2) FOR LEGEND AND NOTES OF SURVEY BENCHMARKS.
6. REFER TO PLAN SHEET 3 FROM THE PLAN OF OPERATION FOR FEATURES OUTSIDE THE COVERAGE OF THIS DRAWING.

WISCONSIN
Douglas R. Genthe
E-27604
Madison, WI
PROFESSIONAL ENGINEER
1/30/2023

| | |
|---|---|
| PROJECT: | DAIRYLAND POWER COOPERATIVE<br>ALMA OFF-SITE DISPOSAL FACILITY<br>PHASE IV LANDFILL PLAN MODIFICATION<br>BUFFALO COUNTY, WISCONSIN |
| TITLE: | 2022 EXISTING CONDITIONS MAP |
| DRAWN BY: N. EDWIN | PROJ. NO: 520238.0000.0000 |
| CHECKED BY: B. KAHNK | PLAN SHEET 3A |
| APPROVED BY: T.MARTIN | |
| DATE: JANUARY 2023 | |

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FILE NO: 520238.0000.08.dwg

24x36 -- USER: NEdwin -- ATTACHED XREF'S: Deliveration-Mod; Grid-Mod; Hatch-Mod; Survey-Mod; Ditch-Mod; Surface2-Mod; Base1-Mod; Surface1-Mod -- ATTACHED IMAGES:
DRAWING NAME: \\Madison-vfp\CADD\CADD\PJT00\Dairyland Power\Alma\520238 - 2022 Annual Airspace\0000\ 520238.0000.08.dwg -- PLOT DATE: January 27, 2023 - 4:39PM -- LAYOUT: PLAN SHEET 1
Version: 2017-10-21

# Appendix A: NR 504 and NR 514.045 Checklists

# NR 504 Checklist

# Design and Construction Criteria Completeness Checklist
# Chapter NR 504, Wis. Adm. Code

**Revised August 2022**

**Waste & Materials Management**
**P.O. Box 7921**
**Madison, WI 53707-7921**

Instructions: This checklist is intended for use by department staff for the review of landfill plan of operation, feasibility reports, or other submittals when determining completeness with respect to the requirements under ch. NR 504, Wis. Adm. Code. The checklist may also be used by applicants and submitted with a landfill plan of operation, feasibility report, or other applicable submittal to facilitate department review. Refer to applicable statues and codes for exact requirements.

General Information

Facility Name: Dairyland Power Cooperative - Alma Off-Site Disposal Facility

Facility Identification (FID) # _____

Facility Type: CCR Landfill

License/Monitoring # 4126

Submittal Type: Plan Modification - Initial Permitting for CCR Landfills

Initial Submittal: Date Received: ____/____/____ Completeness Due: ____/____/____ DNR Response: ____/____/____ (Complete: __ yes __ no)

Addendum # __ Date Received: ____/____/____ Completeness Due: ____/____/____ DNR Response: ____/____/____ (Complete: __ yes __ no)

| DESIGN & CONSTRUCTION CRITERIA REQUIREMENTS | COMPLETE? | | | LOCATION | COMMENTS |
|---|---|---|---|---|---|
| | Y | N | NA | | |
| **NR 504.04(3) LOCATIONAL CRITERIA.** Are the proposed limits of filling within: | | | | | |
| (a) 1,000 feet of any navigable lake, pond or flowage not including landfill drainage or sedimentation control structures?<br>__ yes _X_ no<br>__ If yes, was an exemption requested? | X | | | Not required to be submitted in NR 514.045 Plan of Operation Modification. Information previously provided in Feasibility Report(1997) and Plan of Operation(2000) and confirmed in Feasibility Report Determination Letter. | |
| (b) 300 feet of any navigable river or stream?<br>__ yes _X_ no<br>__ If yes, was an exemption requested? | | | | | |
| (c) A 100-year flood plain?<br>__ yes _X_ no<br>__ If yes, was an exemption requested? | | | | | |

Facility Name: _____

| DESIGN & CONSTRUCTION CRITERIA REQUIREMENTS | COMPLETE? | | | LOCATION | COMMENTS |
|---|---|---|---|---|---|
| | Y | N | NA | | |
| (d) 1,000 feet of the nearest edge of the right-of-way of any state trunk highway, interstate or federal aid primary highway or any public park or state natural area?<br>__ yes _X_ no<br>__ If yes, was a line of site study provided showing that the landfill would not be visible from the road, park or natural area through the use of screening and/or,<br>__ was an exemption requested?<br>Note: If waste may be visible for periods of time even with the use of screening, then an exemption should be requested. | X | | | Not required to be submitted in NR 514.045 Plan of Operation Modification. Information previously provided in Feasibility Report(1997) and Plan of Operation(2000) and confirmed in Feasibility Report Determination Letter. | |
| (e) 10,000 feet of the end of an airport runway designed or planned to be designed and used by turbojet aircraft or within 5,000 feet of any airport runway designed for and used by piston type aircraft?<br>__ yes _X_ no<br>Is FAA notification required?<br>__ yes _X_ no<br>Note: If the proposed limits of waste filling would be within 5 miles (for expansions of an existing MSW landfill) or within 6 miles (for new MSW landfills, after year 2000) of the end of the runway of any airport used by turbojet or piston type aircraft, the applicant must provide notice to both the Federal Aviation Administration (FAA) and the affected airport. The report should contain all correspondence related to the notices including any determinations made by the FAA.<br>(Ref. 49 U.S.C. § 44718(d), See FAA Advisory Circular AC 150/5200-34A, dated 1/26/2006) | | | | | |
| (f) 1,200 feet of any water supply well (i.e. public, private, irrigation or stock water supply wells)?<br>_X_ yes __ no<br>_X_ was an exemption requested?<br>If yes, have the following been provided for each identified well?<br>__ well location __ former and present well owner<br>__ well driller __ well construction log<br>Note: Exemptions may not be granted if the above information is not provided. | | | | Not required to be submitted in NR 514.045 Plan of Operation Modification. Information previously provided in Feasibility Report(1997) and Plan of Operation(2000) and exemption approved in Plan of Operations Approval Letter. | |
| (g) 200 feet of a fault that has had displacement in Holocene time?<br>__ yes _X_ no<br>__ If yes, was an exemption requested? | X | | | Section 2.2 | |
| (h) Seismic impact zones?<br>__ yes _X_ no<br>__ If yes, was an exemption requested? | X | | | Section 2.2 | |
| (i) Unstable areas?<br>__ yes _X_ no<br>__ If yes, was an exemption requested? | X | | | Section 2.2 | |
| **NR 504.04(4) PERFORMANCE STANDARDS.** Will the proposed landfill cause the following: | | | | | |

Facility Name: _____

| DESIGN & CONSTRUCTION CRITERIA REQUIREMENTS | COMPLETE? | | | LOCATION | COMMENTS |
|---|---|---|---|---|---|
| | Y | N | NA | | |
| (a) A significant adverse impact on wetlands?<br>__ yes X no<br>Has a practicable alternatives analysis and a wetland functional values analysis been completed in accordance with ch. NR 103, if a wetland will be affected by the proposed landfill or any noncommercial soil borrow source activity?<br>Note: See DNR wetland regulation website (https://dnr.wisconsin.gov/topic/Wetlands/permits) to help determine if a wetland permit may be needed per s. 281.36, Stats. | X | | | Section 2.1 | |
| (b) A take of an endangered or threatened species in accordance with s. 29.604, Stats?<br>__ yes X no | X | | | Section 2.1 | |
| (c) A detrimental effect on any surface water?<br>__ yes X no<br>Note: Exemptions are not granted. | X | | | Section 2.1 | |
| (d) A detrimental effect on groundwater quality or will cause or exacerbate an attainment or exceedance of any preventive action limit or enforcement standard at a point of standards application as defined in ch. NR 140?<br>__ yes X no<br>__ Has an exemption been requested to the groundwater standards in accordance with ss. NR 507.29 and NR 140.28, Wis. Adm. Code? If an exemption is required, does the feasibility report include:<br>__ A list of the specific wells and parameters for which an exemption is being requested.<br>__ A discussion of how the criteria listed in s. NR 140.28(2), (3) and (4) are met. | X | | | Not required to be submitted in NR 514.045 Plan of Operation Modification. Information previously provided in Feasibility Report(1997) and Plan of Operation(2000) and confirmed in Feasibility Report Determination Letter. | |
| (e) The migration and concentration of explosive gases in excess of 25% of the lower explosive limit for such gases at any time?<br>__yes X no | | | | | |
| (f) The emission of any hazardous air contaminant exceeding the limitations for those substances contained in s. NR 445.04 or 445.05?<br>__ yes X no | | | | | |
| **NR 504.05 GENERAL DESIGN AND CONSTRUCTION CRITERIA.** | | | | | |
| (1) Is the landfill designed in substantial conformance with the design criteria in ss. NR 504.06 to 504.09? | X | | | Section 3.0 | |
| (2) Is supporting justification included for any differences from ss. NR 504.06 to 504.09? | X | | | Not required to be submitted in NR 514.045 Plan of Operation Modification. Information previously provided in Feasibility Report(1997) and Plan of Operation(2000) and exemption approved in Plan of Operations Approval Letter. | |
| (3) Is the proposed operating life of the landfill between 10 and 15 years? | | | X | | |
| If the proposed life is not between 10-15 years is the facility exempted in s. 289.28(2), Stats. or the expansion of an existing facility? | | | | | |
| **NR 504.06 MINIMUM DESIGN AND CONSTRUCTION CRITERIA FOR LANDFILL LINERS AND LEACHATE COLLECTION SYSTEMS.** | | | | | |
| (1) GENERAL. | | | | | |

Facility Name: _____

| DESIGN & CONSTRUCTION CRITERIA REQUIREMENTS | COMPLETE? | | | LOCATION | COMMENTS |
|---|---|---|---|---|---|
| | Y | N | NA | | |
| (a) If the landfill is proposed to accept municipal solid waste does the design incorporate a composite liner and a leachate collection system capable of limiting the average leachate head on the composite liner to 1 foot or less during operation and after closure of the landfill? | | | X | | |
| Does the composite liner consist of the following:<br>_X_ An upper geomembrane component with nominal 60-mil minimum thickness<br>__ A lower component of 4 foot minimum compacted clay meeting NR 504.06(2)(a) | X | | | Alternative liner was submitted and approved in Plan of Operation Conditional Approval. | |
| (2) COMPOSITE OR CLAY LINED LANDFILLS. Does the composite liner or clay liner design meet the following requirements: | | | | | |
| (a) Will all clay used in liner construction meet the following specifications:<br>__ A minimum of 50% by weight passing 200 sieve<br>__ A saturated hydraulic conductivity of $1x10^{-7}$ cm/sec or less<br>__ An average liquid limit of 25 or greater with no values less than 20<br>__ An average plasticity index of 12 or greater with no values less than 10 | | | X | Section 3.2.2 | GCL liner is used at the Landfill. |
| (b) Is there at least a 10 foot separation between the seasonal high groundwater table and the bottom of the clay liner component?<br>Note: For zone of saturation landfills select NA. | X | | | Section 3.2.1 | |
| (c) Is there at least a 10 foot separation between the bedrock surface and the bottom of the clay liner component? | X | | | Section 3.2.1 | |
| (d) Is there a minimum 2% liner surface slope toward the leachate collection system? | X | | | Section 3.2.2 | |
| (e) Is there a minimum 4 foot thick clay component of a composite liner or a minimum 5 foot clay liner thickness? | | | X | Alternative liner was submitted and approved in Plan of Operation Conditional Approval. Installation of the low permeability layer is designed/ was constructed in accordance with NR 504.07 and the Construction Quality Assurance Plan. | |
| (f) 1. Are the clay layers proposed to be constructed in the following manner:<br>__ Lift heights no greater than 6 inches after compaction<br>__ Footed compaction equipment having feet at least as long as the loose lift height<br>__ Disking or mechanical processing of clay to break up clods and adjust moisture<br>__ Clod size no greater than 4 inches<br>__ All compaction equipment to have a minimum static weight of 30,000 pounds<br>__ Alternative procedures or equipment proposed | | | X | | |
| 2. A sufficient number of equipment passes to ensure complete remolding of clay? | | | X | | |
| 3. Is clay compaction proposed to be 90% modified Proctor density at 2% wet of the optimum or 95% standard Proctor density at wet of the optimum moisture content? Alternately, the line of optimums method may be used. | | | X | | |
| (g) Are interior sidewall slopes at a maximum of 3H:1V or at a minimum of 5H:1V? | X | | | Section 3.2.1 | |
| (h) Are clay components of the liner in adjacent phases keyed together? | | | X | | |

Facility Name: _____

| DESIGN & CONSTRUCTION CRITERIA REQUIREMENTS | COMPLETE? | | | LOCATION | COMMENTS |
|---|---|---|---|---|---|
| | Y | N | NA | | |
| Is the keying accomplished by excavating a minimum of 4 steps with a total width of spliced area measuring at least 15 feet? | | | X | | |
| (3) COMPOSITE-LINED LANDFILLS. If the landfill is composite lined, are the following requirements specified in the plan of operation: | | | | | |
| (a) Is the geomembrane specifically formulated for waste containment purposes? | X | | | Section 3.2.2.3 | |
| Is the nominal geomembrane thickness 60 mil or greater with no thickness below minimum industry accepted manufacturing tolerances? | X | | | Appendix F<br>Appendix G | |
| (b) Is there geomembrane protection along areas of traffic or concentrated activity such as sumps, sideslope risers and entry ramps? | X | | | | |
| (c) For slopes in excess of 10%, will geomembrane panels be installed with panel seams perpendicular to the contour lines of the slope? | X | | | | |
| (d) Prior to geomembrane placement, will the clay surface be prepared as follows:<br>X Rolling and grading of clay surface to remove irregularities, protrusions, loose soil and abrupt changes in grade,<br>X Free of stone, grading stakes, construction debris and contain no areas softened by high water content<br>X Sufficiently dry and dense clay surface such that the construction equipment will not create ruts<br>X Depressions and large cracks filled with tamped clay | X | | | | |
| (e) Will the geomembranes be welded as follows:<br>X Geomembrane panels welded by double-tracked, fusion welding machines for all linear seams,<br>X Fusion welding of corners, butt seams and long repairs where possible,<br>X Extrusion or fusion welding for all other repairs, detail work and patches,<br>X Request for Department approval for other welding methods. | X | | | | |
| (f) Will geomembrane components in adjacent phases be welded together to form a continuous geomembrane surface? | X | | | | |
| Will the liner extended beyond the proposed edge of waste at a phase junction be protected from traffic and weather? | X | | | | |
| (g) Will wrinkles which are taller than they are wide be smoothed or cut out prior to covering with soil? | X | | | Section 3.2.3.1 | |
| Will guidance be provided to machine operators placing soil on geomembrane by the use of an observer with an unobstructed view of the advancing lift of soil. | X | | | | |
| (h) Are the following minimum soil thickness on geomembrane proposed before vehicular traffic may occur:<br>X 1 foot for vehicles with ground pressure less than 5 pounds per square inch,<br>X 2 feet for other vehicles equipped with tracks and floatation tires,<br>X 3 feet or more for trucks or wheeled hauling equipment. | X | | | | |

Facility Name: _____

| DESIGN & CONSTRUCTION CRITERIA REQUIREMENTS | COMPLETE? | | | LOCATION | COMMENTS |
|---|---|---|---|---|---|
| | Y | N | NA | | |
| (i) In order to lessen desiccation effects, will the landfill base and the lower 10 feet of the sideslope be covered with a drainage blanket within 30 days after completing quality control and quality assurance testing? | X | | | Section 3.2.3.1 | |
| Will the remaining sideslope be covered with either drainage material or geotextile to prevent damage to the geomembrane? | X | | | Section 3.2.3.1/App G | |
| (j) Will placement of soil over the geomembrane be performed during cooler temperature periods to the extent possible using methods which minimize wrinkling? | X | | | Section 3.2.3.1 App G | |
| (k) Will anchor trenches be designed and constructed around the landfill to secure the permanent edges of the geomembrane? | X | | | Section 3.2.2.3/App G | |
| Will geomembrane be seamed completely to the edge of the panel end to minimize potential of tear propagation? | X | | | Appendix F Appendix G | |
| (4) ZONE-OF-SATURATION LANDFILLS. Landfills with proposed base grades below the groundwater table must meet the following: | | | | | |
| (a) Is the landfill located in a fine-grained soil environment? | | | | Not required to be submitted in NR 514.045 Plan of Operation Modification. Information previously provided in the Plan of Operation(2000) and confirmed in Plan of Operation Conditional Approval Letter. | |
| (b) Does the landfill meet the requirements of sub. (2)(a), (d), (e), (f), (g) and (h) and the requirements under sub. (3), if the landfill will accept municipal solid waste? | | | | | |
| (c) Has an analysis been performed on the effect which groundwater may have on uplift of the liner and the short and long-term stability of the geomembrane component? | | | | | |
| Does the analysis evaluate the effect of an underdrain or other dewatering system? | | | | | |
| (d) Have borings, backhoe pits or other means of exposing the subsurface soils been proposed on a 100-foot grid to a minimum 5 foot depth below the subbase grades of the liner? | | | | | |
| Are all granular or silty soils detected within this 5 foot depth proposed to be removed? | | | | | |
| (5) LEACHATE COLLECTION SYSTEMS. The leachate collection system must incorporate the following design features: | | | | | |
| (a) Does the leachate collection system design include the following features:<br>X A leachate collection system included in each horizontal phase,<br>X Leachate routed to the landfill perimeter in the most direct manner possible,<br>X Limit average leachate head on the liner to 1 foot or less,<br>__ Limit maximum leachate flow distance to the perforated collection pipe to 130 feet. | X | | | Section 3.2.3<br><br>Appendix F Appendix G | Exemption request for the maximum leachate flow distance was approved in the 2001 Plan of Operation Conditional Approval |
| (b) Is the slope on the leachate collection pipe a minimum of 0.5%? | X | | | | |
| (c) Is the minimum diameter of all leachate collection pipes 6 inches? | X | | | | |

Facility Name: _____

| DESIGN & CONSTRUCTION CRITERIA REQUIREMENTS | COMPLETE? | | | LOCATION | COMMENTS |
|---|---|---|---|---|---|
| | Y | N | NA | | |
| Are all collection pipes proposed to be Schedule 80 PVC pipe or an approved substitute? | X | | | Section 3.2.3 | HDPE piping used for leachate collection. |
| (cm) Are the proposed pipe fittings for use with PVC and HDPE pipe secured to the leachate collection pipe as follows:<br>__ PVC fittings and pipe solvent-welded<br>_X_ HDPE fittings and pipe fusion welded | X | | | Appendix F<br>Appendix G | |
| (d) Do the leachate collection trenches conform to the following:<br>__ Rectangular leachate collection trenches for clay liners<br>_X_ V-trenches with a maximum 18 inches depth and 3H: 1V sideslope for composite liners<br>__ V-trenches smooth-drum rolled prior to placement of the membrane | X | | | | |
| (dm) _X_ Is a geotextile with a weight of 12 oz/yd$^2$ used to line the trench base and sidewalls and is it placed directly over the geomembrane<br>_X_ Does the design show that the geotextile does not overlap across the top of the trench.<br>_X_ Are the geotextile specifications, including manufacturer's data for grab and puncture strength, used to demonstrate the resistance to damage from the aggregate to be placed over the geotextile? | X | | | | |
| (e) Does the leachate collection pipe trench backfill conform to the following:<br>_X_ Uniformity coefficient of less than 4,<br>_X_ Maximum particle diameter of 1 ½ inches,<br>_X_ Maximum of 5% passing the number 4 sieve,<br>_X_ Rounded to subangular gravel,<br>_X_ Minimum 4 inches bedding depth before installation of leachate pipe,<br>_X_ Minimum 6 inches of granular material above the pipe, and an additional 12 inches of material mounded above the trench,<br>_X_ Graded soil filter or geotextile to minimize migration of drainage blanket into the trench, in cases where particle size of the bedding is significantly less than the collection trench bedding<br>_X_ No use of limestone and dolomite as trench backfill.<br>__ If limestone and dolomite are proposed for use as trench backfill, does the plan of operation address that there is no other suitable material reasonably available? | X | | | | |
| (f) Have the sand and gravel sizes and geotextile and pipe openings been analyzed for the control of piping of soil materials and have the materials been chosen to achieve a stable and self-filtering structure under all conditions of leachate flow? | X | | | Appendix F and I | |
| (g) Do leachate collection lines have cleanout access on both ends of pipes? | X | | | | |
| Does each leachate collection line have a maximum distance of 1,200 feet from the end of one cleanout to the toe of the opposite slope? | X | | | | |

Facility Name: _____

| DESIGN & CONSTRUCTION CRITERIA REQUIREMENTS | COMPLETE? | | | LOCATION | COMMENTS |
|---|---|---|---|---|---|
| | Y | N | NA | | |
| (h) Are there no vertical liner penetrations due to leachate lines, manholes and other engineering structures? | X | | | Section 3.2.3 | |
| For clay lined landfills, are liner penetrations limited to leachate transfer lines in the horizontal direction only?<br>For composite lined landfills, are there no liner perforations? | | | X | Appendix F | Exemption request for horizontal perforations approved in 2001 Plan of Operation Approval Letter. |
| (i) Is a 4'x4', 5 foot thick, anti-seep collar placed around any leachate transfer line penetrating the clay liner? | | | X | | Composite Liner; alternative anti-seep collar used. |
| (j) Is the composite lined landfill designed with a sump and sideslope riser meeting the following requirements:<br>__ 1. Sump volume and pump capacity sized to accommodate an annual leachate collection rate of 6 inches taking into account the potential for solids to build up over time.<br>__ 2. Sump base protected with polyethylene plate or other acceptable means and placed prior to sideslope riser and backfill installation.<br>__ 3. Leachate discharge pipe between the sideslope riser and the tank installed with valves to prevent backflow into the waste disposal area.<br>__ 4. Sideslope riser pipe has a minimum diameter of 18 inches and geometry at the junction of the sump and sidewall to assure passage of the pump and hardware and assure correct positioning of the intake of the pump.<br>__ 5. The area of the sump and depth of gravel fill are sized to allow remedial installation of access and hardware for removal of leachate if the sideslope riser and pump system fail. | | | X | | Transfer liner horizontally penetrate composite liner and are routed to the leachate storage tank. |
| (k) Are gravity lines transporting leachate out of the landfill constructed with valves for flow control, and are the valves compatible with the leachate and operable from the ground surface? | | | X | | |
| (l) Are all leachate lines located outside the landfill double-cased or in an approved secondary containment? | | | X | | Transfer lines were previously constructed. |
| Are all leachate transfer lines proposed to be pressure tested prior to use? | | | X | | |
| Is the upslope end of secondary pipe sealed and the downslope end open to drain into the manhole? | | | X | | |
| (m) Are all leachate transfer lines, manholes, lift stations and other structures outside the waste limits designed to meet the following:<br>_X_ Designed as shallow as practical, and as far from the waste limits as possible so repair of these devices would not infringe on the landfill cover or liner systems<br>_X_ Constructed above the seasonal high groundwater table.<br>__ If not constructed above the water table, is it not technically feasible to do so and does the design meet the requirements of (l) above. | | | X | | |

Facility Name: _____

| DESIGN & CONSTRUCTION CRITERIA REQUIREMENTS | COMPLETE? | | | LOCATION | COMMENTS |
|---|---|---|---|---|---|
| | Y | N | NA | | |
| (n) Are leachate collection tanks and manholes designed with the following:<br>__ Secondary containment to prevent leachate discharge to ground and surface water<br>__ Means to monitor the tank or manholes for leaks within the secondary containment<br>__ If no, is an alternative method proposed? | | | X | Section 3.2.3<br><br>Appendix F | Leachate collection tank was previously constructed. |
| (o) Are the leachate tanks designed to:<br>__ Contain leachate volume generated over a 4 day period,<br>__ Withstand the soil and liquid loads encountered during installation and use<br>__ Follow the consultant and manufacturer installation instructions. | | | X | | |
| (p) Does the leachate loadout station design contain the following:<br>__ Measures to prevent accidental leachate discharge at the loadout from entering ground or surface water,<br>__ A loadout station paved and sloped to a catch basin to direct all spills to a catch basin. | | | X | | |
| (q) Are leachate and gas system manholes and enclosures vented and do they have controlled access? | X | | X | | Gas system was not designed as Landfill does not produce Gas |
| For landfills designed with active extraction, are manholes and enclosures designed to minimize air intrusion? | | | X | | |
| (r) Are all pumps, valves and meters designed to be controlled and operated from ground surface? | X | | | | |
| (s) Are all leachate and groundwater collection systems designed to monitor the liquid volume removed? | X | | | | |
| (t) Is there a minimum one foot thick granular drainage blanket placed on top of the geomembrane for a composite liner or on top of the clay component of a clay liner which contains the following elements:<br>_X_ no more than 5% passing 200 sieve<br>_X_ If the granular layer contains gravel greater than ¼ “, a certified needle free minimum 12 oz/yd$^2$ nonwoven geotextile below the drainage blanket | X | | | | |
| (tm) _X_ Hydraulic conductivity (at anticipated field density) equal to or greater than 1 cm/sec for sites that accept any amount of MSW or 1x10$^{-2}$ cm/sec for landfills that do not accept MSW<br>_X_ Was the gradation of the drainage blanket (and associated hydraulic conductivity) selected to maintain the maximum head in the drain within the drain thickness? | X | | | | |
| (u) If the major horizontal clay lined phase is above the saturated zone, is each phase designed with collection basin lysimeter (except for composite lined landfills)? | | | X | | Site includes a composite liner. |

Facility Name: _____

| DESIGN & CONSTRUCTION CRITERIA REQUIREMENTS | COMPLETE? | | | LOCATION | COMMENTS |
|---|---|---|---|---|---|
| | Y | N | NA | | |
| (6) ADDITIONAL REQUIREMENTS FOR LANDFILLS WITH EXTENDED COLLECTION LINES. Landfills with leachate collection lines that exceed 1,200 feet and will accept MSW must meet the following: | | | | | |
| (a) Do any leachate collection lines exceed 1,200 feet when measured from the end of each cleanout to the toe of the opposite slope?<br>Will the landfill accept MSW?<br>If no, check NA for (b) through (f) below. | | | X | | Maximum collection line route to cleanout riser does not exceed 1,200 feet. |
| (b) Is the maximum length of each leachate collection line 2,000 feet or less from the access point at one end to the toe of the opposite slope? | | | X | | |
| (c) Is the slope on the leachate collection pipe a minimum of 0.5% after accounting for primary and secondary settlement of the subgrade?<br>Note: The minimum design slope is selected following computation of 100% of the primary and secondary consolidation settlement beneath the facility, which includes, as applicable, in-situ soil, added geologic material structural fill material, and compacted clay liner. Secondary settlement shall be calculated using a 100-year timeframe. | | | X | | |
| (d) Is the pipe bedding material composed of course, uniform gravel with hydraulic conductivity greater than or equal 1 cm/sec?<br>Note: This requirement is in addition to meeting the other requirements of s. NR 504.06(5)(e). | | | X | | |
| (e) Has the maximum anticipated construction, operation and post-closure overburden loads over the leachate collection piping been calculated and used in selecting pipe material and wall thickness?<br>__ Were the calculations based on a 6 inch pipe diameter and appropriate in-field consolidated density? | | | X | | |
| (f) Have all components of the leachate collection system incorporated the following design features:<br>__ prefabricated or smooth sweep bends with a minimum radius of 10 pipe diameters<br>__ pipe alignments that minimize horizontal and vertical alignment changes for the entire pipe length<br>__ elimination or minimization of obstructions which impose drag on pipe cleaning jetter hose or nozzles | | | X | | |
| (7) COMPOSITE-LINED LANDFILLS USING GCLs. | | | | | |
| Is GCL proposed for use in a composite liner?<br>If no, indicated NA for the following and (a) – (c). | x | | | Section 3.2.2 | |
| Does the landfill accept only non MSW waste?<br>Or if it accepts MSW will the GCL be placed over the 4 foot clay liner?<br>If yes to either, the design must meet the requirements of (a) – (c).<br>If no to both, then GCL may not be used as proposed. | X | | | Section 3.1 | |
| (a) Has the hydraulic performance of the GCL been assessed by use of compatibility testing? | X | | | Section 3.2.2<br>Appendix H | |

Facility Name: _____

| DESIGN & CONSTRUCTION CRITERIA REQUIREMENTS | COMPLETE? | | | LOCATION | COMMENTS |
|---|---|---|---|---|---|
| | Y | N | NA | | |
| (b) Does the GCL meet the specifications of NR 504.07(4)(a)1 to 11? | X | | | Section 3.2.2 | |
| (c) Is the GCL underlain by a soil barrier layer a minimum 2 feet thick and meets the specifications of NR 504.07 (4)(a) 12. To 17. | x | | | Appendix F,G | |
| **NR 504.07 MINIMUM DESIGN AND CONSTRUCTION CRITERIA FOR FINAL COVER SYSTEMS.** | | | | | |
| (1) GENERAL. | | | | | |
| (a) Is the final cover system designed to?<br>_X_ Minimize leachate generation by limiting the amount of percolation through the cap<br>_X_ Reduce landfill maintenance by design of compatible surface slopes and vegetation<br>_X_ Account for differential settlement and other stresses on the capping layer<br>_X_ Minimize freeze-thaw effects and desiccation of clay capping layer<br>_X_ Provide for removal of leachate and venting of gas from landfills accepting wastes with high moisture content or that which is readily biodegradable | X | | | Section 3.3<br>Appendix F<br>Appendix J | |
| (b) Does the final cover system meet the requirements of subs. (2) to (9) below unless it is established (to the satisfaction of the department) that portions of final cover system are not needed based on proposed waste type and design? | X | | | Section 3.3<br>Appendix F<br>Appendix J | Alternative final cover previously approved. |
| Is the geomembrane component included in the final cover design unless this is proposed to be an exclusively high volume industrial, or other landfill that does not accept municipal solid waste and is not composite lined? | X | | | | |
| (c) If the landfill is designed with a composite liner, is it also designed with a final cover system meeting subs. (2) to (9) below? | X | | | | Alternative final cover previously approved. |
| (d) Does the landfill accept papermill sludge or other industrial solid wastes with high water contents and low strength?<br>Will the strength of the waste prohibit the type of cover system specified in this section (subs. (2) to (9))?<br>If yes, an alternate final cover system may be proposed. | | | X | | |
| (2) GRADING LAYER. | | | | | |
| If this is a municipal solid waste landfill, does the design include a 6 inch grading layer above the final waste elevation? | | | X | | CCR landfill |
| (3) SUPPORT LAYER AND LOW-STRENGTH WASTES. | | | | | |
| If the landfill accepts industrial wastes with high water content and low strength, does the design include a support layer for stabilization, reinforcement and removal of leachate and gas? | | | X | | |
| (4) CLAY CAPPING LAYER. | | | | | |
| __ Does the landfill design include a two foot clay cap that meets the specification of NR 504.06(2)(a) listed below?<br>__ A minimum of 50% by weight passing 200 sieve | | | X | | Alternative final cover previously approved. |

Facility Name: _____

| DESIGN & CONSTRUCTION CRITERIA REQUIREMENTS | COMPLETE? | | | LOCATION | COMMENTS |
|---|---|---|---|---|---|
| | Y | N | NA | | |
| __ A saturated hydraulic conductivity of $1x10^{-7}$ cm/sec or less<br>__ An average liquid limit of 25 or greater with no values less than 20<br>__ An average plasticity index of 12 or greater with no values less than 10<br>__ Will the clay capping layer be constructed according to NR 504.06(2)(f)? | | | X | Section 3.3<br>Appendix F<br>Appendix J | |
| (a) If the two foot clay cap is replaced with a GCL and 2 foot soil barrier layer, does it meet the following:<br>__ 1. GCL consist of a layer of bentonite clay between 2 geotextiles<br>__ 2. GCL will be covered with a geomembrane the same day it is placed and in dry conditions<br>__ 3. GCL will be installed in a relaxed condition, free of tension or stress<br>__ 4. Adjoining panels of GCL have a minimum 6 inches overlap on longitudinal seams and a minimum 20 inches of overlap on panel end seams<br>__ 5. Irregular shapes, cuts or tears in the GCL are covered with a GCL patch with a minimum 12 inch overlap<br>__ 6. A seal of loose bentonite granules will be placed in seam overlaps at a minimum rate of 1 quarter pound per linear foot of seam for all seams<br>__ 7. Loose bentonite or bentonite amended soil will be placed at all patches and penetrations<br>__ 8. GCL panels are certified needle-free through magnetic and metal detection tests<br>__ 9. GCL will be placed in direct contact with a soil barrier layer<br>__ 10. Vehicle traffic on subgrade of GCL and on GCL will be restricted to minimum weight and number of machines to deploy GCL and geomembrane; vehicles operated to minimize damage to subgrade, GCL and geomembrane; deployment methods selected to prevent tearing or coming out of fibers of the GCL<br>__ 11. Soil cover placement over the geosynthetics will be completed in the same construction season as the geosynthetic construction<br>__ 12. Soil barrier layer will consist of fine-grained soil or a well graded sandy soil with fines, meeting USCS soil types ML, CL, CH, SM, or SC or dual -symbols classifications of these soils, with 25% by weight passing P200 sieve; upper one foot will have maximum particle size of 2 inches and lower one foot will have maximum particle size of 4 inches<br>__ 13. Soil barrier layer will be compacted in lift heights of no greater than 12 inches after compaction using footed compaction equipment with feet at least 6 inches long; each lift will be disked to break up clods; clods no greater than 4 inches<br>__ 14. Soil barrier layer will be compacted to ensure complete remolding of soil with equipment having a minimum static weight of 30,000 pounds | X | | | Section 3.3<br>Appendix F<br>Appendix J<br>Appendix P | If the WDNR specified cover is used then yes; alternative final cover design was approved in 2004 plan mod. |

Facility Name: _____

| DESIGN & CONSTRUCTION CRITERIA REQUIREMENTS | COMPLETE? | | | LOCATION | COMMENTS |
|---|---|---|---|---|---|
| | Y | N | NA | | |
| __ 15. Soil barrier layer will be compacted to 90% modified or 95% standard Proctor density or greater at a moisture content at or wet of optimum<br>__ 16. Each lift of will be keyed into clay or soil barrier layer soils in adjacent phases to form a continuous seal; steps will be a minimum width of 2 feet and there will be a minimum of 2 steps<br>__ 17. The surface of the top lift will be graded or compacted to be smooth and firm and will be inspected for removal of course grave, cobbles and debris prior to placement of GCL | X | | | Section 3.3<br>Appendix F<br>Appendix J<br>Appendix P | If the WDNR specified cover is used then yes; alternative final cover design was approved in 2004 plan mod. |
| (b) For industrial waste landfills that predominantly accept compressible wastes or wastes with high water contents and low strength, will the landfill be replacing the clay layer with a GCL overlying a minimum one foot sand layer?<br>If yes, will the gradation of the sand layer be a uniform sand selected to vent gas, drain leachate and provide hydration water to the GCL? | | | X | | |
| (c) For industrial waste landfills that predominantly accept ash, will the landfill be replacing the clay layer with a GCL overlying a minimum two feet soil barrier layer?<br>If yes, will the soil barrier layer meet the requirement of (a)13 to 17 above and will the upper foot of soil barrier layer meet the requirements of (a)12 above?<br>Note: The lower foot shall be designed to provide a capillary break between the ash and the upper one foot of soil barrier layer. | X | | | | If the WDNR specified cover is used then yes; alternative final cover design was approved in 2004 plan mod. |
| (d) If the lower one foot of the clay layer is replaced with a one foot of foundry green sand system sand, will the sand meet the following:<br>__ Bentonite content of greater than 6%<br>__ Liquid limit of greater than 20<br>__ Plasticity index of greater than 6<br>__ Hydraulic conductivity of less than $1X10^{-7}$ cm/sec<br>__ Compaction of 90% modified or 95% standard Proctor density or greater at a moisture content at or wet of optimum | | | X | | |
| (5) GEOMEMBRANE LAYER. | | | | | |
| If a geomembrane layer is proposed, does it meet the requirements of NR 504.06(3)(c) to (j) and the following: | X | | | Section 3.3<br>Appendix F | |
| (a) Nominal geomembrane thickness 40 mils or greater, and no thickness measurements below accepted industry tolerance | X | | | Appendix G<br>Appendix P | |
| (b) Geomembrane installed in direct contact with the clay capping surface | X | | | | |
| (c) Geomembrane penetrations fitted with prefabricated collar or a plate welded at the angle of final cover slope, which allows for differential settlement of waste without damage to the membrane seal | X | | | | |

Facility Name: _____

| DESIGN & CONSTRUCTION CRITERIA REQUIREMENTS | COMPLETE? | | | LOCATION | COMMENTS |
|---|---|---|---|---|---|
| | Y | N | NA | | |
| (6) DRAINAGE ROOTING ZONE LAYER. Does the design include a drainage and rooting zone layer over the geomembrane or the clay cap that meets the following requirements: | | | | | |
| A minimum thickness of 2.5 feet and is not densely compacted | X | | | | |
| (a) Drainage layer is designed to be placed immediately above the capping layer and consists of a 1-foot sand layer with a min. hydraulic conductivity of $1x10^{-3}$ cm/sec., or a geosynthetic drain layer of equivalent or greater transmissivity, including:<br>_X_ Design includes an analysis which demonstrates whether the maximum head in the drain layer will be confined within the thickness of the drain,<br>_X_ Drain calculations include infiltration rates based on saturated characteristics of the topsoil and rooting zone, and<br>_X_ Drain calculations include hydraulic gradient of one through the topsoil and rooting zone. | X | | | Section 3.3<br>Appendix F<br>Appendix G<br>Appendix J<br>Appendix P | |
| (b) A perimeter drain pipe at the low end of all final cover sideslopes with the following design elements:<br>_X_ Drain pipe surrounded by a minimum of 6 inches of gravel or sand having a minimum hydraulic conductivity of $1x10^{-2}$ cm/sec<br>_X_ Drain pipe sloped to outlets spaced 200 feet apart unless different spacing is supported by modeling | X | | | Section 3.3<br>Appendix F<br>Appendix G<br>Appendix J<br>Appendix P | |
| (7) TOPSOIL. | | | | Section 3.3 | |
| _X_ Is a minimum of 6 inches of topsoil included over the cover layer?<br>_X_ Is fertilizer and lime addition proposed per section 630, WDOT or other spec.? | X | | | Appendix F<br>Appendix G | |
| (8) REVEGETATION. | | | | Appendix P | |
| _X_ Is seed type and fertilizer based upon type and quality of topsoil, and compatibility with the native vegetation and final use?<br>_X_ Is seed mix and application rates per section 630 WDOT specifications unless the department approved different seed mix and application rates?<br>_X_ Are fertilizer and mulch application rates specified? | X | | | Section 3.3<br>Appendix F<br>Appendix G | |
| (9) FINAL USE. | | | | | |
| (a) Is final use compatible with the final cover system? | X | | | Appendix Q | |
| (b) Are the following activities prohibited when landfill is no longer in operation?<br>_X_ Use of waste disposal area for agricultural purposes<br>_X_ Establishment or construction of any buildings over the waste disposal areas<br>_X_ Excavation of final cover or any waste materials | X | | | Appendix Q | |
| **NR 504.075 SOIL BORROW SOURCES.** | | | | | |
| (1) GENERAL. | | | | | |

Facility Name: _____

| DESIGN & CONSTRUCTION CRITERIA REQUIREMENTS | COMPLETE? | | | LOCATION | COMMENTS |
|---|---|---|---|---|---|
| | Y | N | NA | | |
| Is the soil borrow source being developed for the purpose of construction, operating or closing a landfill?<br>If yes, this section applies.<br>Note: Written approval from the department shall be obtained prior to initiating soil borrow activities at any borrow source subject to these requirements. | | | X | | |
| (2) EXEMPTIONS. The following activities are exempt from the requirements of this section: | | | | | |
| (a) __ The production of processed aggregate products.<br>__ Excavation of soils from construction projects off of the landfill property and not being used for compacted clay liner or capping layer, soil barrier layer, leachate collection layer or final cover drain layer? | | | | | |
| (b) Is the soil borrow source within the proposed or approved limits of filling for a landfill? If yes, then the landfill is not subject to the requirements of subs. (3) and (4)(b). | | | | | |
| (3) INITIAL SITE INSPECTION. | | | | | |
| Does the report include a copy of the department's initial site inspection for each proposed borrow source? | | | | | |
| (4) LOCATIONAL INFORMATION. | | | | | |
| (a) Does the submittal describe the following:<br>__Total acreage __ Ownership<br>__ Location (¼-¼ section) __ Present land use<br>__ Transportation routes __ Any access restrictions<br>__ Travel distance to and from landfill | | | | | |
| (b) Does the submittal include the following:<br>__ Surface water drainage patterns<br>__ Significant hydrologic features (surface waters, springs, drainage divides and wetlands)<br>__ Areas of special natural resource interest (critical habitat or state/local natural areas)<br>__ Historical/archaeological areas within and adjacent to proposed limits of excavation | | | | | |
| (5) FIELD AND LABORATORY INVESTIGATIONS FOR CLAY BORROW SOURCES AND SOIL BARRIER LAYER SOURCES. | | | | | |
| Does the submittal for soil borrow sources include field and laboratory investigations to define the physical characteristics of any clay borrow source or soil barrier layer source designated to be used for a liner or final cover? | | | | | |

Facility Name: _____

| DESIGN & CONSTRUCTION CRITERIA REQUIREMENTS | COMPLETE? | | | LOCATION | COMMENTS |
|---|---|---|---|---|---|
| | Y | N | NA | | |
| Has an alternate geotechnical investigation program been approved by the department in writing prior to the field and laboratory investigation? __ yes __ no<br>If yes, does the report include a copy of and justification for any approved alternative geotechnical investigation program?<br>Note: An alternative geotechnical investigation program may be submitted in cases where previous information exists regarding the proposed soil borrow source. | | | X | | |
| (a) Have the required number of test pits or borings been completed on a uniform grid pattern across the proposed borrow source(s)?<br>__ 10 test pits/borings for the first 5 or less acres<br>__ 1 additional test pit/boring for each additional 3 or less acres<br>__ Proposed acreage of proposed borrow source(s)<br>__ Number of test pits/borings required<br>__ Number of test pits/borings made<br>__ Have logs identifying geologic origin, testing results, USCS classification, and visual description of each major soil unit encountered also been included? | | | | | |
| (b) Does the report include Atterberg limits and grain size analyses to 0.002 mm particle size for 2 samples from each test pit/boring? | | | | | |
| (c) Does the report include the relationship of water content to dry density using either the modified or standard Proctor method (curves must be developed with a minimum of 5 points) for 1 sample from each major soil unit and no fewer than 3 samples for uniform clay deposits? | | | | | |
| (d) Does the report include laboratory hydraulic conductivity test results for each sample used to develop the Proctor curves? | | | | | |
| (6) STOCKPILING. | | | | | |
| Does the report include discussion of segregating stockpiled soils by USCS soil type, soil gradation, Atterberg limits and compaction specifications?<br>Note: Stockpiling of soils obtained from clay borrow sources and soil barrier layer sources for landfill liner of final cover construction shall be conducted in an organized manner that minimizes mixing of dissimilar soil types. Soils from differing sources may not be commingled unless soil properties are similar. | | | | | |
| (7) DATA PRESENTATION FOR ALL CLAY BORROW SOURCES AND SOIL BARRIER LAYER SOURCES. Does the submittal for soil borrow sources for clay and soil barrier layers include the following? | | | | | |
| (a) Calculated volume of soil needed and the volume of acceptable soil available | | | | | |
| (b) Property boundaries and test pit/boring locations on a topographic map (scale: 1" = 500') that extends a minimum of 500 feet beyond the proposed borrow source | | | | | |
| (c) Isopach map showing thickness of acceptable soil | | | | | |
| (d) Description of methods for separating acceptable soil from unacceptable soil | | | | | |
| (e) Proposal for maintaining drainage and sedimentation control | | | | | |

Facility Name: _____

| DESIGN & CONSTRUCTION CRITERIA REQUIREMENTS | COMPLETE? | | | LOCATION | COMMENTS |
|---|---|---|---|---|---|
| | Y | N | NA | | |
| (f) All data from the testing program | | | x | | |
| (8) DATA PRESENTATION FOR OTHER BORROW SOURCES. Does the submittal for soil borrow sources other than those used for clay and soil barrier layers include the following? | | | | | |
| (a) Property boundaries shown on a topographic map (scale: 1" = 500') that extends a minimum of 500 feet beyond the proposed borrow source | | | | | |
| (b) Proposal for drainage and sedimentation control | | | | | |
| (9) STORMWATER MANAGEMENT. | | | | | |
| Does the submittal for a soil borrow source include a stormwater management plan that complies with the requirements of s. NR 504.09(1)(a) to (f) and (h) to (j), unless the borrow source is subject ot other permits with equivalent authority and requirements, such as a stormwater discharge permit or non-metallic mining reclamation permit? | | | | | |
| (10) RECLAMATION OR BORROW SITES. | | | | | |
| (a) Does the report include reclamation plans for borrow sources on the landfill property that include the following:<br>__ post-mining land use that is integrated with the existing and proposed drainage<br>__ surface water discharge requirements<br>__ grades and final use of the landfill<br>Is the reclamation plan consistent with NR 135.06 to 135.12? | | | | | |
| (b) For soil borrow areas not on landfill property, is the reclamation plan consistent with NR 135?<br>If required, has a reclamation plan been submitted and a nonmetallic mining reclamation permit been received from the appropriate regulatory authority? | | | | | |
| (11) OTHER REQUIRMENTS. | | | | | |
| (a) If the proposed clay borrow source(s) contains less than a five foot, but greater than 2 foot uniform clay thickness, does the report contain a construction methodology and documentation procedure to ensure the liner meets the soil index property requirements of s. NR 504.06(2)(a)? | | | | | |
| (b) Does the report include a description of measures to be taken to comply with wetlands protection requirements, runoff and sediment controls and surface water discharge permit requirements and to minimize effects on areas of special natural resource interest and historical or archaeological areas within and adjacent to the proposed limits of excavation? | | | | | |
| **NR 504.08 MINIMUM DESIGN AND CONSTRUCTION CRITERIA FOR LANDFILL GAS EXTRACTION SYSTEMS.** | | | | | |
| (1) GENERAL. | | | | | |

Facility Name: _____

| DESIGN & CONSTRUCTION CRITERIA REQUIREMENTS | COMPLETE? | | | LOCATION | COMMENTS |
|---|---|---|---|---|---|
| | Y | N | NA | | |
| If the landfill has the potential to generate landfill gas, is the landfill designed to prevent the migration of explosive gases generated by the waste? | | | X | Site is a CCR landfill. | |
| (2) ACTIVE GAS EXTRACTION AND TREATMENT. Does landfill design include an active gas recovery system which includes the following features: | | | | | |
| (a) Vertical gas extraction wells with a maximum 150 foot radius of influence per well with lesser radii of influence on wells near the perimeter<br>Note: The radii of influence of adjacent wells shall overlap. Alternate well spacings may be proposed if site specific data is obtained through performance of pump tests. | | | | | |
| (b) Vertical gas extraction wells extending to 10 feet above the leachate collection system, and installed in 36 inch diameter boreholes<br>Note: An exemption may be proposed to allow for placement of gas extraction wells closer to the leachate collection system. | | | | | |
| (c) The pipe in the boreholes are a minimum 6 inch diameter, Schedule 80 PVC or an approved equal | | | | | |
| (d) The lower 2/3 to 3/4 of the pipe in the borehole is slotted or perforated pipe | | | | | |
| (e) Backfill around slotted pipe is one inch to 1 ½ inch washed stone and the top 10 feet of the borehole is sealed | | | | | |
| (f) Each gas extraction well has a flow control valve and sampling port | | | | | |
| (g) The header system is looped to allow alternate flow paths for the gas | | | | | |
| (h) A minimum slope of 2% for header pipes over the waste | | | | | |
| (i) Polyethylene is used for the header and lateral pipes | | | | | |
| (j) The blower, header and laterals are sized such that a minimum vacuum of 10 inches of water column is available at the well furthest from the blower | | | | | |
| (k) A drip leg or equivalent is installed immediately before the blower while preserving suction at the wells under maximum operating vacuum | | | | | |
| (l) All condensate and gas transfer piping outside waste limits are encased in 2 feet of clay, double-cased pipe or another approved secondary containment<br>If the piping is not encased is the proposed system designed with multiple drip legs within the landfill where the bulk of the condensate has been removed? | | | | | |
| (m) The system has the ability to collect and treat all condensate, measure volumes and collect samples | | | | | |
| (n) A flare designed to meet the requirements of ch. NR 445 | | | | | |
| (3) GAS MONITORING WELLS. | | | | | |
| __ Does the design provide at least one gas monitoring well on each side of the landfill?<br>__ Will the wells be constructed per NR 507.11? | | | | | |
| (4) PASSIVE GAS EXTRACTION SYSTEMS. If the landfill accepts only industrial waste with the potential to generate gas and which does not use an active gas extraction system, is a passive gas venting system proposed which includes the following: | | | | | |

Facility Name: _____

| DESIGN & CONSTRUCTION CRITERIA REQUIREMENTS | COMPLETE? | | | LOCATION | COMMENTS |
|---|---|---|---|---|---|
| | Y | N | NA | | |
| __ A design that allows gas venting from the entire landfill surface?<br>__ An analysis to determine vent trench spacing for an effective system and to ensure compliance with ch. NR 445 limits for hazardous air contaminants<br>__ A continuous 1 foot layer of granular soil placed under the capping layer with a minimum hydraulic conductivity of $1x10^{-3}$ cm/sec<br>Note: This layer may be part of the support layer required in s. NR 504.07(3).<br>__ A series of flexible, perforated pipes connected to a series of outlets | | | X | Site is a CCR landfill. | |
| **NR 504.09 STORM WATER MANAGEMENT AND MISCELLANEOUS DESIGN AND CONSTRUCTION CRITERIA FOR LANDFILLS.** | | | | | |
| (1) STORM WATER MANAGEMENT. | | | | | |
| (a) Are drainage ditches, structures and sedimentation basins proposed to be constructed during the initial stages of site construction to control runoff and limit entrained sediment from reaching surface water bodies? | | | | Not required to be submitted in NR 514.045 Plan of Operation Modification. Information previously provided in Feasibility Report(1997) and Plan of Operation(2000) and exemption approved in Plan of Operations Approval Letter. | |
| (b) Are the following concepts incorporated in the design of the temporary and permanent erosion and sediment control measures:<br>__ Scheduling of grading and construction to minimize soil exposure<br>__ Retention of existing vegetation whenever feasible<br>__ Seeding and mulching of disturbed areas<br>__ Diversion of runoff away from disturbed and active fill areas<br>__ Minimization of runoff velocities<br>__ Designing drainageways and outlets to handle concentrated and increased flows<br>__ Trapping of sediment on-site<br>__ Inspection and maintenance of runoff control structures<br>Note: The applicant should submit a copy of the facility's storm water pollution prevention plan (SWPPP) with the plan of operation. The SWPPP may address the items listed above, in addition to storm water or surface water monitoring for the facility. | | | | | |
| (c) Are the calculations required in pars. (d), (e) and (f) performed for the period in the landfill's development where the surface conditions and contributing acreage would result in the greatest runoff volume? | | | | | |
| (d) Are all temporary and permanent storm water control structures designed to accommodate peak flow rates from a 25 year, time of concentration storm event? | | | | | |

Facility Name: _____

| DESIGN & CONSTRUCTION CRITERIA REQUIREMENTS | COMPLETE? | | | LOCATION | COMMENTS |
|---|---|---|---|---|---|
| | Y | N | NA | | |
| (e) Are the storm water management features designed to accommodate the following:<br>__ Temporary and permanent sediment controls are designed to settle the 0.015mm particle size for all storms up to and including the 25 year, 6 hour event?<br>__ The sedimentation basin surface area is based upon the average rainfall intensity over the 25 year, 6 hour event?<br>__ The principal spillway and outlet protection for the sedimentation basin is designed to pass a 25 year, time of concentration storm event?<br>__ The emergency spillway for the sedimentation basin is designed to pass a 100 year, time of concentration event?<br>__ The sedimentation basin dewatering structure is designed to drain the basin in less than 3 days<br>__ A design analysis documenting compliance with the above is included | | | X | Not required to be submitted in NR 514.045 Plan of Operation Modification. Information previously provided in Feasibility Report(1997) and Plan of Operation(2000) and exemption approved in Plan of Operations Approval Letter. | |
| (f) Is storm water diverted from active fill and borrow areas to sediment control structures? | X | | | Section 3.4 Appendix K | |
| (g) Are the containment berms around active fill areas designed to comply with the following:<br>_X_ Control and collect runoff from a 25 year-24 hour storm event<br>_X_ Containment analysis is based upon the volume of liquid generated from areas with exposed waste and areas with daily cover<br>_X_ Storm water in contact with active fill areas will be treated as leachate | X | | | Section 3.4 Appendix K | |
| (h) Are storm water drainage ditches, structures and sedimentation basins designed to discharge along the existing drainage patterns capable of accepting anticipated flow volume? | | | | Not required to be submitted in NR 514.045 Plan of Operation Modification. Information previously provided in Feasibility Report(1997) and Plan of Operation(2000) and exemption approved in Plan of Operations Approval Letter. | |
| (i) Has an analysis been performed to determine the amount and velocity of runoff prior to landfill development and to document compliance with above requirement? | | | | | |
| (j) Does storm water diversion and construction at the landfill minimize impacts on adjacent property? | | | | | |
| (j) Do storm water management features comply with other applicable requirements such as those of, but not limited to, ch. NR 103 and ch. 30, Stats., permits?<br>Note: The design should also comply with NR 151 storm water requirements. | | | | | |
| (2) MISCELLANEOUS. | | | | | |
| (a) Is a method of controlling any dust or windblown debris included in the design? | | | | | |
| (b) Is access restricted through fencing, natural barriers or other methods? | | | | | |
| (c) Are all access roads, including those in the active area, designed for all weather operation? | | | | | |
| (d) Are all access roads used by highway vehicles designed with less than 10% grade? | | | | | |

Facility Name: _____

| DESIGN & CONSTRUCTION CRITERIA REQUIREMENTS | COMPLETE? | | | LOCATION | COMMENTS |
|---|---|---|---|---|---|
| | Y | N | NA | | |
| Is the intersection of the landfill access road with an existing highway designed with sufficient sight distance and minimize traffic interference? | | | | Not required to be submitted in NR 514.045 Plan of Operation Modification. Information previously provided in Feasibility Report(1997) and Plan of Operation(2000) and exemption approved in Plan of Operations Approval Letter. | |
| (e) intentionally left blank | | | | | |
| (f) Is a minimum 100 foot separation distance between the fill limits and the adjacent property line, and a minimum 50 foot distance from landfill excavation or berm and the adjacent property line maintained (excluding storm waste diversion structures)? | | | | | |
| (g) Is the landfill designed such that final waste grades are reached as soon as possible and open refuse filling area is minimized? | | | | | |
| (h) Are the final slopes designed to be no less than 5% and no greater than 4H:1V, except for papermill sludge sites which may have a max.6H:1V final slope for papermill and wastewater treatment sludge landfills? | | | | | |
| (i) Are a minimum of 2 leachate headwells proposed per major horizontal phase? | | | | | |
| (j) Is a weight scale supplied (if proposed as a municipal solid waste landfill)? | | | | | |
| (k) Is the landfill designed with properly protected, permanent horizontal and vertical control benchmarks, and are the elevations tied to USGS datum and horizontal control referenced to property boundary? | | | | | |
| **NR 504.095 DESIGN CRITERIA FOR LANDFILLS THAT RECIRCULATE LEACHATE** | | | | | |
| (1) GENERAL. Leachate recirculation systems shall be designed to meet the following requirements: | | | | | |
| (a) Is the MSW landfill designed with a composite liner and leachate collection system meeting the requirements of NR 504.06? If no, leachate recirculation may not be approved. | | | X | | |
| (b) Is the leachate recirculation limited to areas of the landfill where the leachate collection drainage blanket has a hydraulic conductivity of 1cm/sec or greater? Note: The department may approve leachate recirculation in existing cells with lower permeability leachate collection blankets, provided that the operator can demonstrate that the maximum leachate head on the liner can be maintained at less than 12 inches and that the recorded leachate head has not exceeded 12 inches in the past. | | | X | | |
| (c) Is the leachate recirculation limited to areas of the landfill which are connected to the active gas extraction systems where the system is cabpable of collecting the additional gas expected? Note: Active gas extraction shall commence in those areas no later than the initiation of leachate recirculation. | | | X | | |
| (d) Is the leachate recirculation distribution system more than 100 lateral feet from the exterior sideslope final grades? | | | X | | |
| (e) Will there be a minimum depth of 20 feet of waste maintained between the landfill base and the lowest point of leachate distribution? | | | X | | |

Facility Name: _____

| DESIGN & CONSTRUCTION CRITERIA REQUIREMENTS | COMPLETE? | | | LOCATION | COMMENTS |
|---|---|---|---|---|---|
| | Y | N | NA | | |
| (f) Do the operating controls and instructions for leachate recirculation address the following:<br>__ All weather and seasons of operation<br>__ Cessation of leachate recirculation upon discovery of seeps, excessive pressures within the waste mass, saturated conditions within the waste mass, inadequate shear strength of the waste mass or other conditions indicative of instability? | | | X | | |
| (2) SURFACE APPLICATION. | | | | | |
| (a) Is the leachate distribution system designed so no leachate is introduce into the waste in a manner that causes ponding or surface runoff of leachate (No open surface trenches or ponds)? | | | X | | |
| (b) Is the leachate distribution system designed to minimize evaporation of the leachate and volatilization of compounds in leachate? | | | X | | |
| (3) VERTICAL DISTRIBUTION SYSTEMS. | | | | | |
| (a) Are the wells designed for leachate recirculation and gas extraction? | | | X | | |
| (b) Is the well spacing based on the leachate flow rates, pumping characteristics, permeability of the waste mass, and ability of the waste to accept liquid without being pressurized? | | | X | | |
| (c) Are the leachate distribution wells designed with a surface seal to control odors and landfill gas? | | | X | | |
| (d) Are the pumping pressures and pumping intervals for the wells designed to prevent surface emergence of leachate? | | | X | | |
| (e) Is the leachate distribution system designed to achieve a uniform distribution of leachate throughout the zone of influence of the wells? | | | X | | |
| (f) Are the leachate distribution wells designed to also extract landfill gas? | | | X | | |
| (4) HORIZONTAL DISTRIBUTION SYSTEMS. | | | | | |
| (a) Is the leachate distribution piping designed to distribute leachate consistently along its length? | | | X | | |
| (b) Is the distribution system designed with a permeable bedding material capable of rapidly dissipating recirculated leachate into the waste mass? | | | X | | |
| (c) Is the distribution system designed with bedding material capable of maintaining its structure and characteristics during the expected operation life of the system? | | | X | | |
| (d) Is the distribution system designed to operate with specific distribution periods with landfill gas extracted in the interval between those distribution periods and to minimize uncontrolled landfill gas emissions? | | | X | | |
| (e) Are the pumping pressures and pumping intervals for the wells designed to prevent surface emergence of leachate? | | | X | | |

Facility Name: _____

| DESIGN & CONSTRUCTION CRITERIA REQUIREMENTS | COMPLETE? | | | LOCATION | COMMENTS |
|---|---|---|---|---|---|
| | Y | N | NA | | |
| **NR 504.10 ALTERNATIVE DESIGN CRITERIA FOR LANDFILLS ACCEPTING HIGH VOLUME INDUSTRIAL WASTES.** | | | | | |
| This section applies only to landfills designed primarily for high volume industrial waste, wood residue and minor amounts of other waste as approved by the Department. This section applies to all new landfills and to the expansion of existing landfills for which the plan of operation was approved after February 1, 1988. This section also applies to new and existing CCR landfills and lateral expansions of a CCR landfill. | | | | | |
| (1) GENERAL. | | | | | |
| (a) Has the landfill been designed to either meet the requirements of NR 504.05 to 504.09 or has an alternative design been proposed which meets the following provisions? | X | | | Section 3<br>Appendix F<br>Appendix G<br>Appendix J | Alternative final cover design has been previously approved in 2004 Plan mod approval. |
| (b) Note: If the applicant does not completed construction of the first major phase of the landfill within 2 years from the date of the plan of operation approval, the applicant shall reapply for approval to construct. The department may require additional conditions or approval and require redesign of the landfill in accordance with state-of-the-art design criteria. | X | | | | |
| (c) Does municipal waste which is generated by the process, such as manufacturing process packaging not exceed 10% by weight?<br>Note: If yes, then the landfill may not be subject of the design requirements of s. NR 504.05(1). Household and plant waste not generated as a direct result of the manufacturing process such as office and cafeteria waste, may not be disposed of in a landfill which does not meet the requirements of s. NR 504.05(1). | | | X | | Only CCR waste accepted. |
| (2) DESIGN CAPACITY. | | | | | |
| Does the design capacity meet NR 504.05(3)? | | | X | | Site has been previously approved, based on anticipated disposal rates at time of permitting site life was anticipated at 13.9 years. |
| (3) DESIGN CRITERIA. | | | | | |
| Does the feasibility study demonstrate that the alternative design adequately protects the public health, welfare and the environment, and the design meets or exceeds the NR 504.04 location and performance standards?<br>If no, then an alternative design may not be approved.<br>Is the alternative design supported with the following types of information: | | | X | | |
| (a) Landfill characteristics including regional and specific information on land use, geology, hydrology, hydrogeology and soils | | | X | | |
| (b) Waste characteristics such as quantity and physical/chemical analysis of waste and leachate | | | X | | Modified final cover was previously approved. |
| (c) Analysis of any design to control geologic/hydrogeologic conditions | | | X | | |
| (d) Field demonstration data | | | X | | See Appendix B and J. |
| (e) Design and performance data for similarly designed and constructed landfills | | | X | | |
| (f) Accepted scientific or engineering analysis or field studies, field plots, research, manufacturer's data or demonstrations | | | X | | |

Facility Name: _____

| DESIGN & CONSTRUCTION CRITERIA REQUIREMENTS | COMPLETE? | | | LOCATION | COMMENTS |
|---|---|---|---|---|---|
| | Y | N | NA | | |
| (g) For new and existing CCR landfills and any lateral expansion of a CCR landfill, a demonstration that the alternative design meets the federal requirements located under 40 CFR part 257, Subpart D dated April 17,2015 (80 FR 21468), as amended at 83 FR 36451, July 30, 2018.<br>Note: The code of federal regulations may be obtained at www.ecfr.gov. Copies of 40 CFR part 257, subpart D dated April 17, 2015 (80 FR 21468), as amended at 83 FR 36451, July 30, 2018 are available for inspection at the legislative reference bureau. | X | | | Section 3.3 | |
| **NR 504.11 MINIMUM DESIGN AND CONSTRUCTION CRITERIA FOR LANDFILLS ACCEPTING RESIDUE PRODUCED BY BURNING MUNICIPAL SOLID WASTE.** | | | | | |
| (1) APPLICABILITY. This section applies to landfills designed for residue produced by the burning of municipal solid waste as approved by the department. This section applies to all new and existing landfills. | | | | | |
| (2) LANDFILL DESIGN CRITERIA FOR RESIDUE PRODUCED BY BURNING MUNICIPAL SOLID WASTE. | | | | | |
| (a) If the landfill has proposed to accept municipal solid waste combustor residue that tests below the NR 502.13(6)(g) limits, is it a composite lined monofill cell which follows the following criteria: | | | X | | |
| __ Does the composite liner consist of a minimum 60 mil geomembrane overlying a minimum 4 foot thick compacted clay liner meeting NR 504.06 specifications? | | | | | |
| __ Is the monocell designed to separately sample and collect leachate from residue areas? | | | | | |
| __ If an alternate design is proposed, such as a double liner, does the design provide equivalent protection? | | | | | |
| (b) If the landfill is proposed to accept municipal solid waste combustor residue that tests above the limits in NR 502.13(6)(g), does the landfill design include a double composite lined monofill cell which meets the following criteria: | | | | | |
| __ Is there a double composite liner with 2 separate composite liners each with a minimum 60 mil geomembrane liner overlying a minimum 4 foot compacted clay liner meeting NR 504.06 specifications? | | | | | |
| __ Is the composite liner separated by a minimum one foot (detection) layer of granular material? | | | | | |
| __ Are separate leachate collection systems designed above and between the composite liners and is separate leachate sampling and collection from the detection layer possible? | | | | | |
| (c) Note: All landfills which accept municipal solid waste combustor residue shall be approved by the department in accordance with s. NR 514.07 (5) prior to accepting each specific residue waste stream. | | | | | |
| **NR 504.12 MINIMUM DESIGN AND CONSTRUCTION CRITERIA FOR CCR LANDFILLS** | | | | | |

Facility Name: _____

| DESIGN & CONSTRUCTION CRITERIA REQUIREMENTS | COMPLETE? | | | LOCATION | COMMENTS |
|---|---|---|---|---|---|
| | Y | N | NA | | |
| (1) APPLICABILITY. In addition to ss. NR 504.04 to 504.10, applicable to all landfills or landfills accepting high volume industrial waste, this section includes design criteria that are applicable to the construction of a new or existing CCR landfill or a lateral expansion of a CCR landfill. | | | | | |
| (2) RUN-ON AND RUN-OFF CONTROLS. Does the submittal demonstrate that the CCR landfill is/will be designed, constructed, operated, and maintained with a run-off and run-on control system in accordance with the requirements under s. NR 504.09(1)(f) and (g) and all of the following:<br>Note: Complete NR 504.09(1)(f) and (g) above. | | | | | |
| (a) A run-on control system that prevents flow onto the active portion of the CCR landfill during a peak discharge from a 24-hour, 25-year storm event. | X | | | Section 3.4<br>Appendix K | |
| (b) A run-off control system from the active portion of the CCR landfill that collects and controls, at a minimum, the water volume resulting from a 24-hour, 25-year storm event. | X | | | Section 3.4<br>Appendix K | |
| (3) LINER DESIGN.<br>(a) Does the submittal for a new CCR landfill or a lateral expansion of a CCR landfill demonstrate the landfill is/will be designed, constructed, operated, and maintained with a composite liner that meets the requirements under s. NR 504.06(2) and (3), and a leachate collection and removal system that meets the requirements under s. NR 504.06(5).<br>Note: This section does not apply to existing CCR landfills. Complete NR 504.06(2), (3), and (5) above. | X | | | Section 3.2 | |
| Is the new CCR landfill or lateral expansion of a CCR landfill constructed or designed with a composite liner that consists of 2 components:<br>_X_ An uppermost component that consists of a nominal 60-mil or thicker geomembrane liner,<br>___ A lower component that consists of a minimum 4-foot-thick layer of compacted clay, OR<br>_X_ A geosynthetic clay liner (GCL) used in place of the clay liner of a composite liner in accordance with s. NR 504.06(7).<br>Note: Complete NR 504.06(7)(a) – (c) above if a GCL is used. This includes s. NR 504.07(4)(a) 1 to 17 as referenced. | X | | | Section 3.2 | |
| In addition to the minimum design and contruction criteria for landfill liners and leachate collection systems under s. NR 504.06, does the liner and leachate collection system meet all of the following: | | | | | |
| 1. The leachate collection and removal system is/will be designed, constructed, operated, and maintained to limit the leachate head level on the liner to one foot or less. | X | | | Section 3.2.3 | |

Facility Name: _____

| DESIGN & CONSTRUCTION CRITERIA REQUIREMENTS | COMPLETE? | | | LOCATION | COMMENTS |
|---|---|---|---|---|---|
| | Y | N | NA | | |
| 2. The leachate collection and removal system is/will be constructed of materials that exhibit all of the following properties:<br>a. _X_ Chemically resistant to the CCR and any non-CCR waste managed in the CCR landfill and the leachate expected to be generated.<br>b. _X_ Of sufficient strength and thickness to prevent collapse under the pressures exerted by overlying waste, waste cover materials, and equipment used at the CCR landfill. | X | | | Section 3.2.3<br>Appendix F, | |
| 3. The leachate collection and removal system is/will be designed and operated to minimize clogging during the active life and during the long-term care of the landfill. | X | | | Section 3.2.3 | |
| 4. The geomembrane component of the liner is/will be installed in direct and uniform contact with the compacted clay soil component. | | | X | | GCL and geomembrane composite liner is used. |
| 5. A liner that utilizes a GCL and soil barrier layer in accordance with s. NR 504.06 (7) is/will be designed to have a liquid flow rate no greater than the liquid flow rate through 2 ft of compacted soil with a hydraulic conductivity 1 x 10^-7 cm/sec. The liquid flow rate comparison shall be made using the following equation, which is derived from Darcy's Law for gravity flow through porous media:<br>$$Q/A = q = k\,(h/t + 1)$$<br>Where:<br>Q = flow rate (cubic centimeters / second).<br>A = surface area of the liner (squared centimeters).<br>q = flow rate per unit area (cubic centimeters / second / squared centimeter).<br>k = hydraulic conductivity of the liner (centimeters / second).<br>h = hydraulic head above the liner (centimeters).<br>t = thickness of the liner (centimeters). | X | | | Section 3.2.3<br><br>Appendix H | |
| (b) A new CCR landfill or a lateral expansion of a CCR landfill shall be designed and constructed with a subbase grade that is located no less than 5 feet above the upper limit of the uppermost aquifer, or shall demonstrate that there will not be an intermittent recurring or sustained hydraulic connection between any portion of the base of the CCR landfill and the uppermost aquifer due to normal fluctuations in groundwater elevations, including the seasonal high water table.<br><br>Note: A new CCR landfill or lateral expansion of a CCR landfill is also required to comply with s. NR 504.06(2)(b) or (4) for zone-of-saturation landfills. The definition of an uppermost aquifer can be found under s. NR 500.03(246m). | X | | | Section 3.2 | |
| (c) A new CCR landfill or a lateral expansion of a CCR landfill may not be constructed over a closed CCR surface impoundment. | | | X | | No surface impoundments at the facility. |

Facility Name: _____

| DESIGN & CONSTRUCTION CRITERIA REQUIREMENTS | COMPLETE? | | | LOCATION | COMMENTS |
|---|---|---|---|---|---|
| | Y | N | NA | | |
| (4) FINAL COVER SYSTEM.<br>(a) Does the submittal for a new or existing CCR landfill or a lateral expansion of a CCR landfill demonstrate the landfill is/will be designed and constructed with a final cover system that meets requirements under s. NR 504.07?<br>Note: Complete NR 504.07 above. | X | | | Section 3.3 | Alternative cover previously approved. |
| (b) If an alternative final cover design is proposed within the written closure plan, does it meet the requirements unsder s. NR 504.10 and all of the following:<br>Note: Complete NR 504.10 above. | X | | | Section 3.3 | Alternative cover previously approved. |
| 1. The permeability of the final cover system is/will be less than or equal to the permeability of any bottom liner system or natural subsoils present or shall be no greater than 1 x 10^-5 cm/sec, whichever is less. | X | | | Section 3.3 | |
| 2. The design of the final cover system is/will include an infiltration layer that achieves an equivalent reduction in infiltration as the layers specified under s. NR 504.07 (4). | X | | | Section 3.3 | |
| 3. The design of the final cover system is/will include an erosion layer that provides equivalent protection from wind or water erosion as the topsoil layer specified under s. NR 504.07 (7). | X | | | Section 3.3 | |
| 4. The disruption of the integrity of the final cover system is/will be minimized through a design that accommodates settling and subsidence. | X | | | Section 3.3 | |

Legal Note: This document is intended solely as guidance, and does not contain any mandatory requirements except where requirements found in statute or administrative rule are referenced. This guidance does not establish or affect legal rights or obligations and is not finally determinative of any of the issues addressed. This guidance does not create any rights enforceable by any party in litigation with the State of Wisconsin or the Department of Natural Resources. Any regulatory decisions made by the Department of Natural Resources in any matter addressed by this guidance will be made by applying the governing statutes and administrative rules to the relevant facts.

# NR 514.045 Checklist

# Coal Combustion Residual (CCR) Landfill
# Plan of Operation Modification for Initial Permitting Checklist
# Section NR 514.045, Wis. Adm. Code

**August 2022**

**Waste & Materials Management**
**P.O. Box 7921**
**Madison, WI 53707-7921**

This checklist is intended for use by department staff to determine completeness during the review of plan of operation modifications for initial permitting of CCR landfills under s. NR 514.045, Wis. Adm. Code. Refer to applicable statues and codes for exact requirements. The completeness determination is due within 90 days after the owner or operator of a new or existing CCR landfills submits the plan of operation modification for initial permitting. Refer to ss. NR 514.045(2) – (4), Wis. Adm. Code for subsequent steps upon determining whether or not the plan of operation modification is complete. This checklist refers to and should be used with the Design and Construction Criteria Completeness Checklist for ch. NR 504, Wis. Adm. Code requirements and other applicable Wis. Adm. Code chapters.

**General Information**

Facility Name: Dairyland Power Cooperative - Alma Off-Site Disposal Facility

Facility Identification (FID) Number: _____ License Number: 4126

List all CCR units covered under this plan of operation modification for initial permitting. This includes all existing and new CCR landfills and any future cells to be constructed under the current plan of operation approval.

| CCR Unit Name (Phase): | Type of Unit (Existing, New, or Approved – but not constructed): |
|---|---|
| Phase IV Landfill | Existing |
| | |
| | |
| | |
| | |
| | |

Facility Name: Dairyland Power Cooperative - Alma Off-Site Disposal Facility

| | | | | |
|---|---|---|---|---|
| Initial Submittal: | Date Received: ____/____/____ | Completeness Due: ____/____/____ | DNR Response: ____/____/____ | (Complete: __ yes __ no) |
| Addendum # __ | Date Received: ____/____/____ | Completeness Due: ____/____/____ | DNR Response: ____/____/____ | (Complete: __ yes __ no) |

**NR 514.045 Procedural requirements for initial permitting of CCR landfills.** (1) GENERAL. An owner or operator of a new or existing CCR landfill that is licensed or constructed prior to August 1, 2022, shall submit a plan of operation modification to the department no later than February 1, 2023, to update the plan of operation to comply with the applicable requirements under chs. NR 500 to 520 for CCR landfills. The plan of operation modification shall address all phases of the CCR landfill. At a minimum, the plan of operation modification shall include all of the following:

| REGULATORY REQUIREMENTS | COMPLETE? | | | LOCATION | COMMENTS |
|---|---|---|---|---|---|
| | Y | N | NA | | |
| **NR 514.045(1)(a) Does the submittal meet the requirements under s. NR 500.05, including the certifications required under s. NR 500.05(4)?** | | | | | |
| NR 500.05 GENERAL SUBMITTAL REQUIREMENTS. | | | | | |
| (1) Has payment of the review fee of $30,500 been received?<br>Note: The department sends an invoice to the facility contact upon receipt of the submittal. Payment is due within 30 days of receipt of the invoice. | | | | | DPC shall be invoiced. |
| (2) Has a cover letter detailing the desired action been submitted? | X | | | Cover Letter | |
| (3) Have the appropriate number of written and electronic copies been submitted to the department? | X | | | | |
| (4) Are the report and plan sheets submitted under the seals and certifications of a licensed professional engineer and professional geologist? | X | | | | |
| (5) Technical Procedures: | | | | | |
| Were all test procedures specified in the report? | X | | | | |
| Were all technical procedures used to investigate the facility current standard procedures? | X | | | | |
| Were explanations and reasons given for deviations from any current standard method? | X | | | | |
| (6) Do all maps, plan sheets, drawings, isometrics, cross-sections, figures, photographs and tables meet the following requirements? | X | | | Plan Sheets/ Appendix F.2 Figures | |

Facility Name: _____

| REGULATORY REQUIREMENTS | COMPLETE? Y | N | NA | LOCATION | COMMENTS |
|---|---|---|---|---|---|
| (a) No larger than 32 inches by 44 inches and no smaller than 8 ½ inches x 11 inches.<br><br>Note: Section NR 514.045, Wis. Adm. Code requires engineering plans be drawn on standard 24 inch by 36-inch plan sheets. | X | | | Plan Sheets/ Appendix F.2 Figures | |
| (b) Appropriate scale to show all required detail in sufficient clarity. | X | | | | |
| (c) X numbered<br>X referenced in the narrative<br>X titled<br>X legends for all symbols<br>X horizontal & vertical scales<br>X drafting and origination dates | | | | | |
| (d) Use uniform scales. | X | | | | |
| (e) Contain a north arrow. | X | | | | |
| (f) Use mean sea level as the basis for all elevations. | X | | | | |
| (g) Contain a survey grid based on monuments established in the field and which utilize a coordinate system and datum, such as state plane coordinates, Universal Transverse Mercator (UTM), or Wisconsin Transverse Mercator. | X | | | | |
| (h) Show original topography and a grid system shown on the plan sheets that show construction, operation, and closure topography. | X | | | | |
| (i) Any cross-sections:<br>X Show survey grid locations,<br>X Reference major plan sheets,<br>X Include a reduced diagram of plan view showing cross-section location. | X | | | | |
| (7) A table of contents listing all sections of the submittal. | X | | | | |
| (8) An appendix listing the following:<br>X names of all references<br>X testing and sampling procedures<br>X all raw data<br>X calculations | X | | | Appendix A - R | |
| **NR 514.045(1)(b) Does the submittal include a demonstration that all phases of the CCR landfill meet the performance criteria under s. NR 504.04(4)(a), (b), and (c)?** | | | | | |
| NR 504.04(4) PERFORMANCE STANDARDS. Will the proposed landfill cause the following: | | | | | |

Facility Name: _____

| REGULATORY REQUIREMENTS | COMPLETE? | | | LOCATION | COMMENTS |
|---|---|---|---|---|---|
| | Y | N | NA | | |
| (a) A significant adverse impact on wetlands?<br>__ yes _X_ no<br>Has a practicable alternatives analysis and a wetland functional values analysis been completed in accordance with ch. NR 103, if a wetland will be affected by the proposed landfill or any noncommercial soil borrow source activity?<br><br>Note: See DNR wetland regulation website (https://dnr.wisconsin.gov/topic/Wetlands/permits) to help determine if a wetland permit may be needed per s. 281.36, Stats. | X | | | Section 2.1 | |
| (b) A take of an endangered or threatened species in accordance with s. 29.604, Stats?<br>__ yes _X_ no | X | | | Section 2.1 | |
| (c) A detrimental effect on any surface water?<br>__ yes _X_ no<br>Note: Exemptions are not granted. | X | | | Section 2.1 | |
| For new CCR landfills or a lateral expansion of a CCR landfill, if the landfill failed to make the demonstration showing compliance with the criteria above, has the landfill ceased placing CCR in the CCR landfill per NR 514.045(5)(b)? | | | X | | |
| **NR 514.045(1)(c) Does the submittal include a demonstration that all phases of the CCR landfill meet the locational criteria under s. NR 504.04(3)(g), (h), and (i)?** | | | | | |
| NR 504.04(3) LOCATIONAL CRITERIA. Are the proposed limits of filling within: | | | | | |
| (g) 200 feet of a fault that has had displacement in Holocene time?<br>__ yes _X_ no<br>__ If yes, was an exemption requested? | X | | | Section 2.2, Appendix D | |
| (h) Seismic impact zones?<br>__ yes _X_ no<br>__ If yes, was an exemption requested? | X | | | Section 2.2, Appendix D | |
| (i) Unstable areas?<br>__ yes _X_ no<br>__ If yes, was an exemption requested? | X | | | Section 2.2, Appendix D | |
| For new CCR landfills or a lateral expansion of a CCR landfill, if the landfill failed to make the demonstration showing compliance with the criteria above, has the landfill ceased placing CCR in the CCR landfill per NR 514.045(5)(b)? | | | X | | |
| **NR 514.045(1)(c) (continued) Does the demonstration for unstable areas address all of the following factors, at a minimum, when determining whether an area is unstable:** | | | | | |
| 1. On-site or local soil conditions that may result in significant differential settling. | | | | Section 2.2, Appendix D | |
| 2. On-site or local geologic or geomorphologic features. | | | | Section 2.2, Appendix D | |

Facility Name: _____

| REGULATORY REQUIREMENTS | COMPLETE? | | | LOCATION | COMMENTS |
|---|---|---|---|---|---|
| | Y | N | NA | | |
| 3. On-site or local human-made features or events both surface and subsurface. | | | | Section 2.2, Appendix D | |
| For existing CCR landfills that do not comply with the location criteria for unstable areas specified above, has the owner or operator, within 6 months of the determination, done the following per NR 514.045(5)(a):<br>__ ceased placing CCR and non-CCR waste streams into the CCR landfill<br>__ closed the CCR landfill in accordance with the requirements under s. NR 506.083<br><br>Note: This timeframe does not apply if the owner or operator complies with the alternative closure procedures under s. NR 506.083 (7). | | | X | | |
| **NR 514.045(1)(d) Does the submittal include a demonstration that the facility or practices near floodplains will not cause the following effects:** | | | | | |
| X Restrict the flow of the regional flood<br>X Reduce the temporary water storage capacity of the floodplain<br>X Result in washout of solid waste so as to pose a hazard to human life, wildlife, or land or water resources.<br><br>Note: NR 504.04(3)(c) also requires no person may establish, construct, operate, maintain, or permit the use of property for a landfill where the limits of filling are or would be within a floodplain. | X | | | Section 2.3 | |
| For new CCR landfills or a lateral expansion of a CCR landfill, if the landfill failed to make the demonstration showing compliance with the criteria above, has the landfill ceased placing CCR in the CCR landfill per NR 514.045 (5)(b)? | | | X | | |
| **NR 514.045(1)(e) Does the submittal include a demonstration that the facility or practices will not result in the destruction or adverse modifications of the critical habitat of endangered or threatened species as identified in s. NR 27.03(1)?** | X | | | Section 2.4 | |
| For new CCR landfills or a lateral expansion of a CCR landfill, if the landfill failed to make the demonstration showing compliance with the criteria above, has the landfill ceased placing CCR in the CCR landfill per NR 514.045 (5)(b)? | | | X | | |
| **NR 514.045(1)(f) Does the submittal include a demonstration that the CCR landfill design meets requirements under s. NR 504.12 or an alternate design under s. NR 504.10? Does the demonstration include a design report, engineering drawings, and calculations?**<br><br>Note: Complete NR 504.12 and if applicable NR 504.10 (for an alternate design) of the NR 504 Design and Construction Criteria Completeness Checklist. | X | | | Section 3.0 | |
| For new CCR landfills or a lateral expansion of a CCR landfill, if the landfill failed to make the demonstration showing compliance with NR 504.12 and NR 504.10 (for an alternate design), has the landfill ceased placing CCR in the CCR landfill per NR 514.045(5)(b)? | | | X | | |

Facility Name: _____

| REGULATORY REQUIREMENTS | COMPLETE? | | | LOCATION | COMMENTS |
|---|---|---|---|---|---|
| | Y | N | NA | | |
| **NR 514.045(1)(g) Does the submittal include all of the plans required under s. NR 514.07(10)?** | | | | | |
| NR 514.07(10) PLAN OF OPERATION. Does the submittal include all of the following: | | | | | |
| (a) A CCR fugitive dust control plan in accordance with all of the following: | X | | | Section 5.1; Appendix O | |
| 1. The plan shall identify and describe the CCR fugitive dust control measures the owner will use to minimize CCR from becoming airborne at the facility. The owner shall select and include in the CCR fugitive dust control plan the CCR fugitive dust control measures that are most appropriate for site conditions, along with an explanation. See s. NR 514.07 (10)(a)1. for control measure examples. | X | | | Section 5.1; Appendix O | |
| 2. The plan shall include procedures to wet CCR with water to a moisture content that will prevent wind dispersal, but will not result in free liquids. In lieu of water, wetting of CCR may be accomplished with an appropriate chemical dust suppression agent. | X | | | Section 5.1; Appendix O | |
| 3. The plan shall include a description of the procedures the owner will follow to periodically assess the effectiveness of the control plan. At a minimum, the assessment shall include a visual inspection at least every 7 days, unless the CCR landfill is inactive, and all areas are covered by intermediate or final cover. | X | | | Section 5.1; Appendix O | |
| 4. The plan shall be modified in accordance with s. NR 514.04 (6) whenever there is a change in conditions that may substantially affect the plan of operation. | X | | | Section 5.1; Appendix O | |
| 5. The plan shall address the preparation of an annual fugitive dust control report in accordance with s. NR 506.20 (3)(a). | X | | | Section 5.1; Appendix O | |
| (b) A run-on and run-off control system plan that includes all of the following: | | | | | |
| 1. A run-on and run-off control system designed in accordance with the requirements under s. NR 504.12 (2). | X | | | Section 5.2 Appendix K | |
| 2. Plan sheets depicting the location of run-on and run-off control features, detail drawings, and supporting engineering calculations. | X | | | Section 5.2 Appendix K | |
| 3. Construction procedures and a schedule for construction. | X | | | Section 5.2; Appendix K | |
| 4. Modification every 5 years from the date of the most recent plan approval or whenever there is a change in conditions that may substantially affect the written plan in effect. The modification shall be requested by the owner in accordance with s. NR 514.04 (6) prior to the 5-year deadline. | X | | | Section 5.2 Appendix K | |
| (c) A written closure plan in accordance with all requirements under NR 514.06 (10) and all of the following: | | | | | |
| 1. A narrative description of how the CCR landfill will be closed, including a description of the steps necessary to close the CCR unit at any point during the active life of the CCR unit, consistent with recognized and generally accepted good engineering practices. | X | | | Section 5.3 Appendix P | |

Facility Name: _____

| REGULATORY REQUIREMENTS | COMPLETE? | | | LOCATION | COMMENTS |
|---|---|---|---|---|---|
| | Y | N | NA | | |
| 2. A description of the final cover system, designed in accordance with s. NR 504.07, and the methods and procedures to be used to install the final cover.<br><br>Note: Complete NR 504.07 of the NR 504 Design and Construction Criteria Completeness Checklist. | X | | | Section 5.3<br>Appendix P | |
| 3. A demonstration, including a narrative discussion, of how final closure will meet the performance standards under s. NR 506.083 (6). | X | | | Section 5.3<br>Appendix P | |
| 4. An estimate of the maximum volume in cubic yards of CCR that will be disposed on-site over the active life of the CCR landfill. | X | | | Section 5.3<br>Appendix P | |
| 5. An estimate of the largest area of the CCR landfill that will require a final cover at any time during the CCR landfill's active life. | X | | | Section 5.3<br>Appendix P | |
| 6. A schedule for completion of all closure activities, including an estimate of the year in which all closure activities for the CCR landfill will be completed. | X | | | Section 5.3<br>Appendix P | |
| 7. The plan shall be modified in accordance with s. NR 514.04 (6) whenever there is a change in conditions that may substantially affect the written closure plan or unanticipated events necessitate a revision of the written closure plan. | X | | | Section 5.3<br>Appendix P | |
| 8. If closure of the CCR landfill will be accomplished through removal of CCR from the CCR landfill, the closure plan shall be modified and approved by the department prior to implementation in accordance with s. NR 514.04 (6). | | | X | | CCR material will remain in place for closure. |
| (d) A written long-term care plan that addresses all of the following: | | | | | |
| 1. A description of the monitoring and maintenance activities and the frequency at which those activities will be performed. The activities shall include, at a minimum, all of the following:<br>X Long-term care activities specified under s. NR 514.06 (11).<br>X Maintaining the integrity and effectiveness of the final cover system, including making repairs as necessary.<br>X Maintaining the effectiveness of the leachate collection and removal system and operating the leachate collection and removal system in accordance with the requirements under s. NR 504.12 (3) (a).<br>X Maintaining the groundwater monitoring system and monitoring the groundwater in accordance with ch. NR 507 and the sampling plan approval. | X | | | Section 5.4<br>Appendix Q | |
| 2. The name, address, telephone number, and email address of the person or office to contact about the facility during long-term care. | X | | | Section 5.4<br>Appendix Q | |
| 3. A description of the planned uses of the property during long-term care. Post-closure uses may not disturb the integrity of the final cover, liner, or other component of the landfill, or function of the monitoring systems unless approved in writing by the department. A written request for approval as part of the plan of operation submittal or a modification shall include a demonstration that disturbance of any part of the CCR landfill will not increase the potential threat to human health or the environment. | X | | | Section 5.4<br>Appendix Q | |

Facility Name: _____

| REGULATORY REQUIREMENTS | COMPLETE? | | | LOCATION | COMMENTS |
|---|---|---|---|---|---|
| | Y | N | NA | | |
| **NR 514.045(1) (h) Does the submittal include a demonstration that the CCR groundwater monitoring system complies with the requirements under s. NR 507.15(3), including documentation of the design, installation, and development of any CCR wells?** | | | | | |
| NR 507.15(3) CCR LANDFILLS. In addition to the detection groundwater monitoring system required under s. NR 507.19, the CCR landfill owner shall submit a plan establishing a separate CCR groundwater monitoring system for the purpose of monitoring groundwater quality in the uppermost aquifer. The plan shall be submitted with the plan of operation modification for initial permitting in accordance with s. NR 514.045 or in the feasibility report under ch. NR 512. The plan shall include all of the following: | | | | | |
| (a) Does the monitoring system consist of a sufficient number of CCR monitoring wells, installed at appropriate locations and depths? | X | | | Section 4.2 | |
| Are the CCR wells adequate to yield groundwater samples from the uppermost aquifer that accurately represent upgradient groundwater quality that has not been affected by leakage from CCR landfill and downgradient groundwater quality passing the waste boundary of the CCR landfill? | X | | | Section 4.2 | |
| Are the downgradient monitoring wells installed to ensure detection of groundwater contamination in the uppermost aquifer, including all known or suspected contaminant pathways? | X | | | Section 4.2 | |
| (b) Has the number, spacing, and depths of monitoring wells that are part of the CCR groundwater monitoring system plan based upon site-specific technical information that includes the following?<br>X Aquifer thickness<br>X Groundwater flow rate<br>X Groundwater flow direction, including seasonal and temporal fluctuations in groundwater flow | X | | | Section 4.2 | |
| Does the monitoring system consider the saturated and unsaturated geologic units and fill materials overlying the uppermost aquifer, materials comprising the uppermost aquifer and materials comprising the confining unit defining the lower boundary of the uppermost aquifer, including thicknesses, stratigraphy, lithology, hydraulic conductivities, porosities, and effective porosities? | X | | | Section 4.2 | |
| (c) Does the monitoring system plan include the minimum number of monitoring wells necessary to meet performance standards specified under (a) based on the site-specific information specified under (b).? | X | | | Section 4.2 | |
| 1. Does the groundwater monitoring system plan contain a minimum of one upgradient and 3 downgradient monitoring wells to be designated as CCR wells? | X | | | Section 4.2 | |

Facility Name: _____

| REGULATORY REQUIREMENTS | COMPLETE? | | | LOCATION | COMMENTS |
|---|---|---|---|---|---|
| | Y | N | NA | | |
| 2. Does the groundwater monitoring system contain additional monitoring wells as necessary to accurately represent the background groundwater quality in the uppermost aquifer that has not been affected by leakage from the CCR landfill and the quality of groundwater passing the waste boundary of the CCR landfill? | X | | | Section 4.2 | |
| (d) Have the monitoring wells been designed and installed in accordance with NR 507.06 and regularly inspected in accordance with NR 507.13? | X | | | Appendix L | |
| (e) Has the documentation of the design, installation, development, and decommissioning of all wells and measurement/sampling devices been performed in accordance with NR 507.14 and NR 141, where applicable? This includes submission of all required forms to the department in the timeframes specified. | X | | | Appendix L | |
| **NR 514.045 (i) Does the submittal include an updated sampling plan that addresses the requirements under s. NR 507.15(3)?** | | | | | |
| NR 507.15(3) CCR LANDFILLS. Does the sampling plan address all of the following: | | | | | |
| (f) A sampling plan, which includes the CCR groundwater monitoring system, in accordance with s. NR 507.16 and the requirements under s. NR 140.16.<br><br>Note: Complete NR 507.16(1) below. | X | | | Appendix N | |
| Does the sampling plan include consistent sampling and analysis procedures designed to ensure the production of monitoring results that provide an accurate representation of groundwater results that provide an accurate representation of groundwater quality in the uppermost aquifer at the upgradient and downgradient CCR wells and that provide a characterization of leachate quality generated by the CCR landfill? | X | | | Appendix N | |
| (g) Does the sampling plan include sampling and analytical methods that are appropriate for groundwater sampling and that accurately measure all required monitoring parameters under ch. NR 507, Appendix I in groundwater samples? | X | | | Appendix N | |
| Does the sampling plan specify the CCR landfill owner or operator obtain and analyze samples in accordance with the sampling plan and the requirements under s. NR 507.17? | X | | | Appendix N | |
| (h) In addition to the field measurements required under s. NR 507.17(1), does the plan include measurement of the groundwater elevations in each CCR well immediately prior to purging, each time groundwater is sampled. | X | | | Subsection 3.1.2 of Appendix N | |
| Does the plan include determination of the rate and direction of groundwater flow each time groundwater is sampled and reporting the result to the department in accordance with s. NR 507.26? | X | | | Section 7 of Appendix N | |
| Does the plan include that groundwater elevations in wells that monitor the same CCR landfill be measured within a timeframe short enough to avoid temporal variations in groundwater flow that could preclude accurate determination of groundwater flow rate and direction? | X | | | Subsection 3.1.2 of Appendix N | |

Facility Name: _____

| REGULATORY REQUIREMENTS | COMPLETE? | | | LOCATION | COMMENTS |
|---|---|---|---|---|---|
| | Y | N | NA | | |
| (i) Has the owner/operator established baseline groundwater quality levels for each CCR monitoring well in accordance with NR 507.18 for each CCR well and for each of the constituents required under ch. NR 507 Appendix I, Table 1A and the sampling plan? | | X | | Section 2 of Appendix N | In progress |
| (j) Has the owner/operator measured the total recoverable metal concentrations when measuring groundwater quality for each CCR monitoring well? | X | | | Section 2 of Appendix N | |
| Does measurement of total recoverable metals include both the particulate fraction and dissolved fraction of metals in natural waters? To ensure this, groundwater samples from CCR wells may not be field filtered prior to analysis. | X | | | Subsection 3.1.5 of Appendix N | |
| (k) Does the plan specify the owner/operator notify the department in writing within 60 days of completing sampling and analysis at any CCR well when a groundwater standard at the point of standards application has been attained or exceeded in accordance with s. NR 507.30? | X | | | Section 7 of Appendix N | |
| (L) Does the plan specify the owner/operator conduct detection groundwater monitoring at all CCR monitoring wells in accordance with NR 507.19 and all of the following? | X | | | Subsection 1.1 of Appendix N | |
| Does detection groundwater monitoring include groundwater monitoring for all constituents appropriate for CCR wells as listed under ch. NR 507 Appendix I, Table 1A and additional parameters as required by the department. | X | | | Subsection 1.1 of Appendix N | |
| 1. Is the minimum monitoring frequency semi-annual for detection groundwater monitoring? | X | | | Subsection 1.1 of Appendix N | |
| Has baseline groundwater quality been established at each CCR monitoring well in accordance with s. NR 507.18? This includes collection of a minimum of 8 independent groundwater quality samples for each CCR well, analyzed for constituents' approval for CCR landfills as listed under ch. NR 507 Appendix I, Tables 1A and 3 and additional parameters as required by the department. | | X | | Section 2 of Appendix N | In progress |
| 2. Does the plan specify the number and methodology of groundwater quality samples be collected and analyzed for each CCR well during subsequent sampling events consistent with the approved sampling plan? | X | | | Section 1 of Appendix N | |
| Does the plan specify the CCR landfill owner or operator inform the department in accordance with s. NR 507.26 of any CCR well that purges dry, is damaged or obstructed, or in any way is rendered such that a sample was unable to be collected from the well during a scheduled sampling event and does the plan specify the owner or operator propose remedial actions to correct the problem prior to the next sampling event? | X | | | Subsection 3.1.3 of Appendix N | |

Facility Name: _____

| REGULATORY REQUIREMENTS | COMPLETE? | | | LOCATION | COMMENTS |
|---|---|---|---|---|---|
| | Y | N | NA | | |
| 3. Does the plan specify the owner or operator of the CCR landfill notify the department and respond in accordance with s. NR 507.30 when a groundwater standard at the point of standards application has been attained or exceeded at any CCR well? This includes the establishment of an assessment monitoring program meeting the requirements under s. NR 508.06, unless the exceedance is determined by the department to be from a source other than the CCR landfill, or that the groundwater standard exceedance resulted from error in sampling, analysis, or natural variation in background groundwater quality in accordance with s. NR 508.06(2)(f)2. | X | | | Subsection 8.4 of Appendix N | |
| 4. Does the plan specify the point of standards application for a groundwater quality exceedance at a CCR well, the horizontal distance for the design management zone under s. NR 140.22(3)(a) for a CCR landfill is 0 feet from the waste boundary and may not be expanded by the department under s. NR 140.22(3)(b)? The waste boundary includes the horizontal space taken up by any liner, dike or other barrier designed to contain CCR waste. | X | | | Subsection 8.4 of Appendix N | |
| (m) Does the plan specify the owner or operator of the CCR landfill prepare an annual groundwater monitoring and corrective action report for submittal to the department, placement in the written operating record and position g on the publicly accessible internet site under s. NR 506.17(2) and (3) no later than January 31 of the year following the calendar year a groundwater monitoring system has been approved by the department, and annually thereafter? | X | | | Section 7 of Appendix N | |
| Does the plan specify that the annual report document the status of the groundwater monitoring and any corrective action implemented at the CCR landfill, summarize key activities completed, describe any problems encountered, discuss actions to resolve the problems, and project key activities for the upcoming year? | X | | | Section 7 of Appendix N | |
| Does the plan specify the annual groundwater monitoring and corrective action report contain, at a minimum the information included in ss. NR 507.15(3)(m) 1. – 5. | X | | | Section 7 of Appendix N | |
| NR 507.16(1) SAMPLING PLAN. Does the sampling plan include the following information: | | | | | |
| (a) An 8 1/2 by 11 inch site map showing locations of all sample points and devices. An 11 by 17 inch site map may be included if clarity is compromised using the 8 1/2 by 11 inch size. Different symbols shall be used to differentiate types of monitoring devices such as groundwater monitoring wells, collection lysimeters and gas monitoring wells. Each sample point shall be labeled. | X | | | Figure 1 of Appendix N | |
| (b) A sample schedule, including all of the following:<br>X 1. The months that each sample point is to be sampled.<br>X 2. The sampling period, as designated by the department.<br>X 3. The list of parameters that are to be analyzed for in the sample from each monitoring device during each month that sampling occurs. | X | | | Table 2 of Appendix N | |

Facility Name: _____

| REGULATORY REQUIREMENTS | COMPLETE? | | | LOCATION | COMMENTS |
|---|---|---|---|---|---|
| | Y | N | NA | | |
| (c) Procedures for field measurements, including all of the following:<br>X 1. The order in which wells should be sampled if the groundwater has been impacted by regulated or other activities.<br>X 2. The procedures and type of equipment used to measure water level elevations.<br>X 3. The procedures and type of equipment used to measure temperature, pH, conductivity and procedures to determine turbidity, odor and color. | X | | | Section 3 of Appendix N | |
| (d) Procedures for purging wells, including all of the following:<br>X 1. Procedures to purge wells prior to collecting samples.<br>X 2. Procedures for determining the volume of water to be removed from each well.<br>X 3. The type of equipment used to purge wells.<br>X 4. The rate of flow while purging, when applicable.<br>X 5. Procedures to clean purging equipment between wells.<br>X 6. The amount of time required between purging and sampling. | X | | | Section 3 of Appendix N | |
| (e) Procedures for obtaining samples from wells, including all of the following:<br>X 1. Procedures and type of equipment used to retrieve samples.<br>X 2. Volume of sample required for analysis.<br>X 3. Procedures and type of equipment to filter samples, including when to filter and when not to filter samples, if applicable.<br>X 4. The rate of flow when sampling, when applicable.<br>X 5. Procedures and type of equipment to physically and chemically preserve samples.<br>X 6. Procedures to clean sampling equipment following sampling of one well and prior to sampling the next well. | X | | | Section 3 of Appendix N | |
| (f) Procedures for establishing field quality assurance and quality control, including all of the following:<br>X 1. Field blank, duplicate sample and trip blank procedures.<br>X 2. The frequency at which the field blanks, duplicate samples and trip blanks will be collected or processed. | X | | | Section 4 of Appendix N | |
| (g) Special procedures to sample water supply wells. | | | X | | |
| (h) Special procedures to sample leachate headwells and other devices. | X | | | Subsection 3.3 | of Appendix N |
| (i) Chain of custody procedures, including persons responsible for sampling and methods for transporting samples to the laboratory. | X | | | Subsections 3.1.9 and 3.1.10 of Appendix N | |

Legal Note: This document is intended solely as guidance, and does not contain any mandatory requirements except where requirements found in statute or administrative rule are referenced. This guidance does not establish or affect legal rights or obligations and is not finally determinative of any of the issues addressed. This guidance does not create any rights enforceable by any party in litigation with the State of Wisconsin or the Department of Natural Resources. Any regulatory decisions made by the Department of Natural Resources in any matter addressed by this guidance will be made by applying the governing statutes and administrative rules to the relevant facts.

# Appendix B: Phase IV Landfill Approval Letters

F-6 3081.34

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Tommy G. Thompson, Governor
George E. Meyer, Secretary
Scott A. Humrickhouse, Regional Director

West Central Region Headquarters
1300 W. Clairemont Avenue
PO Box 4001
Eau Claire, Wisconsin 54702-4001
Telephone 715-839-3700
FAX 715-839-6076
TDD 715-839-2786

September 10, 1999

Mr. George Johnston
Dairyland Power Cooperative
3200 East Avenue South, P.O. Box 817
La Crosse, WI 54602-0817

FID# 606009360
License # 4126
Buffalo County
SW
Approval

Subject: Feasibility Determination for the Proposed Dairyland Power Cooperative Phase IV Ash Disposal Facility, Town of Belvidere, Buffalo County, Wisconsin. License No. 4126

Dear Mr. Johnston:

We have determined that the proposed Phase IV disposal area, Alma Off-Site Ash Disposal Facility is feasible, subject to certain conditions; and that it should provide for satisfactory solid waste disposal. We have also determined that the Wisconsin Environmental Policy Act requirements have been met through the preparation of an Environmental Assessment. An Environmental Impact Statement is not needed for this project.

This favorable determination entitles you to submit a plan of operation, which meets the conditions set forth in the feasibility report and subsequent addenda, the attached determination and chapter NR 514, Wis. Adm. Code. This determination does not guarantee that we will approve a plan of operation, or license your proposed facility. When preparing your plan of operation, we advise you to carefully review the requirements of chs. NR 500 through 538, Wis. Adm. Codes.

Dairyland Power Cooperative requested an exemption to s. NR 504.04(3)(f), Wis. Adm. Code, for one (1) water supply well (PW-1) located downgradient and within 1,200 feet of the limits of filling for the proposed Phase IV development. This water supply well is approximately 410 feet deep and is cased to a depth of 113 feet below the ground surface. Due to its location downgradient of the proposed landfill no exemption will be granted for this well. This well must be abandoned in accordance with ch. NR 812.26, Wis. Adm. Code, prior to waste placement in the Phase IV development. If an exemption request is made to the Department outlining non-potable uses for this well which can be independently confirmed prior to waste placement in the Phase IV development, an exemption may be considered at that time.

Dairyland Power Cooperative requested an exemption to the locational criteria of s. NR 504.04(3)(f), Wis. Adm. Code, for a proposed high capacity well (PW-2). This well would be located a minimum of 250 feet from the limits of waste and situated hydraulically upgradient/sidegradient of the proposed Phase IV development. The well design would include steel casing down to an elevation of at least 650 M.S.L. which would place the bottom of casing approximately 170 feet below the top of bedrock. The remainder of the well would be constructed as an open borehole in the bedrock and would extend to between 450 and 500 feet below the ground surface. For these reasons the Department is granting this exemption to the separation distance in s. NR 812.08(4)(g)(1), and the locational criteria in s. NR 504.04(3)(f), Wis. Adm. Code.

Dairyland Power Cooperative requested an exemption to s. NR 512.11(3), Wis. Adm. Code, regarding the submittal of a bedrock piezometric map. It has been shown that the groundwater flow direction is the same in the fluvial sand and gravel as it is in the underlying Cambrian Sandstone and the water table intersects both the unconsolidated sediment and bedrock. For these reasons the Department is granting this exemption.

Dairyland Power Cooperative requested an exemption under s. NR 140.28, Wis. Adm. Code, for a number of monitoring wells based on the background quality data. We have granted groundwater quality exemptions at specific monitoring wells where elevated concentrations of certain parameters have been detected during the four (4) rounds of background groundwater sampling. The following criteria as established in s. NR 507.18(2)(b), Wis. Adm. Code, were used to determine if granting groundwater quality exemptions were appropriate:

1. Any of the values from the background sampling exceed a parameter's enforcement standard (ES), or
2. Two or more of the values exceed a parameter's preventive action limit (PAL), or
3. The average of a parameter's value is greater that the PAL.

Landfill owners must perform baseline groundwater monitoring in accordance with s. NR 507.18, Wis. Adm. Code and report any exceedances to Wisconsin's groundwater standards. At sixteen (16) different monitoring locations the groundwater data indicated elevated concentrations above the ch. NR 140, Wis. Adm. Code, groundwater standards for the parameters listed in ch. NR 507, Table 3. We have granted exemptions to the State's groundwater quality standards for specific monitoring wells where elevated concentrations of certain parameters have been detected. Alternate concentration limits (ACLs) will need to be established in accordance with s. NR 705.29 for these wells and parameters. To determine what these ACLs shall be, this approval requires that more baseline data be collected in order to have at least eight (8) rounds of data for the calculations. Elevated concentrations of sulfate at Sta. 6 are related to filling and housekeeping activities of the now closed Phase II area. The Department will grant an exemption to the groundwater standard for sulfate at Sta. 6 for the proposed Phase IV development and allow an ACL to be calculated. However, no calculated ACL for sulfate may be applied to existing landfill phases 1, 2, and 3 (license number 2927, FID number 606009360). Dairyland Power Cooperative must continue to monitor the sulfate concentrations at this well location.

Dairyland Power Cooperative requested and exemption to s. NR 507.21, Wis. Adm. Code, for leachate quality monitoring since the leachate will be disposed at the Dairyland Power Cooperative waste water treatment plant in Alma, Wisconsin. Leachate analytical data provides pertinent information regarding conditions within the landfill. Further, in your October 7, 1998, "Additional Information requested for Feasibility Determination" report was a letter dated September 24, 1998 from the alternate leachate disposal facility – La Crosse Wastewater Utility. In this letter, the La Crosse Wastewater Utility specified that they be routinely provided with leachate analytical data. Therefore, an exemption for leachate quality monitoring will not be granted.

Dairyland Power Cooperative requested an exemption to s. NR 512.15(2)(b), Wis. Adm. Code, for the number of samples analyzed from each clay borrow source test pit. Due to the relatively thin nature of the clay deposit at the on-site borrow source, only one sample was collected and analyzed from most of the test pits. This clay will not be needed if the proposal for a geosynthetic clay liner (GCL) is approved for the liner and cover. For these reasons the Department is granting this exemption.

The proposed Phase IV development will be situated within a valley at the juncture of four surface water drainage ways. The bluff top land surrounding this landfill location is approximately 450 feet above the valley. In a heavy precipitation storm event, the amount and velocity of run-off water flowing from the uplands down into this valley can become quite significant. The landfill owner should be aware a potential exists for high velocity water flows from the higher elevations to erode and/or washout surface water controls during the different phases of construction. It will be imperative that the surface water structures are assessed and repaired, if necessary, as quickly as possible following any heavy storms.

If you have any questions regarding this determination, please contact Mark Stephenson, Hydrogeologist at (608) 785-9983; Marty Herrick, Environmental Engineer, at (608) 789-5518; or Jack Tritt, Waste Management Specialist from our Eau Claire office at (715) 839-3768.

Sincerely,

David R. Lundberg
Waste Management Team Leader
West Central Region

cc: Mark A. Osten, RMT Inc., 744 Heartland Trail, P.O. Box 8923, Madison, WI 53708-8923
Paul Huebner – WA/3
Dennis Mack – WA/3
Chuck Leveque – LC/5
Mark Stephenson – La Crosse
Marty Herrick – La Crosse
Jack Tritt – WCR
Jack Connelly/Bureau File – WA/3
Jim Pardee – EA/6
Patti Cronin – Waste Facility Siting Board
Sandra Ebert – Buffalo County Clerk, P.O. Box 58, Alma, WI 54610
Lyle Hofer – Town of Belvidere Clerk, P.O. Box 216, Cochrane, WI 54622
Nathan D. Sampson – Zoning Administrator, P.O. Box 492, Alma, WI 54610-0492

# PROJECT SUMMARY
# GENERAL SITE INFORMATION

Proposed Facility Name: Dairyland Power Cooperative Phase IV Ash Disposal Area

Authorized Contact: Mr. George Johnston
Dairyland Power Cooperative
P.O. Box 817
3200 East Avenue South
La Crosse, Wisconsin 54601
(608) 787-1322

Site Location and Area: Dairyland Power Cooperative (DPC) is proposing to site and develop a noncontiguous coal ash disposal area (Phase IV) at their existing Alma off-site disposal facility. This disposal facility would be located in the NE1/4 of the NE1/4 of Section 19 and portions of Section 18 and 20, Township 21 North, Range 12 West, Town of Belvidere, Buffalo County, Wisconsin. The proposed limits of filling would cover 32.1 acres within a parcel of 1,113 acres owned by DPC. The proposed site is located adjacent, but not connected to, DPC's current off-site ash disposal facility. The site is located approximately 4,000 ft. east of State Trunk Highway (STH) "35" and 3,200 ft. south of County Road "E". The area surrounding the proposed disposal site is generally sparsely populated agricultural land. Access to the facility is along a private entrance road from STH 35.

One water supply well is located within 1200 feet of the proposed limits of fill. This well would be abandoned prior to waste placement in the Phase IV development.

Proposed Capacity and Site Life: The proposed Phase IV disposal area has a design capacity of approximately 3,011,000 cubic yards. The estimated site life is 13.9 years but may be influenced by the demand for both fly ash and bottom ash as beneficial reuse materials.

Proposed Service Area, Waste Types and Leachate Characteristics: The proposed site will be owned and operated as a private industrial solid waste disposal facility. Waste disposal will, for the most part, be limited to fly ash and bottom ash from the burning of coal. This material will be produced at the Alma Units 1 – 5, the John P. Madgett (JPM), and the Genoa Station No.3 generating facilities owned and operated by DPC. A small quantity (less than 1% of the total waste stream) of asbestos from power plant renovations and waste water treatment plant sludge from DPC's Alma power generating station will also be disposed at this site. The chemical characteristics of the leachate produced within the site are expected to be the same as for the existing Phase III.

Present Land Use and Zoning: DPC is currently using a portion of their property for coal ash disposal operations in Phases I through III. Phases I, II, and III are located 1,000 feet, 100 feet, and 1,400 feet respectively to the south/southwest of the proposed landfill footprint. Phase I was closed in 1993. Phase II was closed in October 1997. Phase III is approximately 7 acres in size and depending on ash generation rates and anticipated beneficial reuse demands, is expected to reach capacity by the year 2004. The 1,113 acre parcel is zoned as an agricultural district as is the surrounding land.

Topography and Hydrology: The site is located within the Mississippi River drainage basin in a valley, at the juncture of four surface water drainage-ways. The lower (southern) end of the valley is currently being used for ash disposal under previous approvals. The bluff top land surrounding this site is primarily used for agricultural purposes and extends roughly 450 feet above the valley floor where the landfill would be situated.

Ephemeral waterways, which flow only in direct response to precipitation, route surface water from the uplands and steep slopes into the central valley. These waters then flow through ditches and culverts toward the Mississippi River located approximately 1 mile south. The nearest wetlands are located approximately 1 mile south of the proposed site along the Mississippi River.

Regional and Site Specific Geology: The surficial soil at the proposed site generally consists of a sand and silty sand with lenses of gravel. Additionally, several borings contained layers of finer grained soil including silt and clay ranging from a few feet to as much as 40 feet in thickness. The sandy soil typically extends to bedrock at depths ranging from 15 to 60 feet below the existing ground surface. The sandy soil is primarily the result of fluvial deposition; however, some of the sand near the bedrock surface appears to be the result of *in situ* weathering of the sandstone bedrock.

Bedrock in the area is composed of the Prairie du Chien Group Dolomite, which acts as a cap rock overlying Cambrian Sandstone. In the proposed landfill footprint, however, the Prairie du Chien has been removed by erosion.

Cambrian Sandstone underlies the unconsolidated sediment in the landfill footprint. This bedrock type is fine-grained with interbedded lenses of dark brown sandstone and calcareous, shaley partings. The bedrock surface mimics the surface topography only at higher relief. The top of bedrock is substantially deeper in the central portion of the landfill footprint than along the valley slope area.

Hydrogeology: The groundwater table beneath the site is present both within the unconsolidated sandy sediment and within the sandstone bedrock. The overlying sand and gravel aquifer is hydraulically connected to the sandstone bedrock. The depth to groundwater varies from 27.5 feet in the northeastern portion of the site to 110 feet below ground surface on the northern end of the site. The minimum separation between the proposed subbase grades and the high water table is approximately 30 feet. Groundwater flows into the central portion of the valley and then toward the Mississippi River approximately 1 mile south/southwest of the site.

The *in situ* hydraulic conductivity of the fluvial sand and gravel across the site ranges from $5.3 \times 10^{-3}$ to $2.8 \times 10^{-4}$ cm/sec. The geometric mean horizontal hydraulic conductivity in this unit is approximately $1.4 \times 10^{-3}$ cm/sec. The in situ hydraulic conductivity in the Cambrian Sandstone ranged from $2.5 \times 10^{-5}$ to $1.0 \times 10^{-2}$ cm/sec. The geometric mean horizontal hydraulic conductivity within the geologic unit is $1.1 \times 10^{-3}$ cm/sec.

Baseline groundwater quality results, for indicator parameters and public health and welfare parameters for the proposed site were provided as part of the feasibility report. In one or more wells installed at the site the concentrations of lead, manganese, nitrogen (nitrate + nitrite), selenium and sulfate attained or exceeded the preventive action limit (PAL) or enforcement standard (ES) established in ch. NR 140, Wis. Adm. Code. The Department is granting an exemption under s. NR 140.28, Wis. Adm. Code for the baseline exceedances of the parameters

listed above at these monitoring wells. Calculations of PAL's for detection parameters and alternative concentration limits (ACLs) for wells granted exemptions to the groundwater standards, should be prepared in accordance with chs. NR 507.27 and NR 507.29, Wis. Adm. Code. As part of the plan of operation, Dairyland Power Cooperative should propose PALs for detection monitoring parameters and ACLs for the parameters granted exemption to the groundwater standards.

Proposed Design: The proposed Phase IV ash disposal facility would be developed in 4 phases with filling beginning in a 6 acre tract along the east central portion of the site and generally progressing westward. The proposed area of ash disposal would cover approximately 32 acres and provide 3,011,000 cubic yards of design capacity.

The proposed surface water control system is designed for a 100-year, 24-hour storm event. Surface water control will include the phased construction beginning prior to landfill construction of the permanent surface water controls around the site perimeter supplemented with temporary surface water controls where necessary.

The proposed design would include a geosynthetic clay liner (GCL) installed over a 2-foot thick, low permeability subbase and overlain by a 60-mil high density polyethylene (HDPE) geomembrane. The low permeability subbase soil would come from on-site material excavated within the Phase IV footprint.

An alternate liner design was included in the feasibility report. This alternate design included a 4-foot thick compacted clay liner in lieu of the GCL. The HDPE geomembrane would be installed over the clay liner and tested in accordance with ss. NR 504.06 (2) (a) and (f), Wis. Adm. Code.

Regardless of which liner type is installed, a leachate collection system would be constructed in an overlying coarse-grained drainage layer material. Leachate that would accumulate in a collection tank would be recycled for the purpose of sluicing ash waste into the disposal area. Excess leachate will be trucked to Dairyland Power's own wastewater treatment plant at the Alma, Wisconsin generation station or to the alternate treatment plant (La Crosse Wastewater Utility) in the City of La Crosse, Wisconsin. This landfill would not be classified as a zone of saturation landfill because the minimum separation between the subbase grades and the high water table is approximately 30 feet.

Final cover would consist of a 6-inch soil grading layer over the ash, followed by a GCL, a 40-mil very flexible polyethylene (VFPE) geomembrane, a 1-foot sand drainage layer, a 1-foot general soil cover layer and a 6-inch topsoil layer. Final grades are designed at a maximum of 4H:1V slope

An alternate final cover design was also included in the feasibility report. This alternate design consists of a 2-foot thick compacted clay layer in lieu of the grading layer, GCL and geomembrane in accordance with NR 504.07, Wis. Adm. Code. A 2.5-foot thick general soil cover layer would be placed over the clay followed by a 6-inch thick layer of topsoil.

The ash to be disposed at this site is biologically inert; thus, a gas management system was not included in the project design.

The planned final use for the Phase IV ash disposal area will be as open green space.

Environmental Monitoring: The proposed ash landfill would include an environmental monitoring program to measure groundwater levels and quality, surface water quality and leachate quantity and quality. Samples would be taken semi-annually from groundwater monitoring wells installed at various depths and locations around the site. Leachate head wells and the leachate collection tank will also be monitored on a regular basis. All environmental monitoring data including groundwater, leachate quality and leachate head measurements and surface water monitoring would be reported to the Department electronically on diskettes.

Groundwater analysis would include those parameters specified in NR 507, Appendix 1, Table 2, Wis. Adm. Code. Leachate analysis would include those parameters specified in NR 507, Appendix 1, Table 4, Wis. Adm. Code.

BEFORE THE STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES

DETERMINATION OF SITE FEASIBILITY
DAIRYLAND POWER COOPERATIVE
PHASE IV ASH DISPOSAL FACILITY
TOWN OF BELVIDERE, BUFFALO COUNTY, WISCONSIN
WDNR LICENSE # 4126

FINDINGS OF FACT

The Department finds that:

1) Dairyland Power Cooperative (DPC) has proposed to construct and operate an ash disposal landfill in the NE1/4 of the NE1/4 of Section 19 and portions of Sections 18 and 20, Township 21 North, Range 12 West, Town of Belvidere, Buffalo County, Wisconsin.

2) The proposed ash disposal facility is intended to serve the needs of DPC as a private industrial solid waste disposal facility. Waste disposal at this site will consist of fly and bottom ash which is produced at the Alma Units 1 – 5, the John P. Madgett (JPM), and the Genoa Station No. 3 (G-3) power generation facilities owned and operated by DPC.

3) The proposed ash disposal landfill would have a design capacity of 3,011,000 cubic yards with an approximate operational life of 13.9 years.

4) The Department made an initial site inspection of the proposed site on August 24, 1994.

5) On April 25, 1995, the Department received an Initial Site Report (ISR) dated April 1995, and submitted by RMT, Inc., on behalf of DPC.

6) On July 17, 1995, the Department determined that the ISR was complete and issued an opinion that the proposed site may have potential for development as an industrial solid waste disposal facility.

7) The Department considered the following documents in its review of the feasibility of the proposed ash disposal landfill:

   (a) A Feasibility Report, dated September 19, 1997, and received by the Department on September 19,1997, prepared by RMT, Inc., on behalf of DPC.

   (b) A DPC Feasibility Report Clarification dated November 25, 1997, and received by the Department on November 26, 1997, prepared by RMT, Inc., on behalf of DPC.

   (c) A Feasibility Report Addendum – Geotechnical Testing Results dated December 15, 1997, and received by the Department on December 16, 1997, prepared by RMT, Inc., on behalf of DPC.

(d) An Additional Information Requested for Feasibility Determination report dated October 7, 1998, and received by the Department on October 8, 1998, prepared by RMT, Inc., on behalf of DPC.

(e) A Supplemental Information to Support Feasibility Determination report dated April 30, 1999 and received by the Department on May 3, 1999, prepared by RMT, Inc., on behalf of DPC.

(f) A Request for Approval of High Capacity Well Location report dated August 19, 1999, and received by the Department on August 20, 1999, prepared by RMT, Inc., on behalf of DPC.

8) The Feasibility Report review fee of $20,000 was received by the Department on October 28,1997.

9) On June 22, 1998, the Department determined that the Feasibility Report was complete; however, additional information was requested to aid in the feasibility determination.

10) On January 5, 1999 and January 27, 1999, the Department requested additional information to aid in the feasibility determination.

11) A public notice under s. 289.25 (3) Stats., was published in The Buffalo County Journal on July 2, 1998. The Department did not receive any responses to the public notice.

12) The proposed landfill expansion would not be located within:

(a) 1,000 feet of any navigable lake, pond, or flowage;

(b) 300 feet of a navigable river or stream;

(c) a floodplain;

(d) 1,000 feet of the nearest edge of the right-of-way of any state trunk highway, interstate, federal aid primary highway, or the boundary of any public park;

(e) 10,000 feet of any airport runway end used or planned to be used by turbojet aircraft or within 5,000 feet of any airport runway end used by piston type aircraft or within an area where the design or operation of the landfill would pose a significant bird hazard to aircraft;

(f) within 200 feet of a fault that has had displacement in Holocene time;

(g) within a seismic impact zone; or

(h) within an unstable area.

13) The proposed limits of fill of the ash disposal landfill would be located within 1,200 feet of the DPC high-capacity water supply well (PW-1) for which an exemption to s. NR 504.04 (3) (f), Wis. Adm. Code, was requested. The Department has determined that the exemption is

not warranted and that this well must be abandoned prior to waste placement in the Phase IV disposal area.

14) A new well (PW-2) is proposed for construction and would be located a minimum of 250 feet hydraulically upgradient/sidegradient to the Phase IV disposal area. An exemption to s. NR 504.04 (3) (f), Wis. Adm. Code is requested for this well. The Department has determined that the exemption is warranted because of the proposed design and location.

15) The proposed ash disposal landfill, if designed, constructed, and operated in accordance with the feasibility report and the conditions set forth below, would not be within an area where there is a reasonable probability that the facility will cause:

    (a) a significant adverse impact on wetlands as provided in ch. NR 103, Wis. Adm. Code;

    (b) a significant adverse impact on critical habitat areas;

    (c) a detrimental effect on any surface water;

    (d) a detrimental effect on groundwater quality;

    (e) the migration of explosive concentrations of gases in any facility structure or in the soil or air beyond the facility boundary; or

    (f) the emission of any hazardous air contaminants in excess of standards contained in s. NR 445.03, Wis. Adm. Code.

16) The Department considered the following information while reviewing the need for exemptions to groundwater standards at this facility:

    (a) baseline groundwater monitoring data provided in the Feasibility Report and Addenda to the Feasibility Report;

    (b) well construction details and boring logs provided in the Feasibility Report;

    (c) well location plan sheets and water table maps provided in the Feasibility Report and Addenda to the Feasibility Report;

    (d) the landfill design specifications provided in the Feasibility Report and Addenda to the Feasibility Report as conditioned herein.

17) Based on an examination of site conditions, the Department finds the following:

    (a) Groundwater concentrations of arsenic, lead, manganese, nitrogen (nitrate + nitrite), selenium, silver and sulfate at the site area are found at concentrations exceeding the ch. NR 140, Wis. Adm. Code, groundwater standards. These exceedances are due to baseline groundwater quality associated with natural hydrogeologic conditions or substances released by other human activities on, or near, the proposed facility.

(b) The elevated concentrations of sulfate at Station 6 reflects groundwater quality related to the Phase II ash disposal area.

18) Based on an examination of the groundwater quality data for the proposed facility for substances of public health concern, and the information listed in Findings of Fact 16 and 17, the Department finds the following:

(a) Mean baseline concentrations above the preventive action limit (PAL) but below the enforcement standard (ES) established for the following substances of public health concern were observed in groundwater samples from the monitoring wells listed below:

| SUBSTANCE | WELL NUMBER |
|---|---|
| lead | W-100A, W-101 |
| nitrogen (nitrate + nitrite) | W-100, W-100A, W-107 |
| selenium | Sta. 6, W-100, W-100A, W-102A, W-104A |

(b) The mean concentration of samples analyzed for arsenic in well W-107 does not attain the PAL established in NR 140, Wis. Adm. Code.

(c) The mean concentration of samples analyzed for manganese in monitoring wells W-42. W-100A, W-104A, and W-107 do not attain the PAL established in NR 140, Wis. Adm. Code. Therefore, the requested exemption to the groundwater standard for manganese is not necessary.

(d) The concentration of silver in the duplicate sample obtained from Station 1, on February 14, 1996, was not detected in the regular sample obtained from Station 1, on the same date and was not detected more than once during the sampling period. Therefore, an exemption to the groundwater standard for this well is not necessary.

(e) The proposed facility will not cause the concentration of lead, nitrogen (nitrate + nitrite) and selenium to exceed the ES for these substances at a point of standards application because of the landfill design.

(f) The proposed facility is designed to achieve the lowest possible concentrations for lead, nitrogen (nitrate + nitrite) and selenium which are technically and economically feasible.

19) Based on an examination of the groundwater quality data for the proposed facility for substances of public welfare concern and Findings of Fact 16 and 17 above, the Department finds the following:

(a) Mean baseline concentrations above the ES established for the following substance of public welfare concern was observed in groundwater samples from the monitoring well listed below:

| SUBSTANCE | WELL NUMBER |
|---|---|
| sulfate | Sta. 6 |

(b) The proposed facility is designed to achieve the lowest possible concentration of sulfate, which is technically and economically feasible.

(c) The anticipated increase in the concentration of sulfate does not present a threat to public health or welfare because of the landfill design.

20) Granting the exemptions that are set forth below will not inhibit compliance with the Wisconsin solid waste management standards in chs. NR 500 through 538, Wis. Adm. Code.

21) Neither the applicant, not any person owning a 10% or greater legal or equitable interest in the applicant or in the assets of the applicant:

(a) is in noncompliance with a plan approval or order issued by the Department for a solid or hazardous waste facility in Wisconsin;

(b) owns or previously owned a 10% or greater legal or equitable interest in a person, or in the assets of a person, who is not in compliance with a plan approval or order issued by the Department for a solid or hazardous waste facility in Wisconsin.

22) The Department has complied with the requirements of chs. NR 150, Wis. Adm. Code, and s. 1.11, Stats., and has adopted all practical means to avoid or minimize environmental harm consistent with social, economic and other essential considerations.

23) The special conditions set forth below are needed to assure that the facility will not pose a substantial hazard to public health or welfare.

## CONCLUSIONS OF LAW

1. The proposal will comply with the applicable requirements of chs. NR 500 through 538, Wis. Adm. Code, provided that the conditions of the feasibility determination set forth below are met.

2. The procedural requirements of ss. 1.11 and 289.21 to 289.29, Stats., have been complied with.

3. The Department has the authority to determine that a site is feasible with special conditions, if the conditions are needed to ensure compliance with chs. NR 500 through 538, Wis. Adm. Code.

4. The Department has the authority to deny a landfill design that does not meet the requirements of s. NR 140.28 and s. NR 504.06 (1), Wis. Adm. Code.

5. The Department has the authority under s. NR 140.28, Wis. Adm. Code, and ss. 160.19 (8) and (9), Stats., to grant exemptions to the groundwater standards for lead, nitrogen (nitrate + nitrite), selenium and sulfate.

6. The Department has the authority under s. NR 504.04 (2), Wis. Adm. Code, to grant exemptions to the location criterion of s. NR 504.04 (3) (f), Wis. Adm. Code, regarding the siting of a solid waste land disposal facility within 1,200 feet of any private water supply well.

7. The Department has the authority under s. NR 812.43 (1), Wis. Adm. Code, to grant variances to the location criterion of s. NR 812.08 (4) (g) (1), Wis. Adm. Code, regarding private water supply wells located within 1,200 feet of a proposed landfill.

8. As provided for under s. 289.28 (1), Stats., sufficient need for the proposed ash disposal facility has been established.

9. In accordance with the foregoing, the Department has the authority under s. 289, Stats., to issue the following grant of exemptions, determination of need and design capacity, and conditional feasibility determination.

## GRANT OF EXEMPTIONS

1. Dairyland Power Cooperative (DPC) has demonstrated circumstances which warrant an exemption to the groundwater standards for lead, nitrogen (nitrate + nitrite), selenium and sulfate in ch. NR 140, Wis. Adm. Code as specified in s. NR 140.28, Wis. Adm. Code. Therefore, the Department grants an exemption to allow the landfill expansion to be developed in an area where a preventive action limit or enforcement standard has been attained or exceeded. Exemptions are, therefore, granted for these parameters and the wells listed in Findings of Facts 18 and 19. DPC must establish alternative concentration limits (ACLs) for the wells and substances listed in Findings of Facts 18 and 19 when sufficient rounds of baseline groundwater quality samples have been collected. These alternative concentration limit calculations must be presented to the Department for approval prior to waste placement in the Phase IV ash disposal area. The sulfate concentration found in Sta. 6 is related to filling activities associated with the now close Phase II area. An ACL may be calculated and applied for sulfate concentrations at Sta. 6 associated only with the proposed Phase IV development. The calculated ACL for Sta. 6 may not be applied to the other ash disposal landfills (Phases I, II, or III, License No. 2927, FID No. 606009360) at the Alma, Wisconsin off-site facility.

2. Dairyland Power Cooperative has demonstrated circumstances which warrant an exemption from s. NR 504.04 (3) (f), Wis. Adm. Code and a variance from s. NR 812.08 (4) (g) (1), Wis. Adm. Code, to allow construction of a solid waste landfill where the proposed limits of filling are within 1,200 feet of any private water supply well. An exemption is hereby granted for the proposed well (PW-2) provided that the conditions set forth in the August 27, 1999 variance approval letter from the Department of Natural Resources, Bureau of Drinking Water and Groundwater are met.

3. Dairyland Power Cooperative has demonstrated circumstances which warrant an exemption from s. NR 512.11 (3), Wis. Adm. Code, regarding the submittal of a bedrock piezometric map. An exemption is hereby granted.

4. Dairyland Power Cooperative has demonstrated circumstances which warrant an exemption from s. NR 512.15 (2) (b), Wis. Adm. Code, for the number of samples analyzed from each clay borrow source test pit. An exemption is hereby granted.

## DETERMINATION OF NEED AND DESIGN CAPACITY

The Department hereby determines as follows:

1. There is sufficient need within the anticipated service area for the proposed Dairyland Power Cooperative, Phase IV Ash Disposal Area in the Town of Belvidere, Buffalo County, Wisconsin.

2. A design capacity of 3,011,000 cubic yards for the proposed Phase IV Ash Disposal Facility will provide for an expected operational life of approximately 13.9 years.

## CONDITIONAL FEASIBILITY DETERMINATION

The Department hereby determines that the proposed Dairyland Power Cooperative, Phase IV Disposal Area, Alma Off-Site Ash Disposal Facility, Town of Belvidere, Buffalo County, Wisconsin is environmentally feasible and has the potential for use as an industrial solid waste disposal landfill. This determination is contingent on the fact that the following conditions are complied with and the Plan of Operation is prepared in accordance with chs. NR 500 through NR 538, Wis. Adm. Codes.

GENERAL:

1. The maximum design capacity of the proposed Dairyland Power Cooperative, Phase IV Ash Disposal Area shall not exceed 3,011,000 cubic yards.

2. The Plan of Operation, at a minimum, shall comply with the requirements of chs. NR 500 through 538, Wis. Adm. Code, the Feasibility Report, and conditions of this approval. Additionally, supporting justification shall be provided if the plan differs from the provisions of the Administrative Code.

FACILITY DESIGN:

3. This Feasibility Determination is in part based on the use of a geosynthetic clay liner (GCL). The GCL is a new technology and installation, quality assurance (QA) and quality control (QC) standards have not been codified in the NR 500 series, Wis. Adm. Code. Consequently the Bureau of Waste Management's "Guidance for the Use of Geosynthetic Clay Liners (GCLs) at Solid Waste Facilities" should be followed as well as the manufacturers recommendations when submitting final design for the GCL in the Plan of Operation. The compatibility of the anticipated waste stream with respect to the GCL has been addressed in the Feasibility Report. If waste stream characteristics change from those presented in the Feasibility Report then the compatibility of those changes may have to be readdressed.

ENVIRONMENTAL MONITORING:

4. A minimum of 8 rounds of baseline groundwater sampling data, which represent background groundwater conditions, shall be provided for the substances and wells requiring an exemption from the groundwater standards of ch. NR 140, Wis. Adm. Code. The results of this monitoring, justification for use or removal of any baseline monitoring results in the calculation of alternative concentration limits (ACL) and the ACL calculations shall be submitted with the Plan of Operation.

5. The facility environmental monitoring plan, including groundwater, leachate, and surface water shall be included in the Plan of Operation and shall be consistent with that outlined in the environmental monitoring section of the attached feasibility summary. Detection monitoring shall comply with ch. NR 507, Wis. Adm. Code, including using the analytical methods specified in Appendix II.

6. A revised sampling plan shall be included in the Plan of Operation. The plan shall comply with ch. NR 507.16, Wis. Adm. Code. The months of sampling and order of sampling wells shall be defined in the sampling plan.

7. Detection leachate monitoring shall be conducted in accordance with ch. NR 507, Appendix I, Table 4. The months of sampling shall be defined in the sampling plan.

8. The environmental monitoring program shall meet the requirements of NR 507, Wis. Adm. Code, or provide justification for not doing so. The monitoring points assigned to the Phase IV ash disposal area are detailed in Attachment A, Tables 1, 2 and 3.

9. As part of the Plan of Operation, Dairyland Power Cooperative shall provide a plan to protect existing monitoring devices during construction of the Phase IV ash disposal area.

10. Dairyland Power Cooperative shall propose inspection of erosion control measures on a regular basis and/or following major precipitation events. Include a timeline for making any necessary repairs.

11. As part of the Plan of Operation, Dairyland Power Cooperative shall specify the sequencing of erosion control and stormwater control structures with regard to landfill sequencing.

12. As part of the Plan of Operation, Dairyland Power Cooperative shall include a timeline for proper abandonment of water supply well PW-1, or justification for continued use of this well. If the Department does not approve continued use as a non-potable water supply, the well shall be abandoned on accordance with ch. NR 812.26, Wis. Adm. Code prior to waste placement in the Phase IV development.

The Department retains the jurisdiction either to require the submittal of additional information or to modify this approval at any time if, in the Department's opinion, conditions warrant further modifications.

## NOTICE OF APPEAL RIGHTS

If you believe you have a right to challenge this decision, you should know that Wisconsin statutes and administrative rules establish time periods within which requests to review Department decisions must be filed.

For judicial review of a decision pursuant to sections 227.52 and 227.53, Stats., you have 30 days after the decision is mailed, or otherwise served by the Department, to file your petition with the appropriate circuit court and serve the petition on the Department. Such a petition for judicial review shall name the Department of Natural Resources as the respondent.

This notice is provided pursuant to section 227.48(2), Stats.

Dated Sept. 10, 1999

DEPARTMENT OF NATURAL RESOURCES
For the Secretary

David R. Lundberg
Waste Management Team Leader
West Central Region

Mark Stephenson / DRL
Mark Stephenson
Plan Review Hydrogeologist

## ATTACHMENT "A"

## TABLE 1

ENVIRONMENTAL MONITORING SUMMARY
DAIRYLAND POWER COOPERATIVE PHASE IV ASH DISPOSAL AREA

ASH DISPOSAL LANDFILL DETECTION MONITORING, FILTERED SAMPLES:

| WELL NAME | DNR I.D. # | WUWN | Selenium Dissolved 1145 | Alkalinity Total 39036 | Boron Dissolved 1020 | COD 341 | Specific Conduct. 94 | Field pH 400 | Ground-water Temp. 10 | Ground-water Elevation 72020 | Hardness Total 22413 | Sulfate Dissolved 946 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Station 1 | 1 | BX385 | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Station 2 | 2 | BX386 | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Station 6 | 16 | IM717 | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| W-42 | 17 | LO914 | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| P-42A | 18 | LO915 | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| P-42B | 19 | LO916 | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| W-43 | 20 | LO917 | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| W-100 | 21 | LO918 | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| W-100A | 22 | LO919 | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| W-101 | 23 | LO920 | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| W-101A | 24 | LO921 | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| W-102 | 25 | LO922 | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| W-102A | 26 | LO923 | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| W-104 | 27 | LO924 | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| W-104A | 28 | LO925 | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| W-105 | 29 | LO926 | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| W-106 | 30 | LO927 | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| W-107 | 31 | LO928 | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |

WUWN = Wisconsin Unique Well Number
SA = Semi-Annual Sampling

## TABLE 2

HIGH CAPACITY WATER SUPPLY WELL
MONITORING SUMMARY

| WELL NAME | DNR I.D. # | WUWN | Selenium Total 1147 | Alkalinity Unfilter 410 | Boron Total 1022 | COD Unfiltered 340 | Specific. Conduct. 94 | Field pH 400 | Ground-water Temp. 10 | Hardness Unfiltered 900 | Sulfate Total 945 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PW-2 | * | NG834** | SA | SA | SA | SA | SA | SA | SA | SA | SA |

WUWN = Wisconsin Unique Well Number
* - To be assigned upon completion of well installation

** - Well number assigned by Dept. of Natural Resources, Bureau of Drinking Water and Groundwater in a letter dated August 27, 1999 to Dairyland Power Cooperative.

SA = Semi-Annual Sampling

**TABLE 3**

LEACHATE MONITORING SUMMARY

LEACHATE COLLECTION SYSTEM, UNFILTERED SAMPLES

| PARAMETER | PARAMETER # | FREQUENCY |
|---|---|---|
| $BOD_5$ | 310 | SA |
| Field Conductivity | 94 | SA |
| Field pH | 400 | SA |
| Alkalinity, Total | 410 | SA |
| Boron, Total | 1022 | SA |
| Cadmium, Total | 1027 | SA |
| Chloride | 940 | SA |
| COD, Total | 340 | SA |
| Hardness, Total | 900 | SA |
| Iron, Total | 74010 | SA |
| Lead, Total | 1051 | SA |
| Manganese, Total | 1055 | SA |
| Mercury, Total | 71900 | SA |
| Selenium, Total | 1147 | SA |
| Sulfate | 945 | SA |
| Total Suspended Solids | 150 | SA |
| *Leachate Volume Pumped | 32 | MONTHLY |

SA = Semi-Annually

* = The volume of the leachate removed shall be recorded at least monthly (reported semi-annually).

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Scott McCallum, Governor
Darrell Bazzell, Secretary
Scott A. Humrickhouse, Regional Director

West Central Region Headquarters
1300 W. Clairemont Avenue
PO Box 4001
Eau Claire, Wisconsin 54702-4001
Telephone 715-839-3700
FAX 715-839-6076
TTY 715-839-2786

May 15, 2001

Mr. Robert Carothers
Dairyland Power Cooperative
JPM Station
500 Old State Highway 35
Alma, WI. 54610

FID # 606009360
Buffalo Co.
SW/LIC. File

Subject: Conditional Plan of Operation Approval for Dairyland Power Cooperative Phase IV Disposal Area, Alma Off-Site Ash Disposal Facility, Town of Belvidere, Buffalo County, License #4126.

Dear: Mr. Carothers:

We have completed our review of your plan of operation for the proposed Phase IV Disposal Area Landfill and determined that it is consistent with Wisconsin's solid waste regulations. Therefore, the plan of operation is approved, subject to compliance with chs. NR 500-590, Wis. Adm. Code, and the conditions of the attached approval.

This approval contains conditions that require certain changes to the proposed design, construction, and monitoring of this facility. They include revisions to the final cover design, leachate extraction system, and several minor aspects of construction documentation, and leachate monitoring.

You are reminded that this approval does not relieve you of obligations to meet all other applicable federal, state and local permits, as well as zoning and regulatory requirements.

If you have any questions regarding this approval please call Marty Herrick at (608) 789-5518 or Barb Hennings at (608) 264-6021.

Sincerely,

David R. Lundberg
Waste Management Team Leader
West Central Region

Attachments: Project Summary, Conditional Plan of Operation Approval, Table 1 (PALs), Table 2 (ACLs), Monitoring Summary

cc: Dennis Mack/Paul Huebner/Bureau Files-WA/3
Jack Tritt-WCR
Barb Hennings-WA/3
Marty Herrick-LAX
Tony McKimmy-DPC
Bernie Krantz-RMT
Colleen Hellenbrand-WA/3
Bob Grefe-WA/3
Steve Karklins – DG/3

PROJECT SUMMARY
DAIRYLAND POWER COOPERATIVE
PHASE IV DISPOSAL AREA
ALMA OFF-SITE ASH DISPOAL FACILITY

GENERAL INFORMATION

AUTHORIZED CONTACT: Mr. Robert Carothers
Dairyland Power Cooperative
JPM Station
500 Old State Highway 35
Alma, WI. 54610

LICENSEE AND PROPERTY OWNER: Dairyland Power Cooperative

SITE LOCATION: Dairyland Power Cooperative (DPC) is proposing to construct an industrial ash landfill located in the NE ¼ of the NE ¼ of Section 19 and portions of Sections 18 and 20, Township 21N, Range 12 W, Town of Belvidere, Buffalo County, Wisconsin. The site is located approximately 4,000 ft. east of State Trunk Highway (STH) "35" and 3200 ft. south of County Road "E".

One water supply well is located within 1,200 feet of the proposed limits of fill and will be abandoned prior to waste placement in the Phase IV disposal facility. A new water supply well will be installed south of the existing landfills at a distance greater than 1200 feet from any limits of filling.

ACREAGE AND ACCESS: The licensed disposal area will be 32.1 acres of a 1,113 acre parcel of land owned by DPC. Access to the facility is from U.S. Highway 35 onto the landfill's private haul road.

PROPOSED CAPACITY AND SITE LIFE: The facility will provide 3,011,000 cubic yards of capacity for the disposal of ash from DPC's Alma and Genoa power generating facilities. The Phase IV disposal area has a projected site life of 13.9 years. The estimated annual quantity of ash to be placed is 217,000 cubic yards. Filling rates will be influenced by power demands and the ability of DPC to use the ash for beneficial reuse purposes.

WASTE TYPES AND GENERATORS SERVED: The site is owned and operated as a private industrial solid waste disposal facility. The facility will accept primarily fly ash and bottom ash from the burning of coal at DPC's Alma and Genoa power generating stations. The facility will also accept sludge from the wastewater treatment plants for the Alma and Genoa facilities and asbestos generated from renovations at the respective facilities as well. An asbestos disposal plan is being approved as part of this plan of operation. The chemical characteristics of the leachate are expected to be similar to the existing Phase III disposal site.

PRESENT LAND USE AND ZONING: Land use in the area of the landfill is restricted by the local vertical relief which is approximately 500 feet between the southern end of the valley floor and the bluff top. Some of the land located above the facility on the bluff tops is used for agricultural purposes. The Phase IV disposal facility is located in the valley below the bluffs and the Phases I though III disposal facilities are located on the adjacent side hills. The bluffs and valley are forested and bedrock crops out at the top of the bluffs.

The proposed landfill is not located within a floodplain or a wetland but is located at the confluence of the surface waterways for the surrounding bluffs. Sediment and retention ponds and diversion channels will

reroute the surface discharges from the surrounding bluffs around the perimeter of the landfill, which will occupy the center of the drainage confluences. Ultimately the surface water drains into the Mississippi River.

DPC is currently using a portion of the property for coal ash disposal operations in Phases I through III. Phases I, II and III are located 1000 feet, 100 feet and 1400 feet respectively to the south/southwest of the proposed landfill's footprint. Phase I was closed in 1993 and Phase II was closed in October 1997. Phase III is approximately 7 acres in size and is expected to reach its final approved capacity in the near future. The 1113 acre parcel is zoned as an agricultural district. As part of this approval DPC has modified the conditional use permit from Buffalo County to include the Phase IV disposal facility. There are no designated recreational areas within a mile of the site and the facility is not visible from U.S. HWY 35. No historical, archaeological or environmentally unique areas are known to be present within one mile of the proposed landfill or borrow sites.

PERIOD OF LONG TERM CARE RESPONSIBILITY: DPC has, by law, a 40 year proof of financial responsibility period for long term care following landfill closure. However, DPC will be responsible for the long term care of the facility in perpetuity.

SITE CHARACTERISTICS

The site is located within the Mississippi River drainage basin in a valley at the confluence of four ephemeral surface water drainage-ways.

The surficial soil at the proposed site generally consists of sand and silty sand with lenses of gravel. Lenses of finer grained soil, including silt and clay, range from a few feet to forty feet in thickness. The sandy soils typically extend to bedrock with depths of 15 to 60 feet below the existing ground surface. The soils are from fluvial deposition and weathering of the sandstone bedrock.

Generally the bedrock in the area is composed of the Prairie du Chien Group Dolomite underlain by Cambrian Sandstone. However in the area of the Phase IV landfill the dolomite has been eroded and the bedrock is composed of the Cambrian Sandstone. The bedrock is fine grained with interbedded lenses of dark brown sandstone and calcareous, shaley constituents. The Prairie du Chien group crops out at upper elevations of the valley. The bedrock surface varies between 24 to 64 feet below the existing ground surface. The subbase of the landfill liner will be a minimum of 12 feet above the bedrock surface and no bedrock removal is anticipated as part of the landfill development.

The groundwater table beneath the site is present both within the unconsolidated sandy sediment and within the sandstone bedrock. The overlying sand and gravel aquifer is hydraulically connected to the sandstone bedrock. The depth to groundwater varies from 27.5 feet to 110 feet below ground surface. The minimum separation between the proposed subbase grades and the high water table is approximately 30 feet. Groundwater flows into the central portion of the valley and then toward the Mississippi River approximately one mile south /southwest of the site.

The *in situ* hydraulic conductivity of the fluvial sand and gravel across the site ranges from $5.3 \times 10^{-3}$ to $2.8 \times 10^{-4}$ cm/sec. The geometric mean horizontal hydraulic conductivity for this unit is approximately $1.4 \times 10^{-3}$ cm/sec. The in situ hydraulic conductivity in the Cambrian sandstone is varied with the permeability ranging from $2.5 \times 10^{-5}$ to $1.0 \times 10^{-2}$ cm/sec. The geometric mean horizontal hydraulic conductivity within the geologic unit is $1.1 \times 10^{-3}$ cm/sec.

For the proposed site, baseline groundwater quality results for indicator parameters and for public health

and welfare parameters were provided as part of the feasibility report. In one or more wells installed at the site the concentrations of lead, manganese, nitrogen (nitrate + nitrite), selenium and sulfate attained or exceeded the preventive action limit (PAL) or enforcement standard (ES) established in ch. NR 140, Wis. Adm. Code. The Department granted exemptions to groundwater standards in the feasibility determination. As part of the plan of operation, DPC has requested both alternative concentration limits (ACLs) for the parameters listed above and additional exemptions to the groundwater standards for selenium and lead. The plan of operation approval grants the exemptions for selenium but rescinds both a previously granted exemption for lead at well MW-101 because 6 of the 8 results are "no detect" and all exemptions at Station 6 because the well will not be part of the monitoring program for Phase IV. The requested exemptions for lead were not granted.

FACILITY DESIGN

The Phase IV ash disposal facility will be developed in four phases with filling beginning in a six acre tract along the east central portion of the site and generally progressing westward. The area of the Phase IV ash disposal is approximately 32 acres with a design capacity of 3, 011,000 cubic yards.

The surface water control system was designed for a 100 year, 24 hour storm event. Surface water control measures will be phased to match the construction of the landfill. Temporary sedimentation basins will be constructed and abandoned during various phases of construction and operation.

The landfill liner design includes the following components from top to bottom: a one foot thick granular drainage layer, a 60 mil High Density Polyethylene (HDPE) geomembrane, a geosynthetic clay liner (GCL) and a 2 foot thick low permeability subbase soil layer. The subbase will be compacted prior to placement of the low permeability soil barrier layer. The subbase is a fluvial sand deposit that will have loess material placed in various locations to bring it to the final grade. The low permeability soil barrier layer is a loess material obtained on site. It will be placed to achieve a density or compaction of at least 90% of the Modified Proctor and a hydraulic conductivity no greater than $1.0 \times 10^{-5}$ cm/s. The loess barrier soils will be obtained as part of the excavation for the respective cells and will be characterized prior to placement.

Leachate from the landfill will be captured in a granular drainage layer and directed to the sump area of the leachate collection system. Because the volume of leachate generated is anticipated to be low a sidewall penetration of the liner is being allowed. This allows leachate to flow by gravity to the leachate collection tank. The leachate collection tank is a 30,000-gallon double walled steel tank located near the existing processing facility. The leachate would then be pumped into the processing facility where it is mixed with a retarding agent and then applied to the incoming ash prior to placement in the landfill. The retarding agent is used to slow the cementing nature of the ash. Excess leachate will be trucked to either DPC's wastewater treatment plant at the Alma generating station or to the City of LaCrosse, Wisconsin wastewater treatment plant.

Final cover for the landfill includes, from the bottom up: a 2 foot soil barrier above the ash, a GCL, a 40 mil very flexible polyethylene (VFPE) geomembrane, a 1 foot sand drainage layer, an 18 inch general cover layer and a 6 inch topsoil layer. Final grades are designed at a maximum of 4H: 1V slope. Because of the lack of organic matter in the ash a gas extraction system is not required. The two foot soil barrier layer below the GCL will consist of a one foot layer of coarse grained material placed on top of the ash and an upper one foot layer having properties similar to the material used for the soil barrier in the liner.

The final use for the landfill is green space.

ENVIRONMENTAL MONITORING

Environmental and performance monitoring will extend through the period of active site operation and perpetual long-term care. Monitoring data will be reported to the Department on diskettes in a format supplied by the Department, as specified in s. NR 507.26(3), Wis. Adm. Code. To determine exceedances of groundwater standards, analytical results will be compared to the indicator PALs in Table 1 and the ACLs in Table 2 of the attached approval, or the standards in ch. NR 140, Wis. Adm. Code.

Environmental monitoring will be conducted semi-annually at groundwater monitoring wells, the water supply well, and sedimentation ponds. Monthly monitoring will be performed at the leachate collection tank and leachate head wells. Environmental monitoring requirements are provided in the Environmental Monitoring Summary Report attached to the plan of operation approval.

Annual testing of the coal ash will be performed for three years following completion of the first phase of the landfill. The results will be compared to the existing data and at the end of the third year a brief report will be submitted. The purpose of the analysis is to account for the variability of the coal sources and demonstrate the compatibility of the ash with the GCL components of the liner and cap for the landfill. Four discrete samples will be collected on a quarterly basis and then blended to form a composite sample from which a synthetic leachate will be generated. The leachate will be analyzed for the following properties: boron, calcium, chromium, potassium, sodium, chloride, specific conductance, total suspended solids and sulfate.

CLOSURE AND LONG TERM CARE COSTS

Although DPC will be perpetually responsible for the long term care of the landfill, proof of owner financial responsibility for a long term care period of 40 years is required by law. Actions to be taken during closure and the 40 year owner financial responsibility period, along with the associated cost estimates, are summarized below. Closure costs for the Phase IV facility are based on a worst case scenario where cell 3 is open and final cover would be required for cells 1, 2A, 2B and 3. The premature closure cost estimate includes installing the final cover system, seeding and vegetating the final cover system and preparing a closure documentation report. The final cover system is composed of the barrier soils, the GCL, the geomembrane and the surface water management features.

CLOSURE COSTS:

| Item | Quantity | Unit Cost | Estimated Cost |
|---|---|---|---|
| Barrier Layer (24 in.) | | | |
| 12 in. Silty Soil | 20,000 cy | $1.5/cy | $30,000 |
| 12 in. Coarse Material | 20,000 cy | $1.5/cy | $30,000 |
| GCL | 542,300 sf | $0.4/sf | $217,000 |
| 40 Mil VFPE Geomembrane | 542,300 sf | $0.36/sf | $195,200 |
| Granular Drainage Layer (12in.) | 60,260 sy | $5.57/sy | $335,700 |
| Vegetative Layer (18 in) | 90,390 sy | $1.26/sy | $113,900 |
| Topsoil (6 in) | 10,000 cy | $1.50/cy | $15,000 |
| Surface Water Control System | | | $50,000 |
| Seed, Fertilize, Mulch | 12.4 Acre | $1350/Acre | $16,700 |
| Construction Plans | | | $20,000 |
| Construction Observation | 16 Weeks | $5500/Week | $88,000 |
| Documentation Report | | | $ 20,000 |
| Contingencies (25%) | | | $282,875 |
| Total Cost | | | $1,414,375 |

LONG TERM CARE COSTS:

Long term care costs are itemized below and are based on estimated yearly expenses for:

| Item | Quantity | Unit Cost | Estimated Cost/Year |
|---|---|---|---|
| Cover Vegetation | | | |
| Reseed/Erosion Damage | 32 Acre | $ 500/Acre | $16,000 |
| Mowing | Event | $3200 | $3200 |
| O &M | | | |
| Storm Water Control Structures | Event | $5000 | $5000 |
| Settlement/Siltation | | | |
| Repair Cover | 32 Acre | $200/Acre | $6400 |
| Sedimentation Basin Cleaning | Event | $500 | $500 |
| Leachate Control Features | | | |
| Leachate Collection Line Cleaning | Event | $2000 | $2000 |
| Operation & Maintenance | Event | $3000 | $3000 |
| Leachate Disposal | 876,000 Gallons | $.025 | $21,900 |
| Environmental Monitoring | Event | $6500 | $6500 |
| Compatibility Testing | Event | $10,000 | $10,000 (one time) |
| Inspections | | $2000 | $2000 |
| Reporting | | $3000 | $3000 |
| Contingencies (25%) | | $17,375 | $17,375 |
| 40 Year Total | | | $3,485,000 |

DPC will use the Net Worth test for demonstrating compliance the long term care account in s. NR 520.06(6), Wis. Adm. Code.

BEFORE THE
STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES

CONDITIONAL PLAN OF OPERATION APPROVAL
FOR
DAIRYLAND POWER COOPERATIVE
PHASE IV DISPOAL AREA
ALMA OFFSITE ASH DISPOAL FACILITY
TOWN OF BELVIDERE, WISCONSIN
WDNR LICENSE # 4126

FINDINGS OF FACT

The Department finds that:

1. Dairyland Power Cooperative (DPC) has proposed to construct an ash disposal landfill in the NE ¼ of the NE ¼ of Section 19 and portions of Sections 18 and 20, T21N, R12W, Town of Belvidere, Buffalo, County, Wisconsin.

2. The proposed ash disposal facility is intended to serve the needs of DPC as a private industrial solid waste disposal facility. Waste disposed at this site will consist of fly and bottom ash, which is produced at Units 1-5 at the John P. Madgett (JPM) and the Genoa Station No. 3 (G-3) power generating facilities owned and operated by DPC. The facility will also accept sludge from the wastewater treatment plants for the JPM and Genoa facilities and asbestos generated from renovations at the respective facilities as well.

3. The proposed ash disposal landfill would have a design capacity of 3,011,000 cubic yards with an approximate operational life of 13.9 years.

4. On September 10, 1999, the Department issued a favorable feasibility determination for the proposed Dairyland Power Cooperative Phase IV Ash Disposal Facility.

5. On October 23, 2000, the Bureau of Waste Management received a report entitled " Plan of Operation, Phase IV Disposal Area, Alma Off-Site Ash Disposal Facility, Town of Belvidere, Buffalo County Wisconsin." The report, which included 23 plan sheets, was dated October 2000 and was prepared by RMT of Madison, Wisconsin. The Plan of Operation review fee, invoice SWK-0159, for $7000 was received by the Department on November 22, 2000.

6. The information submitted in connection with the plan of operation includes the following:

   a. On September 19, 2000, DPC received a ruling from the Department's Air Management program noting that a construction permit was not required,

   b. On November 21, 2000, additional information on the compatibility testing of the GCL and the associated synthetic leachate generation analysis was submitted to the Department by RMT for DPC,

   c. On February 8, 2001, DPC submitted to the Department an asbestos disposal plan,

d. On March 15, 2001, DPC submitted to the Department additional information including a revised plan sheet number 13. The information was in response to a January 22, 2001 e-mail to DPC and RMT from Martin Herrick of the Department,

e. In response to a telephone conversation with Barb Hennings of the Department, on April 2, 2001, DPC submitted revised monitoring plan sheets because well "Station 6" was removed from the monitoring program.

7. Additional Documents considered in the review of the plan of operation include the following:

a. The Department's guidance on GCL's and sample conditions,

b. The DPC Feasibility Report, accompanying plan sheets, and the Department's Feasibility determination,

c. March 21, 2001 memo from Barb Hennings to the DPC file explaining how PALs and ACLs were reviewed and approved,

d. March 21, 2001 memo from Barb Hennings to Steve Karklins of the Department requesting review of exemptions to groundwater standards,

f. March 27,2001 memo from Steve Karklins to Dave Lundberg concurring with the proposed exemptions to the groundwater standards for selenium at wells P-42A, P-42B, Station 1, W-42, W-101, W-101A, W-102, W-104, W-105, and W-106.

8. Additional facts relevant to the review of the engineering aspects of the plan of operation include the following:

a. Geosynthethic Clay Liners (GCLs) have been proposed, in conjunction with a soil a barrier layer, as a technical substitute for the clay component of composite liners and final covers for this project,

b. The Department has issued guidance on the use of GCL's, which has been combined with technical literature, soil barrier layers, and other project experience to develop conditions that are intended to maximize the longevity and integrity of the GCL's.

9. Additional facts relevant to the review of the groundwater quality and monitoring aspects of the plan of operation include the following:

a. The proposed location of the replacement water supply well is outside the border of plan sheet 3 at station 168470N, 1476700E. This location is 1200 feet from the limits of filling of the Phase 3 landfill.

b. The Plan of Operation included indicator Preventive Action Limit (PAL) and Alternative Concentration Limit (ACL) calculations and requests for approval.

c. The Plan of Operation included a request for additional exemptions to groundwater standards.

d. At least eight values were used in the calculations of PALs. The calculated PALs and ACLs were rounded up to two significant figures.

e. PALs and ACLs were granted largely as proposed except that actual result values were used in the calculation of specific conductance rather than the rounded values used in the calculations by the facility. Several PALs were not calculated due to insufficient information or likely impacts due to well construction.

f. The baseline monitoring results for chemical oxygen demand at wells W-42, W-100, W-101A, and W-105 indicate likely impacts due to well construction. The more recent results show no detect whereas the initial results vary considerably, in the range of 5 to 60 mg/L.

g. Of the eight analytical results submitted for chemical oxygen demand at well W-100A, one is ten times higher than the others. Excluding this outlier leaves seven values to be used for the calculation of a preventive action limit where s. NR 140.20(1), Wis. Adm. Code, requires 8 values.

h. The Department considered the following information while reviewing the need for exemptions to groundwater standards at this facility:

   i. Baseline groundwater monitoring data provided in the Plan of Operation, the Addendum and electronic submittal dated 3/05/2001,

   ii. Well construction details and boring logs provided in the Feasibility Report,

   iii. Well location plan sheets provided with the Plan of Operation and the Addendum,

   iv. Water table maps provided in the Feasibility Report and Addenda to the Feasibility Report,

   v. Reports from the Department's GEMS electronic database including time vs. concentration plots for various parameters at Station 1 and Station 6,

   vi. The landfill design specifications provided in the Plan of Operation as conditioned herein.

10. Based on an examination of site conditions, the Department finds the following:

    a. Groundwater concentrations of lead, and selenium are found at concentrations exceeding the ch. NR 140, Wis. Adm. Code, groundwater standards. These exceedances are due to baseline groundwater quality associated with natural hydrogeologic conditions or substances released by other human activities on, or near, the proposed facility,

    b. The elevated concentrations of boron at Station 6 reflect groundwater quality related to the Phase II ash disposal area,

    c. Station 6 will not be used as a monitoring point for the Phase IV facility.

11. Based on an examination of the groundwater quality data for the proposed facility for substances of public health concern, and the information listed in Findings of Fact 9 and 10, the Department finds the following:

    a. Mean baseline concentrations of samples analyzed for selenium in wells P42A, P42B, Station 1, W42, W101, W101A, W102, W104, W105, and W106 are less than the PAL but the results vary

widely,

b. Mean baseline concentrations for lead at wells W104 and W105 approach but are not greater than the PAL. Six of the eight results are no detect. Therefore, an exemption to the groundwater standard for lead at these wells is not necessary,

c. An exemption for the groundwater standard for lead was granted at well W 101 in the 9/10/00 Feasibility Determination. The mean baseline concentration is greater than the PAL for lead. However, 6 of the 8 results are "no detect". Therefore, the exemption to the groundwater standard for lead at well W 101 is not necessary.

d. The proposed facility will not cause the concentration of selenium to exceed the ES for these substances at a point of standards application because of the landfill design,

e. The proposed facility is designed to achieve the lowest possible concentrations for selenium, which are technically and economically feasible.

12. The indicator PALs and special conditions set forth below are needed to assure that an increase in the concentration of selenium does not cause an increased threat to public health or welfare or inhibit compliance with chs. NR 500-590, Wis. Adm. Code.

13. Neither the applicant, nor any person owning a 10% or greater legal or equitable interest in the applicant or in the assets of the applicant:

    a. Is in noncompliance with a plan approval or order issued by the Department for a solid or hazardous waste facility in Wisconsin,

    b. Owns or previously owned a 10% or greater legal or equitable interest in a person, or in the assets of a person, who is not in compliance with a plan approval or order issued by the Department for a solid or hazardous waste facility in Wisconsin.

14. Granting the exemptions that are set forth below will not inhibit compliance with the Wisconsin solid waste management standards in chs. NR 500 through 590, Wis. Adm. Code

15. The Department has complied with the requirements of NR 150, Wis. Adm. Code, and s.1.11, Stats., and has adopted all practical means to avoid or minimize environmental harm consistent with social, economic and other essential considerations.

The special conditions set forth below are needed to assure that the facility will not pose a substantial hazard to public health or welfare.

## CONCLUSIONS OF LAW

1. The Department has authority under s. 289.30, Stats. to approve a plan of operation with special conditions if the conditions are needed to ensure compliance with chs. NR 500 to 590, Wis. Adm. Code.

2. The Department has authority s. NR 500.08(4), Wis. Adm. Code, to approve exemptions to the requirements of chs. NR 500 to 590 in special cases except as otherwise provided.

3. The Department has the authority under s. NR 140.28, Wis. Adm. Code, and ss. 160.19 (8) and (9), Stats., to grant exemptions to groundwater standards and to specify terms and conditions under which the Department may seek remedial action relating to standards for which an exemption has been granted. This may include establishing alternative concentration limits.

4. The Department has the authority under s. 160.15(3), Stats., and s. NR 140.20, Wis. Adm. Code, to establish preventive action limits for indicator parameters.

5. The conditions of approval set forth below are needed to ensure compliance with chs. NR 500 to 590, Wis. Adm. Code.

6. In accordance with foregoing, the Department has the authority under ch. 289, Stats., to issue the following conditional approval.

## GRANT OF EXEMPTIONS

1. DPC has demonstrated circumstances, which warrant an exemption from s. NR 504.05(5), Wis. Adm. Code requirement, whereby leachate flowing across the base of a liner is required to encounter a perforated leachate collection line within 130 feet. The following areas are exempted from the 130 foot flow length requirement:

| Location | Area (acres) | Average Exceedance | Base Slope |
|---|---|---|---|
| NE Corner of Cell 2, Module A | 0.165 | 27 | 6% |
| SW Corner of Cell 3 | 0.025 | 9 | 6% |
| SW Corner of Cell 4, Module A | 0.070 | 19 | 6% |
| Small Area along East Wall of Cell 4, Module B | 0.035 | 12 | 10% |

2. DPC has demonstrated circumstances, which warrant an exemption from s. NR 504.06(5)(j), Wis. Adm. Code, whereby a penetration through the sideslope of the liner is being allowed and a sump and sideslope riser will not be installed. But instead the leachate is able to gravity drain to the leachate collection tank located near the ash processing facility.

3. DPC has demonstrated circumstances, which warrant an exemption to the groundwater standards for selenium in ch. NR 140, Wis. Adm. Code as specified in s. NR 140.28, Wis. Adm. Code. Therefore, the Department grants an exemption to allow the landfill to be developed in an area where a preventive action limit or enforcement standard has been attained or exceeded. Exemptions are, therefore, granted for these parameters and the wells listed in Findings of Facts 9 and 10. The Alternative Concentration Limits established for these exemptions and those granted in the Feasibility determination can be found in Table 2 of this approval. Based on additional information the Department may modify this approval.

RESCINDED EXEMPTIONS

1. With the initial four sampling results DPC demonstrated that an exemption to the groundwater standard for lead at well W101 was warranted. However, of the last four sampling results, three were no detect for a total of 6 results that showed no detect. Therefore, an exemption to the groundwater standard for lead at well W101 is not necessary and the grant of exemption is rescinded.

2. DPC demonstrated that an exemption to the groundwater standards for selenium and sulfate at well Station 6 was warranted. However, DPC has removed well Station 6 from the groundwater monitoring plan for this facility. Therefore, an exemption to the groundwater standards for sulfate and selenium at well Station 6 is not necessary and the grant of exemption is rescinded.

CONDITIONAL PLAN OF OPERATION APPROVAL

The Department hereby approves the Plan of Operation for the DPC Phase IV Ash Disposal Area, subject to compliance with chs. NR 500 to 590 Wis. Adm. Code, and the following conditions:

General

1. The capacity of this facility may not exceed its design volume of 3,011,000 cubic yards.

2. DPC shall perform all aspects of construction and operation of the landfill in accordance with the plan of operation, the requirements of chs. NR 500 to 590, Wis. Adm. Code, and the conditions of the approval. In the case of any discrepancies between the approval conditions and the plan of operation and its associated plan sheets, the approval conditions shall take precedence.

3. DPC shall present any proposed changes to the plan or this approval to the Department. If the changes are compatible with the desired performance of this landfill, as determined by the Department, an addendum will be added to this approval indicating acceptance of those modifications to this approval. Written Department approval is necessary prior to implementing any changes with the exception of minor field modifications that are documented in accordance with s. NR 516.04(3)(d), Wis. Adm. Code. All field modifications shall be discussed with the Department prior to implementation. Other changes may be handled as expedited plan modifications under s. NR 514.09, Wis. Adm. Code, as appropriate.

Design, Construction and Construction Documentation

4. A preconstruction report shall be submitted to the Department for review at least 2 weeks prior to the installation of the GCL component of the liner and final cover. One copy shall be submitted to the Bureau of Waste Management Technical Support Section and one copy shall be submitted to the regional environmental engineer. The report shall:

   a. Identify any proposed revisions to the approved design, construction or documentation requirements including detailed diagrams incorporating all changes.

   b. Identify the manufacturer of the GCL and the manufacturer's qualifications, and provide technical specifications of the bentonite and geosynthetics used for the GCL (e.g., thickness, bentonite mass, powdered or granules, bonding method, printed overlap lines on both sides).

   a. Identify the installation contractor for the GCL, indicating specific on-site supervisory staff and a summary of their qualifications and experience, and quality control plans that the installation contractors will follow in the installation of the GCL.

   b. Identify the quality assurance consultant indicating specific on-site staff and summarizing their qualifications and experience, and include a copy of the construction quality assurance plan to be used during documentation of the construction.

   c. Describe contractor-specific storage and material handling procedures, deployment methods, attachment methods, panel overlaps, patching, procedures for minimizing bentonite loss in the GCL, and acceptable limits on sub-grade including maximum rut depth, maximum stone size and weather conditions.

d. Provide results of all chemical compatibility and slope stability testing. Describe any measures intended to assure that an adequate slope stability safety factor will be present during construction and after hydration of the GCL.

e. Describe the method to be used to assure a smooth and firm surface prior to GCL placement including a method of removing gravel, cobbles and other debris in the surface of the soil layer.

f. Describe the method to be used to assure the GCL does not become saturated prior to covering with soil and the procedure that will be followed if the GCL does become saturated. Describe the methods and equipment to be used to place the geomembrane over the GCL, and the maximum time between deployment of the GCL and placement of soil cover layers to limit free swell of bentonite.

g. Provide the planned panel layout pattern for GCL placement.

5. Conformance sampling and testing shall be conducted on the GCL delivered on site and used in construction. Sampling shall be conducted by the quality assurance engineer or qualified technician. Laboratory testing shall be performed by the quality assurance engineer or at another laboratory not affiliated with the quality control testing.

   a. Clay mass per unit area (dried) shall be tested at a rate of one test per 40,000 $ft^2$ of GCL installed; results shall be reported at 0% moisture content.

   b. Grab and peel tensile strength (MD and CD) shall be tested at a rate of one test per 100,000 $ft^2$ of GCL installed (ASTM D-4632).

   c. Index flux shall be tested at a rate of one test per 100,000 $ft^2$ of GCL installed (ASTM D-5887).

   d. Bentonite recovered from GCL sample shall be tested for free swell at a rate of one test per 100,000 $ft^2$ of GCL installed.

   e. GCL shall be certified needle-free through magnetic and metal detection tests.

6. The placement of the GCL component of the final cover shall comply with the following:

   a. The GCL shall consist of a layer of pure sodium bentonite clay encapsulated between two geotextiles.

   b. The GCL shall be installed in a relaxed condition and shall be free of tension or stress upon completion of the installation. Stretching of the GCL to fit shall not be allowed.

   c. Adjoining panels of GCL shall be laid with a minimum of six inches of overlap on the longitudinal seams and a minimum 20 inches of overlap on the panel end seams.

   d. Irregular shapes, cuts, or tears in the installed GCL shall be covered with a GCL patch that provides a twelve-inch overlap onto adjacent GCL surfaces.

   e. Loose bentonite or bentonite amended soil shall be placed at all penetrations.

   f. The GCL shall be covered with a geomembrane the same day that it is unpacked and placed in

position. The GCL shall not be installed in standing water or during rain. The GCL shall be dry when installed and covered. GCL exhibiting unconfined swelling shall be removed and replaced.

g. A rub sheet shall be placed over the GCL during installation of a geomembrane if a textured geomembrane will be in contact with the GCL.

7. Placement and testing of the two-foot soil barrier layer below the GCL shall meet the following minimum requirements:

   a. The upper one-foot of the barrier layer shall be composed of either a fine-grained soil or a well graded sandy soil with fines, with a maximum particle diameter less than one inch and meeting the criteria for USCS soil types ML, CL, CH, SM or SC with at least 80% by weight passing the No. 60 screen and a P200 content of 40% or greater.

   b. Compacted in maximum one-foot lifts to at least 90% modified Proctor density.

   c. One sample grain size distribution through the .005-millimeter particle size for each 1,500 cubic yards of soil placed.

   d. Dry density and moisture testing in accordance with s. NR 516.07(1)(a), Wis. Adm. Code.

8. Quality assurance personnel shall be on site and performing their assigned duties at all times that the GCL is being deployed and covered. Daily inspector's summary reports shall be prepared by the quality assurance personnel for each day that installation of the GCL is either attempted or accomplished. The reports shall describe practices employed during the low-permeability soil layer placement and acceptance before GCL installation. Outline drawings on 8-1/2" X 11" paper shall be prepared as necessary to record the construction events. These reports shall be appended to the construction documentation reports and shall include the following information:

   a. Amount and location of the GCL placed, with changes from the design plan noted.

   b. Methods and procedures used during placement of the GCL, minimum overlap of the panels, placement of additional bentonite, any problems due to precipitation events, and any loss of bentonite from the GCL.

   c. Methods and equipment used to place the geomembrane over the GCL. The amount of time elapsed between placement of the GCL and placement of the geomembrane over the GCL.

   d. Dates, locations and panel numbers where GCL samples are taken.

9. DPC shall notify the Department's environmental engineer assigned to this site a minimum of one week prior to beginning each of the construction events, listed below, for the purpose of allowing the Department to inspect the work. A construction documentation report shall be submitted in accordance with the requirements in ch. NR 516, Wis. Adm. Code, for the liner and final cover construction in the respective cells as noted below. Fees shall be paid to the Department in accordance with s. NR 520.04(5), Wis. Adm. Code, for each of the inspections and associated construction documentation reports as noted below.

| | Liner Construction | Final Construction |
|---|---|---|
| Cells | 1, 2A, 2B, 3, 4A, 4B | 1, 2A& 2B, 3, 4A, 4B |
| Inspections | Subase & barrier soils | Barrier Layer Soils |
| | Place GCL & geomembrane | GCL & Geomembrane installation |
| | Leachate collections system components | Drainage Layer |
| | Drainage blanket | Rooting Zone & Topsoil Placement |

10. The construction documentation reports for the final cover shall include the following additional items listed below:

    a. Written certifications from the GCL installer's quality control representative, and the quality assurance consultant, that the construction was completed in accordance with approved plans with any deviations noted.

    b. Identification of all contractors and subcontractors involved with construction.

    c. Identification of the GCL supplier/manufacturer, material specifications of the installed GCL, and attachment methods used on the project. The report shall include the names of the on-site GCL installer and quality assurance personnel. A sample of the GCL used in the construction shall be included with the report.

    d. A narrative chronologically describing the construction including placement and compaction of the soil barrier layer, installation of the GCL, orientation, repairs and penetrations of the GCL, and placement of the geomembrane. If a textured geomembrane is used, the discussion of the method of placing the geomembrane shall include the type of slip sheet used. The narrative shall describe in detail the method used to connect the GCL to the previously constructed area and protection of edges for future connections.

    e. Identification of the source of the soil used to construct the low-permeability soil layer below the GCL.

    f. Documentation of the soil barrier layer thickness below the GCL on a 100-foot grid pattern, and results of all testing completed on the soil barrier layer.

    g. Photos/details documenting the following construction activities:

        i. Equipment compacting the soil barrier layer in preparation for GCL placement.

        ii. Equipment deploying the GCL and overlying materials.

        iii. Tie-in of GCL to previously placed barrier (i.e., clay or GCL) layers.

        iv. Protection of the edge of the GCL at end of day and for future connections.

11. The final cover structure shall be revised to include the following:

    a. A minimum of three feet of drain layer, rooting zone soil, and topsoil above the geomembrane component of the composite capping layer.

    b. A minimum of two feet of soil barrier layer between the top of the ash waste and the bottom of the GCL component of the capping layer. The soil barrier component of the composite capping layer shall include a minimum one foot of compacted soil meeting the construction and material specifications of the soil barrier layer component of the composite liner. A minimum of one foot of coarse-grained soil shall underlay the fine-grained upper layer. The coarse-grained lower layer shall be selected based on grain size and permeability properties such that this layer acts as a capillary break between the ash waste and the fine grained component.

12. Soil borrow sources for the fine-grained and coarse–grained components of the soil barrier component of the capping layer shall be identified, investigated, sampled, and proposed to the Department for review and approval no later than the date of submittal of the preconstruction report for the liner construction of cell 2A. The soil properties of the fine-grained and coarse-grained soils shall be compared and analyzed to demonstrate that the proposed soils are compactable, self-filtering, and capable of establishing a capillary break.

13. The construction documentation requirements proposed in the plan of operation and required by ch, NR 516, Wis. Adm. Code, shall be amended to include the following items and submitted within 90 days from the date of this approval:

    a. The fine-grained components of the soil barrier layer components of the composite liner and cap shall be sampled and tested for liquid limit and plasticity index at a minimum rate of 1 per 5,000 yd$^3$ of soil placed. Testing of the coarse grained component of the soil barrier layer of the cap shall be conducted as proposed in the plan of operation.

    b. Piping/permeability calculations for the ash waste and leachate collection sand, based upon the grain size characteristics of the ash waste and the soil used for the collection layer.

    c. Summary of the electrical resistivity testing to be conducted on the geomembrane component of the liner and capping layer for each cell. The summary shall include identification of the contractor that performed the inspection, and identification of all defects detected and remedial measures taken to correct such defects. A plan sheet with locations and identifications of all defects and repairs, and actions taken to replace and repair other soil and geosynthetic layers that were disturbed as a part of the remedial actions.

    d. Summary of quality assurance measures taken to detect and remove broken needles in the geotextile and GCL products used in the liner or final cover construction, both in fabricating plants and during installation of geosynthetics.

14. The leachate removal system shall be revised to include details for the anti-seep collar and use of factory-fabricated pipe boots and liner penetrations.

15. The final cover drainage system shall be revised to include a downslope flume on the Northeast side of the final covered area. The downslope flume shall intercept drainage sufficiently to eliminate routing water around the eastern exterior corner of the final cover.

16. The collection tank design shall be revised to eliminate the direct connection of the piping from manhole 5. The drain piping from manhole 5 shall be revised to connect directly to the manway of the tank, with provisions for inspecting, cleaning and pressure testing the pipe as the need arises.

17. Sedimentation basin details 2/22 and 3/22 shall be revised to include shutoff valves to control flow from the sedimentation basins.

18. Geotechnical stability analyses shall be conducted on each cell of liner construction, using the site specific testing data from ash waste, soils, and geosynthetics to be used in each cell. The stability analyses shall include a sliding block analysis. The sliding block analysis for cell 1 shall be submitted no later than the construction documentation for cell 1. For all subsequent liner cells, the analysis shall be included in the preconstruction report for each cell. The report for the analysis shall assess each interface of ash waste, soils, and geosynthetics for its effect on the stability analysis.

Environmental Monitoring

19. DPC shall perform environmental monitoring during both the active and post closure perpetual care periods in accordance with the attached Environmental Monitoring Summary report.

20. DPC shall provide all environmental monitoring data required in the Department's electronic format. Semi–annual environmental monitoring shall be performed in the months of March and September and the annual monitoring shall be performed in September. Monthly monitoring results shall be submitted with the semi-annual monitoring results.

21. Based on Finding of Fact 11c, the exemption to the groundwater standard for lead at well W-101 is no longer necessary. The exemption for lead at well W-101 is withdrawn.

22. DPC shall electronically submit the results for alkalinity, parameter number 39036, at wells W-102 on 12/15/1997 and W-107 on 9/8/1998 with in 30 days from the date of this approval.

23. Results from at least four additional rounds at wells W-42, W-100, W-101A and W105 shall be submitted to the Department electronically, in order to calculate PALs for chemical oxygen demand.

24. Indicator PALs and ACLs are established as presented in Tables 1 and 2. PALs and ESs for all other substances shall be as specified in ch. NR 140, Wis. Adm. Code, Tables 1 and 2. When submitting data to the Department, DPC shall compare the groundwater sampling results with these standards to determine whether exceedances have occurred.

Replacement Wells

25. The replacement water supply well shall be located no closer than 1200 feet from any limits of filling. The proposed location is approximately station 168470N, 1476700E.

26. In addition to any other Department requirements, DPC shall submit both the assigned Wisconsin Unique Well Number and copies of the well construction and well development forms to the Department's waste management hydrogeologist located in the LaCrosse Service Center.

27. The location of well nest W-100R, as proposed in the March 9, 2001 revised plan sheet 13, is approved. In the event that the W-100R well nest is submerged, DPC shall notify the Department within 30 days.

28. At any new or replacement wells, DPC shall collect the eight baseline monitoring samples no more than 90 days apart during the first two years following installation

Compatibility Testing and Report

29. In the event of a major process change or change of a coal source, DPC shall analyze the ash for compatibility with the GCL. The compatibility test protocol shall be proposed to the Department for review and approval prior to starting the compatibility testing. Compatibility testing shall assess the impact of the ash leachate on the bentonite minerals of the GCL, particularly concerning geochemical changes and subsequent permeability changes.

30. Beginning during the first year of filling, DPC shall perform testing of the coal ash for compatibility with the GCL by taking a representative sample of the ash quarterly and then blending it to make one composite sample. The composite sample shall be tested annually using the synthetic leachate analysis procedures in Appendix J of the feasibility submittal. At a minimum the compatibility test protocol shall include the following constituents be analyzed annually according to the referenced test methods:

| Analyte | Units | Prep Method | Analysis Method |
|---|---|---|---|
| Boron | Ug/l | SW 846 3015 | SW 846 6010B |
| Calcium | Ug/l | SW 846 3015 | SW 846 6010B |
| Chromium | Ug/l | SW 846 3015 | SW 846 6010B |
| Potassium | Ug/l | SW 846 3015 | SW 846 6010B |
| Sodium | Ug/l | SW846 3015 | SW 846 6010B |
| Chloride | Ug/l | EPA 300.0 | EPA 300.0 |
| Conductance, specific | Umhos/cm | | EPA 120.1 |
| Solids, total suspended | Mg/l | EPA 160.2 | EPA 160.2 |
| Sulfate | Mg/l | EPA 300.0 | EPA 300.0 |

a. The sample results shall be submitted electronically within 90 days of testing and can be included with another data submittal.

b. After the third year, DPC shall analyze the trends and provide the Department with a recommendation whether additional testing or other modifications are warranted. The recommendation shall be submitted to the department within 90 days of the completion of testing.

The Department reserves the right to require the submittal of additional information and to modify this approval at any time, if in the Department's opinion, modifications are necessary. Unless specifically noted, the conditions of this approval do not supersede or replace any previous conditions of approval for this facility.

NOTICE OF APPEAL RIGHTS

If you believe that you have a right to challenge this decision, you should know that Wisconsin statutes and administrative rules establish time periods within which requests to review Department decisions must be filed.

For judicial review of a decision pursuant to ss. 227.52 and 227.53, Stats., you have 30 days after the decision is mailed, or otherwise served by the Department, to file your petition with the appropriate circuit court and serve the petition on the Department. Such a petition for judicial review shall name the Department of Natural Resources as the respondent.

This notice is provided pursuant to s. 227.48(2), Stats.

Dated: May 15, 2001

DEPARTMENT OF NATURAL RESOURCES
For the Secretary

David R. Lundberg
Waste Management Team leader
West Central Region

Martin Herrick, P.E.
Environmental Engineer
West Central Region

Barbara Hennings, P.G.
Hydrogeologist
West Central Region

TABLE 1
Summary of Indicator Preventive Action Limits

| Well Name | **Specific Conductance** (umho/cm) | **Chemical Oxygen Demand,** Filtered (mg/l) | **Hardness,** Total Filtered (mg/l as $CaCO_3$) | **Alkalinity,** Total Filtered (mg/l as $CaCO_3$) |
|---|---|---|---|---|
| Station 1 | 700 | 30 | 410 | 390 |
| W-42 | 680 | -- | 410 | 390 |
| P-42A | 680 | 36 | 410 | 390 |
| P-42B | 660 | 31 | 410 | 390 |
| W-100 | 1300 | -- | 660 | 710 |
| W-100A | 870 | -- | 490 | 650 |
| W-101 | 670 | 39 | 400 | 380 |
| W-101A | 660 | -- | 390 | 380 |
| W-102 | 660 | 49 | 400 | -- |
| W-102A | 640 | 33 | 390 | 370 |
| W-104 | 660 | 36 | 390 | 380 |
| W-104A | 660 | 41 | 400 | 370 |
| W-105 | 670 | -- | 390 | 370 |
| W-106 | 670 | 32 | 400 | 380 |
| W-107 | 740 | 38 | 420 | -- |

Note: Empty cells indicate insufficient data available to calculate PALs.

TABLE 2
Summary of Approved Alternative Concentration Limits

| Well Name | **Selenium**, Filtered (ug/L) PAL = 10, ES = 50 | **Nitrate plus Nitrate**, Filtered (mg/L as N) PAL = 2, ES = 10 | **Lead**, Filtered (ug.L) PAL = 1.5, ES = 15 |
|---|---|---|---|
| Station 1 | 23 | -- | -- |
| P-42 | 23 | -- | -- |
| P-42A | 25 | -- | -- |
| P-42B | 24 | -- | -- |
| W-100 | 56 | 4.4 | -- |
| W-100A | 31 | 3.4 | 12 |
| W-101 | 22 | -- | exemption rescinded |
| W-101A | 20 | -- | -- |
| W-102 | 20 | -- | -- |
| W-102A | 25 | -- | -- |
| W-104 | 24 | -- | -- |
| W-104A | 26 | -- | -- |
| W-105 | 24 | -- | -- |
| W-106 | 25 | -- | -- |
| W-107 | -- | 2.8 | -- |

Note: Empty cells denote no groundwater standard exemption.

License: 4126 Facility: DAIRYLAND POWER COOP PHASE IV-BELVIDERE

FID: 606043900 County: Buffalo City: BELVIDERE TN, WI

| DNR Point ID | Point Name | Point Type | Point Status | WUWN | Linked | Gradient |
|---|---|---|---|---|---|---|
| 1 | STATION 1 | 12 Piezometer-Non Sub D Well | A | BX385 | Y | Up |
| 2 | STATION 2 | 12 Piezometer-Non Sub D Well | A | BX386 | Y | Up |
| 17 | W-42 | 11 WT Obs Well-Non Sub D | A | LO914 | | Side |
| 18 | P-42A | 12 Piezometer-Non Sub D Well | A | LO915 | | Side |
| 19 | P-42B | 12 Piezometer-Non Sub D Well | A | LO916 | | Side |
| 20 | W-43 | 11 WT Obs Well-Non Sub D | A | LO917 | | Down |
| 21 | W-100 | 11 WT Obs Well-Non Sub D | A | LO918 | | Down |
| 22 | W-100A | 12 Piezometer-Non Sub D Well | A | LO919 | | Down |
| 23 | W-101 | 11 WT Obs Well-Non Sub D | A | LO920 | | Up |
| 24 | W-101A | 12 Piezometer-Non Sub D Well | A | LO921 | | Up |
| 25 | W-102 | 11 WT Obs Well-Non Sub D | A | LO922 | | Side |
| 26 | W-102A | 12 Piezometer-Non Sub D Well | A | LO923 | | Side |
| 27 | W-104 | 11 WT Obs Well-Non Sub D | A | LO924 | | Side |
| 28 | W-104A | 12 Piezometer-Non Sub D Well | A | LO925 | | Side |
| 29 | W-105 | 11 WT Obs Well-Non Sub D | A | LO926 | | Side |
| 30 | W-106 | 11 WT Obs Well-Non Sub D | A | LO927 | | Side |
| 31 | W-107 | 11 WT Obs Well-Non Sub D | A | LO928 | | Up |
| 32 | PW-01 | 13 Private Well - Potable | A | LO929 | | Down |
| 33 | PW-02 | 99 Other | I | | | |
| 40 | W-100R | 99 Other | I | | | |

License: 4126 Facility: DAIRYLAND POWER COOP PHASE IV-BELVIDERE

FID: 606043900 County: Buffalo City: BELVIDERE TN, WI

| DNR Point ID | Point Name | Point Type | Point Status | WUWN | Linked | Gradient |
|---|---|---|---|---|---|---|
| 42 | MW-100AR | 99 Other | I | | | |
| 44 | W-102R | 99 Other | I | | | |
| 46 | W-102AR | 99 Other | I | | | |
| 401 | LEACHATE TANK | 23 Leachate Collection Sys | I | | | |
| 601 | LH-1 | 24 Leachate Head Well | I | | | |
| 604 | LH-2 | 24 Leachate Head Well | I | | | |
| 607 | LH-3 | 24 Leachate Head Well | I | | | |
| 610 | LH-4 | 24 Leachate Head Well | I | | | |
| 613 | LH-5 | 24 Leachate Head Well | I | | | |
| 616 | LH-6 | 24 Leachate Head Well | I | | | |
| 619 | LH-7 | 24 Leachate Head Well | I | | | |
| 622 | LH-8 | 24 Leachate Head Well | I | | | |
| 851 | SG-1 | 36 Staff Gauge | I | | | |
| 852 | SG-2 | 36 Staff Gauge | I | | | |
| 871 | OUTFALL 001 | 34 Run-Off | I | | | |
| 872 | OUTFALL 002 | 34 Run-Off | I | | | |
| 997 | FIELD BLANK | 99 Other | A | | | |

# Environmental Monitoring Summary
## By Group Category Report Order Number

License Number: 4126 Facility: DAIRYLAND POWER COOP PHASE IV-BELVIDERE

FID: 606043900 DNR Region: West Central Region County: Buffalo

PLAN OF OPERATION APPROVAL

Group Category: Groundwater Monitoring Well Group Description: routine monitoring wells

Group Number: 1 Group Name: GROUNDWATER MONITORING WELLS

| Common Name | DNR ID # |
|---|---|
| MW-101AR | 42 |
| P-42A | 18 |
| STATION 1 | 1 |
| W-100 | 21 |
| W-100A | 22 |
| W-100R | 40 |
| W-101 | 23 |
| W-101A | 24 |
| W-102 | 25 |
| W-102A | 26 |
| W-102AR | 46 |
| W-102R | 44 |
| W-104 | 27 |
| W-104A | 28 |
| W-105 | 29 |
| W-106 | 30 |
| W-107 | 31 |
| W-42 | 17 |

Sample Frequency: Semi-Annual Schedule Number: 1

Sample Months: J F M-Yes A M J J A S-Yes O N D

| Parameter | |
|---|---|
| 1 | COMMENT, SAMPLE ODOR |
| 2 | COMMENT, SAMPLE COLOR |
| 3 | COMMENT, SAMPLE TURBIDITY |
| 10 | TEMPERATURE, WATER (DEGREES CENTIGRADE) |
| 94 | SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C) |
| 341 | CHEMICAL OXYGEN DEMAND, FILTERED (MG/L) |
| 400 | PH, FIELD (STANDARD UNITS) |
| 946 | SULFATE, DISSOLVED (MG/L SO4) |
| 1020 | BORON, DISSOLVED (MG/L B) |
| 1145 | SELENIUM, DISSOLVED (UG/L SE) |
| 22413 | HARDNESS, TOTAL, FILTERED (MG/L AS CACO3) |
| 39036 | ALKALINITY, TOTAL FILTERED (MG/L AS CACO3) |
| 72020 | ELEVATION, GROUNDWATER (FEET ABOVE MSL) |

License Number: 4126 Facility: DAIRYLAND POWER COOP PHASE IV-BELVIDERE

FID: 606043900 DNR Region: West Central Region County: Buffalo

PLAN OF OPERATION APPROVAL

Group Category: Groundwater Monitoring Well Group Description: Elevation only

Group Number: 2 Group Name: WELLS TO BE ABANDONED

| Common Name | DNR ID # |
|---|---|
| STATION 2 | 2 |
| W-43 | 20 |

Sample Frequency: Semi-Annual Schedule Number: 2

Sample Months: J F M-Yes A M J J A S-Yes O N D

| Parameter |
|---|
| 72020 ELEVATION, GROUNDWATER (FEET ABOVE MSL) |

License Number: 4126. Facility: DAIRYLAND POWER COOP PHASE IV-BELVIDERE

FID: 606043900 DNR Region: West Central Region County: Buffalo

PLAN OF OPERATION APPROVAL

Group Category: Groundwater Monitoring Well Group Description: wells for background monitoring

Group Number: 8 Group Name: REPLACEMENT GROUNDWATER WELLS

| Common Name | DNR ID # |
|---|---|
| MW-101AR | 42 |
| W-100R | 40 |
| W-102AR | 46 |
| W-102R | 44 |

Sample Frequency: Quarterly Schedule Number: 10

Sample Months: J F M-Yes A M J-Yes J A S-Yes O N D-Yes

| Parameter | |
|---|---|
| 1 | COMMENT, SAMPLE ODOR |
| 2 | COMMENT, SAMPLE COLOR |
| 3 | COMMENT, SAMPLE TURBIDITY |
| 10 | TEMPERATURE, WATER (DEGREES CENTIGRADE) |
| 94 | SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C) |
| 341 | CHEMICAL OXYGEN DEMAND, FILTERED (MG/L) |
| 400 | PH, FIELD (STANDARD UNITS) |
| 631 | NITRITE PLUS NITRATE, DIS. 1 DET. (MG/L AS N) |
| 946 | SULFATE, DISSOLVED (MG/L SO4) |
| 950 | FLUORIDE, DISSOLVED (MG/L F) |
| 1000 | ARSENIC, DISSOLVED (UG/L AS) |
| 1005 | BARIUM, DISSOLVED (UG/L BA) |
| 1020 | BORON, DISSOLVED (MG/L B) |
| 1025 | CADMIUM, DISSOLVED (UG/L CD) |
| 1030 | CHROMIUM, DISSOLVED (UG/L CR) |
| 1040 | COPPER, DISSOLVED (UG/L CU) |
| 1049 | LEAD, DISSOLVED (UG/L PB) |
| 1056 | MANGANESE, DISSOLVED (UG/L MN) |
| 1075 | SILVER, DISSOLVED (UG/L AG) |
| 1090 | ZINC, DISSOLVED (UG/L ZN) |
| 1145 | SELENIUM, DISSOLVED (UG/L SE) |
| 22413 | HARDNESS, TOTAL, FILTERED (MG/L AS CACO3) |
| 39036 | ALKALINITY, TOTAL FILTERED (MG/L AS CACO3) |
| 71890 | MERCURY, DISSOLVED (UG/L HG) |
| 72020 | ELEVATION, GROUNDWATER (FEET ABOVE MSL) |

License Number: 4126 Facility: DAIRYLAND POWER COOP PHASE IV-BELVIDERE

FID: 606043900 DNR Region: West Central Region County: Buffalo

PLAN OF OPERATION APPROVAL

Group Category: Private Well Group Description: water supply

Group Number: 3 Group Name: WATER SUPPLY WELL

| Common Name | DNR ID # |
|---|---|
| PW-01 | 32 |
| PW-02 | 33 |

Sample Frequency: Semi-Annual Schedule Number: 3

Sample Months: J F M-Yes A M J J A S-Yes O N D

| Parameter | |
|---|---|
| 1 | COMMENT, SAMPLE ODOR |
| 2 | COMMENT, SAMPLE COLOR |
| 3 | COMMENT, SAMPLE TURBIDITY |
| 10 | TEMPERATURE, WATER (DEGREES CENTIGRADE) |
| 94 | SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C) |
| 340 | CHEMICAL OXYGEN DEMAND, UNFILTERED (MG/L) |
| 400 | PH, FIELD (STANDARD UNITS) |
| 410 | ALKALINITY, TOTAL (MG/L AS CACO3) |
| 900 | HARDNESS, TOTAL (MG/L AS CACO3) |
| 945 | SULFATE, TOTAL (MG/L SO4) |
| 1022 | BORON, TOTAL (MG/L B) |
| 1147 | SELENIUM, TOTAL (UG/L SE) |

License Number: 4126 Facility: DAIRYLAND POWER COOP PHASE IV-BELVIDERE
FID: 606043900 DNR Region: West Central Region County: Buffalo

PLAN OF OPERATION APPROVAL

Group Category: Leachate Group Description: collection tank
Group Number: 4 Group Name: LEACHATE COLLECTION TANK

| Common Name | DNR ID # |
|---|---|
| LEACHATE TANK | 401 |

Sample Frequency: Semi-Annual Schedule Number: 4
Sample Months: J F M-Yes A M J J A S-Yes O N D

| Parameter | |
|---|---|
| 1 | COMMENT, SAMPLE ODOR |
| 2 | COMMENT, SAMPLE COLOR |
| 3 | COMMENT, SAMPLE TURBIDITY |
| 94 | SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C) |
| 150 | SOLIDS, TOTAL SUSPENDED (MG/L) |
| 310 | BIOCHEMICAL OXYGEN DEMAND (MG/L, 5 DAY - 20DEG C) |
| 340 | CHEMICAL OXYGEN DEMAND, UNFILTERED (MG/L) |
| 400 | PH, FIELD (STANDARD UNITS) |
| 410 | ALKALINITY, TOTAL (MG/L AS CACO3) |
| 900 | HARDNESS, TOTAL (MG/L AS CACO3) |
| 940 | CHLORIDE, TOTAL OR DISSOLVED IN WTR SMPL (MG/L CL) |
| 945 | SULFATE, TOTAL (MG/L SO4) |
| 1022 | BORON, TOTAL (MG/L B) |
| 1027 | CADMIUM, TOTAL (UG/L CD) |
| 1051 | LEAD, TOTAL (UG/L PB) |
| 1055 | MANGANESE, TOTAL (UG/L MN) |
| 1147 | SELENIUM, TOTAL (UG/L SE) |
| 71900 | MERCURY, TOTAL (UG/L HG) |
| 74010 | IRON, TOTAL (MG/L FE) |

Sample Frequency: Annual Schedule Number: 5 ***** ACID / BASE Neutral Extractable *****
Sample Months: J F M A M J J A S-Yes O N D

Parameter

License Number: 4126 Facility: DAIRYLAND POWER COOP PHASE IV-BELVIDERE
FID: 606043900 DNR Region: West Central Region County: Buffalo

PLAN OF OPERATION APPROVAL

Group Category: Leachate Group Description: collection tank

Group Number: 4 Group Name: LEACHATE COLLECTION TANK ***** GROUP CONTINUED FROM PREVIOUS PAGE *****

| Common Name | DNR ID # |
|---|---|

Sample Frequency: Monthly Schedule Number: 6

Sample Months: J-Yes F-Yes M-Yes A-Yes M-Yes J-Yes J-Yes A-Yes S-Yes O-Yes N-Yes D-Yes

| Parameter | |
|---|---|
| 32 | LEACHATE, VOLUME PUMPED (1000 GALLONS) |

License Number: 4126 Facility: DAIRYLAND POWER COOP PHASE IV-BELVIDERE

FID: 606043900 DNR Region: West Central Region County: Buffalo

PLAN OF OPERATION APPROVAL

Group Category: Leachate Group Description: leachate head wells

Group Number: 5 Group Name: LEACHATE HEAD WELLS

| Common Name | DNR ID # |
|---|---|
| LH-1 | 601 |
| LH-2 | 604 |
| LH-3 | 607 |
| LH-4 | 610 |
| LH-5 | 613 |
| LH-6 | 616 |
| LH-7 | 619 |
| LH-8 | 622 |

Sample Frequency: Monthly Schedule Number: 7

Sample Months: J-Yes F-Yes M-Yes A-Yes M-Yes J-Yes J-Yes A-Yes S-Yes O-Yes N-Yes D-Yes

| Parameter | |
|---|---|
| 31 | LEACHATE, DEPTH IN FEET |
| 99423 | ELEVATION, LEACHATE (FEET ABOVE MEAN SEA LEVEL) |

License Number: 4126 Facility: DAIRYLAND POWER COOP PHASE IV-BELVIDERE

FID: 606043900 DNR Region: West Central Region County: Buffalo

PLAN OF OPERATION APPROVAL

Group Category: Surface Water Group Description: sed pond outfalls

Group Number: 7 Group Name: OUTFALLS

| Common Name | DNR ID # |
|---|---|
| OUTFALL 001 | 871 |
| OUTFALL 002 | 872 |

Sample Frequency: Semi-Annual Schedule Number: 9

Sample Months: J F M-Yes A M J J A S-Yes O N D

| Parameter | |
|---|---|
| 3 | COMMENT, SAMPLE TURBIDITY |
| 10 | TEMPERATURE, WATER (DEGREES CENTIGRADE) |
| 94 | SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C) |
| 340 | CHEMICAL OXYGEN DEMAND, UNFILTERED (MG/L) |
| 400 | PH, FIELD (STANDARD UNITS) |
| 410 | ALKALINITY, TOTAL (MG/L AS CACO3) |
| 900 | HARDNESS, TOTAL (MG/L AS CACO3) |
| 945 | SULFATE, TOTAL (MG/L SO4) |
| 1022 | BORON, TOTAL (MG/L B) |
| 1147 | SELENIUM, TOTAL (UG/L SE) |

License Number: 4126 Facility: DAIRYLAND POWER COOP PHASE IV-BELVIDERE

FID: 606043900 DNR Region: West Central Region County: Buffalo

PLAN OF OPERATION APPROVAL

Group Category: Surface Water Group Description: sed ponds

Group Number: 6 Group Name: STAFF GAGES

| Common Name | DNR ID # |
|---|---|
| SG-1 | 851 |
| SG-2 | 852 |

Sample Frequency: Semi-Annual Schedule Number: 8

Sample Months: J F M-Yes A M J J A S-Yes O N D

| Parameter | |
|---|---|
| 72020 | ELEVATION, GROUNDWATER (FEET ABOVE MSL) |

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

WISCONSIN
DEPT. OF NATURAL RESOURCES

Scott McCallum, Governor
Darrell Bazzell, Secretary
Scott A. Humrickhouse, Regional Director

West Central Region Headquarters
1300 W. Clairemont Avenue
PO Box 4001
Eau Claire, Wisconsin 54702-4001
Telephone 715-839-3700
FAX 715-839-6076
TDD 715-839-2786

March 11, 2002

Mr. Robert Carothers
Dairyland Power Cooperative
JPM Station
500 Old State Highway 35
Alma, WI. 54610

FID # 606009360
Buffalo Co.
SW/APPRV File

Subject: Construction Documentation Approval for Phase IV Liner , Alma Off-Site Ash Disposal Facility, Town of Belvidere, Buffalo County, License # 4126.

Dear Mr. Carothers:

We have completed our review of your report entitled " Dairyland Power Cooperative Phase IV Cell I Liner Construction Documentation Report." The report was prepared by RMT and was dated November 2001. The report was received on December 7, 2001. At this time we are approving the construction documentation for the Phase IV liner.

Conditions have been included requiring placement of four feet of ash by December 1, 2002, and inspection and repair of the drainage blanket as necessary. Additionally, Dairyland Power Cooperative has requested to increase the moisture content of the ash being placed on the Phase IV liner. A performance standard relating wheel rutting to moisture content of the ash being placed has also been established as a condition of the approval.

This approval should be attached to your May 15, 2001 Plan of Operation Approval.

Please contact Martin Herrick at (608) 789-5518 if you have any questions regarding this approval.

Sincerely,

David R. Lundberg
Waste Management Team Leader
West Central Region

cc: WA/3 – Files
Jack Tritt - WCR
Brian Kalvelage/Marty Herrick - LAX
Tony McKimmy - Dairyland Power Cooperative, 3200 East Avenue South, PO Box 817, LaCrosse, WI 54602-0817
Bernie Krantz - RMT

BEFORE THE
STATE OF WISCONISN
DEPARTMENT OF NATURAL RESOURCES

CONSTRUCTION DOCUMENTATION APPROVAL
PHASE IV, LINER

FOR THE

DAIRYLAND POWER COOPERATIVE
ALMA OFF-SITE ASH DISPOSAL FACILITY
TOWN OF BELVIDERE, BUFFALO COUNTY,
LICENSE # 4126

FINDINGS OF FACT

The Department finds that:

1. Dairyland Power Cooperative (DPC) owns and operates a nonhazardous solid waste disposal facility located in the NE1/4 of the NE1/4 of Section 19 and portions of Sections 18 and 20, Township 21 North, Range 12 West, Town of Belvidere, Buffalo County, Wisconsin,

2. The Department issued a conditional plan of operation approval for the facility on May 15, 2001.

3. The information submitted in connection with the construction documentation includes the following:
   a. A report entitled " Dairyland Power Cooperative Phase IV Liner Construction Documentation Report" and 15 associated engineering drawings dated November 2001.

4. Additional information considered in the review of the construction documentation;
   a. July 18, 2001, Dairyland Power Cooperative-Alma Offsite Disposal Facility (License #4126) Phase IV Disposal Area, Cell 1 Preconstruction Report,
   b. August 1, 2001, Dairyland Power Cooperative –Alma Offsite Disposal Facility (License #4126) Phase IV Disposal Area Cell 1 Preconstruction Report-Addendum #1,
   c. January 31, 2002 Fax from Tony McKimmy of Dairyland Power providing information on the status of the high capacity well and financial responsibility for the landfill,
   d. March 4,2002 response from RMT to a February 5, 2002 letter from Martin Herrick of the Department requesting additional information.

5. Construction inspections were performed by the Department for the following on:
   a. Low permeability barrier soils placement on September 8, 2001
   b. Geomembrane and GCL liner installation on September 14, 2001
   c. Sand Drainage blanket and leachate collection system installation on September 13, 2001
   d. Electrical resistivity testing of the liner on October 18, 2001.

6. On December 4, 2001 the Department submitted invoice # SWK-0262 to Dairyland Power Cooperative. The invoice included $1000 for review of the construction documentation and $2000 for four construction inspections. Full payment was received on December 26, 2001.

## CONCLUSIONS OF LAW

1. The Department has authority under ss. 289.43(7) and 289.43(8), Stats., and ch. NR 516, Wis. Adm. Code, to require that the owner of a solid waste disposal facility demonstrate that the facility has been constructed in substantial compliance with the May 15, 2001 Conditional Plan of Operation Approval.

2. If the conditions of approval set forth below are complied with the applicant will have demonstrated that the facility has been constructed in substantial compliance with the NR 500 to NR 590 Series of the Wisconsin Administrative Code and the May 15, 2001 Conditional Plan of Operation Approval.

3. The Department has authority under s. 289.30(6), Stats., to modify a plan of operation approval if the modification would not inhibit compliance with the applicable portions of chs. NR 500- 590, Wis. Adm. Code

## CONDITIONS OF APPROVAL

The Department hereby approves the construction documentation for the Dairyland Power Cooperative Phase IV Liner at the Alma Off-Site Ash Disposal Facility subject NR 500-590, Wis. Adm. Code, the May 15, 2001 Conditional Plan of Operation Approval and the following conditions:

1. Dairyland Power Cooperative shall inspect the sand drainage blanket of Phase IV on a monthly basis and make repairs as necessary. Inspections and repair of the sand drainage blanket shall continue until there has been enough waste placed to prevent it from eroding.

2. The depth of wheel rutting from the haul trucks placing the ash shall be used as a performance measure to limit the moisture content of the ash placed in Phase IV. When ash is being placed no wheel ruts deeper than 2 inches shall be allowed.

3. Dairyland Power Cooperative shall place four feet of ash on the bottom and initial 10 ft of slope for the newly constructed module by December 1, 2002.

The Department retains the jurisdiction to either require the submittal of additional information or to modify this approval at any time if, in the Department's opinion, conditions warrant further modifications. Unless specifically noted, the conditions of this approval do not supersede or replace any previous conditions of approval for this facility.

NOTIFICATION OF APPEAL RIGHTS

If you believe that you have a right to challenge this decision you should know that Wisconsin Statues and Administrative Code establish time periods within which requests to review Department decisions must be filed. For judicial review of a decision pursuant to ss. 227.52 and 227.53, Stats., you have 30 days after the decision is mailed, or otherwise served by the Department, to file your petition with the appropriate circuit court and serve the petition on the Department. Such a petition for judicial review shall name the Department of Natural Resources as the respondent.

Dated: March 11, 2002

Department of Natural Resources
For the Secretary

David R. Lundberg
Waste Management Team Leader
West Central Region

Martin Herrick, P.E.
Environmental Engineer
West Central Region

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Jim Doyle, Governor
Scott Hassett, Secretary
Scott A. Humrickhouse, Regional Director

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TDD 715-839-2786

March 4, 2004

Mr. Robert Carothers
Dairyland Power Cooperative
JPM Station
500 Old State Highway 35
Alma, WI, 54610

FID # 606009360
Buffalo Co.
SW/APPRV File

Subject: Conditional Plan Modification to the Plan of Operation Approval for the Phase IV Cap, Alma Off-Site Ash Disposal Facility, Town of Belvidere, Buffalo County, License # 4126

Dear Mr. Carothers:

We have completed our review of your report entitled " Plan of Operation Modification Dairyland Power Cooperative Phase IV Disposal Area - License 4126, Alma Off-Site Ash Disposal facility, Town of Belvedere, Buffalo County, Wisconsin." The January 2004 report was prepared by RMT, and received by the Department on January 26, 2004. At this time we are conditionally approving the proposed plan modification for the Phase IV cap.

Conditions have been included for submittal of cap details, payment of the plan review fee, revised closure costs and construction activities. This approval should be attached to your May 15, 2001 Plan of Operation Approval.

Please contact Martin Herrick at (608) 789-5518 if you have any questions regarding this approval.

Sincerely,

David R. Lundberg
Waste Management Team Leader
West Central Region

cc: Jack Tritt - WCR
Brian Kalvelage/Marty Herrick - LAX
Tony McKimmy - Dairyland Power Cooperative, 3200 East Avenue South, PO Box 817, La Crosse, WI 54602-0817
Bernie Krantz - RMT, 744 Heartland Trail 53717-1934, PO Box 8923, Madison, WI 53708-8923
Bob Grefe-WA/3

BEFORE THE
STATE OF WISCONISN
DEPARTMENT OF NATURAL RESOURCES

CONDITIONAL PLAN OF OPERATION MODIFICATION
PHASE IV, CAP

FOR THE

DAIRYLAND POWER COOPERATIVE
ALMA OFF-SITE ASH DISPOSAL FACILITY
TOWN OF BELVIDERE, BUFFALO COUNTY,
LICENSE # 4126

## FINDINGS OF FACT

The Department finds that:

1. Dairyland Power Cooperative (DPC) owns and operates a nonhazardous solid waste disposal facility located in the NE1/4 of the NE1/4 of Section 19 and portions of Sections 18 and 20, Township 21 North, Range 12 West, Town of Belvidere, Buffalo County, Wisconsin.
2. The Department issued a conditional plan of operation approval for the facility on May 15, 2001.
3. The information submitted in connection with the construction documentation includes the following:
   a. A report entitled " Plan of Operation Modification Dairyland Power Cooperative Phase IV Disposal Area- License #4126 Alma Off-Site Ash Disposal Facility Town of Belvedere Buffalo County, Wisconsin." The report was dated January 2004.
4. On February 24, 2004 the Department submitted invoice # 0007307 for $1500 to Dairyland Power Cooperative. The invoice of $1500 was for review of the proposed plan of operation modification.

## CONCLUSIONS OF LAW

1. The Department has authority under s. 289.30(6)Stats. to modify a plan of operation approval if the modification would not inhibit compliance with the applicable portions of chs. NR 500-590, Wis. Adm. Code.
2. The Department has authority to approve a plan operation modification with special conditions if the conditions are needed to ensure compliance with the applicable portions of chs. NR 500-590, Wis. Adm. Code.
3. The conditions of approval set forth below are needed to ensure compliance with the applicable portions of chs. NR 500- 590, Wis. Adm. Code
4. In accordance with the foregoing, the Department has authority under ch. 289., Stats., to issue the following conditional plan of operation approval.

CONDITIONS OF APPROVAL

The Department hereby approves the proposed plan modifications for the Dairyland Power Cooperative Phase IV Cap at the Alma Off-Site Ash Disposal Facility subject to NR 500-590, Wis. Adm. Code, the May 15, 2001 Conditional Plan of Operation Approval and the following conditions:

1. The closure costs are revised as follows:

CLOSURE COSTS

| Item | Quantity | Unit Cost | Estimated Cost |
|---|---|---|---|
| Barrier Layer (24 in) Fine Grained Soil | 40,170 cy | $6.5/cy | $261,100 |
| Geomembrane 40 mil VFPE | 542,300 sf | $.36/sf | $195,200 |
| Granular Drainage Layer (12in) | 60,260 cy | $5.57/cy | $335,700 |
| Vegetative Layer (18 in) | 90,390cy | $1.26/cy | $113,900 |
| Topsoil (6 in) | 10,000 cy | $1.50/cy | $15,000 |
| Surface Water Control System | | | $50,000 |
| Seed, Fertilize, Mulch | 12.4 acre | $1350/acre | $16,700 |
| Construction Plans | | | $20,000 |
| Construction Observation | 16 weeks | $5500/week | $88,000 |
| Documentation Report | | | $20,000 |
| Contingencies (25%) | | | $278,900 |
| Total Cost | | | $1,394,500 |

2. The Department's inspection schedule in Condition 9 of the May 15, 2001 Plan of Operation Approval is revised as follows:

| | Liner Construction | Cap Construction |
|---|---|---|
| Cells | 1, 2A, 2B, 3, 4A, 4B | 1,2A, 2B, 3, 4A, 4B |
| Inspections | Subase & Barrier Soils | Placing/compacting Select Flyash Layer |
| | Place GCL & Geomembrane | Place Geomembrane |
| | Leachate Collection System Components | Drainage Layer |
| | Drainage Blanket | Topsoil Placement |

3. Detail Drawings for the following items shall be provided to the Department within 60 days from the date of this approval:

   a. Transition details between the cap and the liner,
   b. Revised surface features,
   c. Cross section of the interior berm.

4. Rock size for the drainage layer material shall be limited to two inches in size or smaller.

5. Payment of the February 24, 2004, plan review fee, Invoice # 0007307, shall be made to the Department within 30 days from the date it was received.

The Department retains the jurisdiction to either require the submittal of additional information or to modify this approval at any time if, in the Department's opinion, conditions warrant further modifications. Unless specifically noted, the conditions of this approval do not supersede or replace any previous conditions of approval for this facility.

## NOTIFICATION OF APPEAL RIGHTS

If you believe that you have a right to challenge this decision you should know that Wisconsin Statues and Administrative Code establish time periods within which requests to review Department decisions must be filed. For judicial review of a decision pursuant to ss. 227.52 and 227.53, Stats., you have 30 days after the decision is mailed, or otherwise served by the Department, to file your petition with the appropriate circuit court and serve the petition on the Department. Such a petition for judicial review shall name the Department of Natural Resources as the respondent.

Dated: March 4 2004

Department of Natural Resources
For the Secretary

David R. Lundberg
Waste Management Team Leader
West Central Region

Martin Herrick, P.E.
Environmental Engineer
West Central Region

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Jim Doyle, Governor
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September 22, 2006

COPY

Mr. Bill Kowalski
Dairyland Power Cooperative
3200 East Avenue South
PO Box 817
La Crosse, WI 54601-0817

FID# 606009360
License # 4126
Buffalo County
SW/Approvals

**Subject:** WDNR approval of proposed PAL/ACL calculations for the Dairyland Power Cooperative Phase IV Ash Disposal Facility, Town of Belvidere, Buffalo County Wisconsin. (License No. 4126)

Dear Mr. Kowalski:

On May 12, 2006 the Department received your report entitled "Proposed PAL and ACL Values for wells W100AR, W100R, W102AR and W102R". This report was submitted on your behalf by your environmental consultant, RMT, Inc. This report proposed PAL and ACL calculation values for specific replacement wells at the landfill facility.

On July 21, 2006 the Department received additional information with respect to the proposed PAL/ACL calculations. This additional information submittal clarified some issues and also withdrew the requested ACL for mercury at monitoring wells W100AR, W100R and W102AR. The Department has completed our review of the requested modifications to the plan of operation for the Dairyland Phase IV Landfill. You will be pleased to know that, with minor exceptions, the proposed PALs/ACLs have been accepted subject to the conditions listed in the attached approval.

Section 4 of the above-mentioned report requests exemptions to NR 140.28, Wis. Adm. Code for specific parameters. Exemptions for Barium, Cadmium and Mercury are not warranted, and therefore not approved, because sampling results of these parameters did not exceed the NR 140 PAL value on two or more occasions. An exemption to NR 140.28, Wis. Adm. Code for "Nitrate + Nitrite" parameter is approved subject to the approved ACL values in the attached approval.

Please remember that all future PAL/ACL calculation submittals are considered separate plan modifications and are also subject to the requirements of NR 500.05, 507.18, 507.27, and 520.15 Wis. Adm. Codes.

If you have questions regarding this approval, please contact Brian Kalvelage at (608) 785-9983.

Sincerely,

David R. Lundberg
Waste Program Manager

cc: Brian Kalvelage/Martin Herrick-WDNR, La Crosse Service Center
Dave Lundberg/Sue Brumberg-WDNR, Eau Claire Service Center

BEFORE THE
STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES

PAL/ACL PLAN MODIFICATION APPROVAL
FOR
DAIRYLAND POWER COOPERATIVE
PHASE IV DISPOSAL AREA
ALMA OFFSITE ASH DISPOSAL FACILITY
TOWN OF BELVIDERE, WISCONSIN
WDNR LICENSE # 4126

## FINDINGS OF FACT

The Department finds that:

1. Dairyland Power Cooperative (DPC) owns and operates an ash disposal landfill in the NE1/4 of the NE1/4 of Section 19 and portions of Sections 18 and 20, Township 21 North, Range 12 West, Town of Belvidere. Buffalo County, Wisconsin

2. The Department issued a conditional plan of operation approval for the facility on May 15, 2001 under which the landfill is currently operating (including all subsequent plan modification approvals).

3. On May 12, 2006 the Department received a report submitted on your behalf by your environmental consultant, RMT, Inc. The report was entitled, "Proposed PAL and ACL Values for Wells W100AR, W100R, W102AR and W102R".

4. On May 30, 2006 the Department sent an email request for additional information. This information request was sent to Bernie Krantz and Tom Koch of RMT, Inc.

5. On May 31, 2006 the Department received full payment of $1650 for invoice # 0008068 related to the review of the May 12, 2006 report.

6. On July 21, 2006 Waste Program staff in the WDNR La Crosse Service Center received additional information related to the proposed PAL/ACL calculation proposal. This document provided answers to the Department's May 30, 2006 request for additional information, and also withdrew all the requested ACLs for Mercury (parameter).

7. On September 20, 2006 the Department sent a draft of this approval to Dairyland Power Cooperative for review and comment. On September 21, 2006 the Department received comments on the draft.

8. Additional documents considered in the review of the plan of operation include the following:

   a. The Department's May 15, 2001 Conditional Plan of Operation Approval.

b. July 24, 2003 Groundwater exceedance notification for the DPC-Phase IV, Alma Ash Disposal Landfill.

c. The Department's March 21, 2001 memorandum from Steve Karklins. This memo discussed initial PALs and ACLs for the Plan of Operation.

d. Groundwater information contained within the March 10, 2004 document entitled "2003 Annual Report for the Alma Off-site Ash Landfill, License #4126.

e. Department paper and electronic files for the Dairyland Power Cooperative-Phase IV-Alma Offsite Ash Disposal Landfill (#4126).

9. Based on an examination of the groundwater quality data for the existing facility, and the information listed in the preceding Findings of Fact, the Department finds the following:

a. Baseline concentrations for detection monitoring indicator parameters were established for the following substances at the wells listed below:

| Substances | Wells |
|---|---|
| Alkalinity | W-100AR, W-100R, W-102AR, and W-102R |
| COD | W-100AR, W-100R, W-102AR, and W-102R |
| Spec. Conductance | W-100AR, W-100R, W-102AR, and W-102R |
| Hardness | W-100AR, W-100R, W-102AR, and W-102R |

b. Baseline concentrations for detection monitoring parameters were established for the following substances at the wells listed below:

| Substances | Wells |
|---|---|
| Nitrate+Nitrite (as N) | W-100AR and W-100R |

10. The special condition set forth below is needed to assure that the facility is operated in an environmentally sound manner and will not inhibit compliance with the standards set forth in the applicable provisions of chs. NR 500-538, Wis. Adm. Code.

11. If the special conditions set forth below are complied with, the proposal will meet the requirements of chs. NR 500-538, Wis. Adm. Code.

## GRANT OF EXEMPTIONS

1. Pursuant to s. NR 140.28, Wis. Adm. Code, Dairyland Power Cooperative has demonstrated circumstances which warrant exemptions to groundwater quality standards at certain wells for nitrate+nitrite (as N), in chapter NR 140, Wis. Adm. Code, as specified in NR 140.28, Wis. Adm. Code, at its Phase IV-Alma Offsite Landfill. Therefore, the Department grants the exemptions to the groundwater standards. The exemptions apply to wells and parameters specified in Finding of Fact 9 of this document. The Department may modify this approval, based on additional information.

## CONCLUSIONS OF LAW

1. The Department has the authority to approve a modification to the plan of operation with special conditions if the conditions are needed to ensure compliance with the applicable portions of chs. NR 500 to 538, Wis. Adm. Code.

2. The Department has the authority under s. 160.15(3), Stats., and s. NR 140.20, Wis. Adm. Code, to establish preventive action limits for indicator parameters.

3. The Department has the authority under s. 160.19(8), Stats., and s. NR 140.28, Wis. Adm. Code, to grant exemptions to groundwater standards and to specify terms and conditions under which the department may seek remedial action relating to standards for which an exemption has been granted. This may include establishing alternative concentration limits.

4. The conditions of approval set forth below are needed to assure compliance with ch. NR 140, Wis. Adm. Code and applicable portions of chs. NR 500 through 538, Wis. Adm. Code.

In accordance with the foregoing, the Department has authority under chs. 160 and 289, Stats., to issue the following conditional approval for modifying the plan of operation/closure plan.

## CONDITIONAL PLAN OF OPERATION APPROVAL

The Department hereby approves the proposed PAL and ACL calculations/plan modification for the Dairyland Phase IV-Alma Offsite Landfill, subject to compliance with chs. NR 500-538, Wis. Adm. Code, and the following conditions:

1. The preventive action limits (PALs) for indicator parameters at this facility are established as detailed in the table below:

PREVENTIVE ACTION LIMITS

| DNR ID # | Well Name | Alkalinity (mg/L) | Spec. Conductance (umho/cm @25 C) | Hardness (mg/L) | COD (ug/L) |
|---|---|---|---|---|---|
| 042 | W-100AR | 420 | 790 | 440 | 34 |
| 040 | W-100R | 400 | 760 | 420 | 31 |
| 046 | W-102AR | 370 | 700 | 390 | 31 |
| 044 | W-102R | 370 | 700 | 380 | 30 |

2. The alternative concentration limits (ACLs) for parameters at this facility are established as detailed in the table below:

ALTERNATIVE CONCENTRATION LIMITS

| DNR ID # | Well Name | Nitrate + Nitrite (as N) mg/L |
|---|---|---|
| 042 | W-100AR | 3.0 |
| 040 | W-100R | 3.1 |

The Department retains the right to require the submittal of additional information or to modify this approval at any time if, in the Department's opinion, further modifications are necessary. Unless specifically noted, the conditions of this approval do not supersede or replace any previous conditions of approval for this facility.

## NOTICE OF APPEAL RIGHTS

If you believe you have a right to challenge this decision made by the Department, you should know that Wisconsin statutes, administrative codes and case law establish time periods and requirements for reviewing Department decisions.

To seek judicial review of the Department's decision, sections 227.52 and 227.53, Stats., establish criteria for filing a petition for judicial review. Such a petition shall be filed with the appropriate circuit court and shall be served on the Department. The petition shall name the Department of Natural Resources as the respondent.

Dated: Sept. 22, 2006 SB

Department of Natural Resources
For the Secretary

David R. Lundberg
Waste Program Manager
West Central Region

Brian Kalvelage
Region Hydrogeologist
West Central Region

**State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES**

WISCONSIN
DEPT. OF NATURAL RESOURCES

Jim Doyle, Governor
Scott Hassett, Secretary
Scott Humrickhouse, Regional Director

West Central Region Headquarters
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TTY Access via relay - 711

March 28, 2007

Mr. Robert Carothers
Dairyland Power Cooperative
JPM Station
500 Old State Highway 35
Alma, WI. 54610

FID # 606009360
Buffalo County
SW/APPRV File

Subject: Construction Documentation Approval for Phase IV Cell 2A Liner, Alma Off-Site Ash Disposal Facility, Town of Belvidere, Buffalo County, License # 4126.

Dear Mr. Carothers:

We have completed our review of your report entitled "Dairyland Power Cooperative Phase IV Cell 2A Liner Construction Documentation Report." The report was prepared by RMT and was dated January 2007. The report was hand delivered to the La Crosse Service Center on January 25, 2007. At this time we are approving the construction documentation for the Phase IV Cell 2A liner.

Conditions have been included for placement of four feet of ash by December 1, 2007, inspection and repair of the drainage blanket, associated surface water control features and review of the closure and long term care costs for the landfill. Note that the condition in the March 11, 2002 construction documentation approval establishing no wheel rutting from haul trucks as a basis for the maximum moisture content of the ash still exists and is repeated in this approval.

This approval should be attached to your May 15, 2001 Plan of Operation Approval.

Please contact Martin Herrick at (608) 789-5518 if you have any questions regarding this approval.

Sincerely,

David R. Lundberg
Waste Program Manager
West Central Region

cc: Brian Kalvelage/Marty Herrick-LAX
Wendy Berndt, Dairyland Power Cooperative, 3200 East Avenue South, PO Box 817, La Crosse, WI 54602-0817
Bernie Krantz, RMT

BEFORE THE
STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES
CONSTRUCTION DOCUMENTATION APPROVAL
PHASE IV, CELL 2A LINER
FOR THE
DAIRYLAND POWER COOPERATIVE
ALMA OFF-SITE ASH DISPOSAL FACILITY
TOWN OF BELVIDERE, BUFFALO COUNTY,
LICENSE # 4126

FINDINGS OF FACT

The Department finds that:

1. Dairyland Power Cooperative (DPC) owns and operates a nonhazardous solid waste disposal facility located in the NE1/4 of the NE1/4 of Section 19 and portions of Sections 18 and 20, Township 21 North, Range 12 West, Town of Belvidere, Buffalo County, Wisconsin,

2. The Department issued a conditional plan of operation approval for the facility on May 15, 2001.

3. The Department issued a conditional construction documentation approval for the first cell's liner on March 11, 2002.

4. The information submitted in connection with the construction documentation includes the following:
   a. A report entitled "Phase IV, Cell 2A Liner Construction Dairyland Power Cooperative Documentation Report Alma Off-site Disposal Facility" and 15 associated engineering drawings dated January 2007.
5. Additional information considered in the review of the construction documentation:
   a. August 15, 2006 Dairyland Power Cooperative-Alma Offsite Disposal Facility (License #4126) Phase IV Disposal Area, Cell 2A Preconstruction Report.
   b. September 29, 2006 Dairyland Power Cooperative–Alma Offsite Disposal Facility (License #4126) Phase IV Disposal Area Cell 1 Preconstruction Report-Addendum #1.
   c. March 31, 2006 Report for Coal Ash testing for GCL Compatibility Phase IV Disposal Area, License # 4126-Dairyland Power Cooperative.
   d. 2006 Annual Report for the Alma Off-site Ash Landfill, License #04126.

6. Construction inspections were performed by the Department as follows:
   a. Low permeability barrier soils placement on August 10, 2006 by Martin Herrick,
   b. Geomembrane and GCL liner installation on September 12, 2006 by Martin Herrick,
   c. Sand Drainage blanket and leachate collection system installation on October 18, 2006 by Martin Herrick,
   d. Electrical resistivity testing of the liner on October 26, 2006 by Brian Kalvelage.

7. On January 29, 2007 the Department submitted invoice # 000-8247 to Dairyland Power Cooperative. The invoice included $1100 for review of the construction documentation and $2200 for four construction inspections. Full payment was received on February 23, 2007.

## CONCLUSIONS OF LAW

1. The Department has authority under ss. 289.43(7) and 289.43(8), Stats., and ch. NR 516, Wis. Adm. Code, to require that the owner of a solid waste disposal facility demonstrate that the facility has been constructed in substantial compliance with the May 15, 2001 Conditional Plan of Operation Approval.

2. If the conditions of approval set forth below are complied with the applicant will have demonstrated that the facility has been constructed in substantial compliance with the NR 500 to NR 590 Series of the Wisconsin Administrative Code and the May 15, 2001 Conditional Plan of Operation Approval.

3. The Department has authority under s. 289.30(6), Stats., to modify a plan of operation approval if the modification would not inhibit compliance with the applicable portions of chs. NR 500- 590, Wis. Adm. Code

## CONDITIONS OF APPROVAL

The Department hereby approves the construction documentation for the Dairyland Power Cooperative Phase IV Cell 2A Liner at the Alma Off-Site Ash Disposal Facility subject NR 500-590, Wis. Adm. Code, the May 15, 2001 Conditional Plan of Operation Approval and the following conditions:

1. Dairyland Power Cooperative shall inspect the sand drainage blanket of Phase IV Cell 2A on a monthly basis and make repairs as necessary. Inspections and repair of the sand drainage blanket shall continue until there has been enough waste placed to prevent it from eroding.

2. The depth of wheel rutting from the haul trucks placing the ash shall be used as a performance measure to limit the moisture content of the ash placed in Phase IV Cell, 2A. When ash is being placed no wheel ruts deeper than 2 inches shall be allowed.

3. Dairyland Power Cooperative shall place four feet of ash on the bottom and initial 10 ft of slope for the newly constructed cell by December 1, 2007.

4. Erosion of the surface water control features shall be repaired as necessary.

5. The closure and long term care costs for the Phase IV landfill shall be reviewed and updated as necessary. If revisions are required they shall be submitted to the Department within 90 days from the date of this approval.

The Department retains the jurisdiction to either require the submittal of additional information or to modify this approval at any time if, in the Department's opinion, conditions warrant further modifications. Unless specifically noted, the conditions of this approval do not supersede or replace any previous conditions of approval for this facility.

NOTIFICATION OF APPEAL RIGHTS

If you believe that you have the right to challenge this decision made by the Department, you should know that Wisconsin statues, administrative codes and case law establish time periods and requirements for reviewing Department decisions.

To seek judicial review of the Department's decision, sections 227.52 and 227.53, Stats. establish criteria for filing a petition for judicial review. Such a petition shall be filed with the appropriate circuit court and shall be served on the Department. The petition shall name the Department of Natural Resources as the respondent.

Dated: March 28, 2007

Department of Natural Resources
For the Secretary

David R. Lundberg
Waste Program Manager
West Central Region

Martin Herrick, P.E.
Environmental Engineer
West Central Region

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

WISCONSIN
DEPT. OF NATURAL RESOURCES

Jim Doyle, Governor
Matthew J. Frank, Secretary
Scott A. Humrickhouse, Regional Director

West Central Region Headquarters
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Telephone 715-839-3700
FAX 715-839-6076
TDD 715-839-2786

March 21, 2008

Mr. Robert Carothers
Dairyland Power Cooperative
JPM Station
500 Old State Highway 35
Alma, WI. 54610

FID # 606009360
Buffalo Co.
SW/APPRV File

Subject: Construction Documentation Approval for Phase IV Cell 2B Liner, Alma Off-Site Ash Disposal Facility, Town of Belvidere, Buffalo County, License # 4126.

Dear Mr. Carothers:

We have completed our review of your report entitled "Dairyland Power Cooperative Phase IV Cell 2B Liner Construction Documentation." The report was prepared by RMT and was dated January 2008. The report was received in the La Crosse Service Center on February 4, 2008. At this time we are approving the construction documentation for the Phase IV Cell 2B liner.

Conditions have been included for payment of the plan review and construction inspections invoice, placement of four feet of ash by December 1, 2009, inspection and repair of the drainage blanket, associated surface water control features and review of the closure and long term care costs for the landfill.

This approval should be attached to your May 15, 2001 Plan of Operation Approval.

Please contact Martin Herrick at (608) 789-5518 if you have any questions regarding this approval.

Sincerely,

David R. Lundberg
Waste Management Team Leader
West Central Region

cc: Brian Kalvelage/Marty Herrick-LAX
Wendy Berndt-Dairyland Power Cooperative, 3200 East Avenue South, PO Box 817, La Crosse, WI 54602-0817
Curt Madsen - RMT, 744 Heartland Trail, Madison, WI 53717

BEFORE THE
STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES

CONSTRUCTION DOCUMENTATION APPROVAL
PHASE IV, CELL 2B LINER

FOR THE
DAIRYLAND POWER COOPERATIVE
ALMA OFF-SITE ASH DISPOSAL FACILITY
TOWN OF BELVIDERE, BUFFALO COUNTY,
LICENSE # 4126

## FINDINGS OF FACT

The Department finds that:

1. Dairyland Power Cooperative (DPC) owns and operates a nonhazardous solid waste disposal facility located in the NE1/4 of the NE1/4 of Section 19 and portions of Sections 18 and 20, Township 21 North, Range 12 West, Town of Belvidere, Buffalo County, Wisconsin,

2. The Department issued a conditional plan of operation approval for the facility on May 15, 2001.

3. The Department issued conditional construction documentation approvals for the cell's I and 2A liners on March 11, 2002 and March 28, 2007 respectively.

4. The information submitted in connection with the construction documentation includes the following:
   a. A report entitled " Phase IV, Cell 2B Liner Construction Dairyland Power Cooperative Documentation Report Alma Off-site Disposal Facility" and 12 associated engineering drawings dated January 2008.

5. Additional information considered in the review of the construction documentation;
   a. June 18, 2007 Dairyland Power Cooperative-Alma Offsite Disposal Facility (License #4126) Phase IV Disposal Area, Cell 2B Preconstruction Report,
   b. September 29, 2006 Dairyland Power Cooperative –Alma Offsite Disposal Facility (License #4126) Phase IV Disposal Area Cell 1 Preconstruction Report-Addendum #1,
   c. March 31, 2006 Report for Coal Ash testing for GCL Compatibility Phase IV Disposal Area, License # 4126-Dairyland Power Cooperative,
   d. March 12, 2008 Annual Report for the Alma Off-site Ash Landfill, License #04126.

6. Construction inspections were performed by the Department for the following on:
   a. Subbase preparation on 3/23/2007 by Martin Herrick,
   b. Low permeability barrier soils placement on 6/26/2007 by Martin Herrick,
   c. Geomembrane and GCL liner installation on 8/02/2007 and 8/14/2007 by Martin Herrick,
   d. Sand Drainage blanket and leachate collection system installation on 9/10/2007 by Martin Herrick,

7. On February 5, 2008 the Department submitted invoice # 000-8565 to Dairyland Power Cooperative. The invoice included $1100 for review of the construction documentation and $2200 for four construction inspections.

## CONCLUSIONS OF LAW

1. The Department has authority under ss. 289.43(7) and 289.43(8), Stats., and ch. NR 516, Wis. Adm. Code, to require that the owner of a solid waste disposal facility demonstrate that the facility has been constructed in substantial compliance with the May 15, 2001 Conditional Plan of Operation Approval.

2. If the conditions of approval set forth below are complied with the applicant will have demonstrated that the facility has been constructed in substantial compliance with the NR 500 to NR 590 Series of the Wis. Adm. Code and the May 15, 2001 Conditional Plan of Operation Approval.

3. The Department has authority under s. 289.30(6), Stats., to modify a plan of operation approval if the modification would not inhibit compliance with the applicable portions of chs. NR 500- 590, Wis. Adm. Code

## CONDITIONS OF APPROVAL

The Department hereby approves the construction documentation for the Dairyland Power Cooperative Phase IV Cell 2B Liner at the Alma Off-Site Ash Disposal Facility subject NR 500-590, Wis. Adm. Code, the May 15, 2001 Conditional Plan of Operation Approval and the following conditions:

1. Dairyland Power Cooperative shall inspect the sand drainage blanket of Phase IV Cell 2B after major storm events and on a monthly basis and make repairs as necessary. Inspections and repair of the sand drainage blanket shall continue until there has been enough waste placed to prevent it from eroding.

2. The depth of wheel rutting from the haul trucks placing the ash shall be used as a performance measure to limit the moisture content of the ash placed in Phase IV Cell, 2B. When ash is being placed no wheel ruts deeper than 2 inches shall be allowed.

3. Dairyland Power Cooperative shall place four feet of ash on the bottom and initial 10 ft of slope for the newly constructed cell by December 1, 2009.

4. Cleaning and restoration of the surface water control features shall be performed as necessary.

5. The closure and long term care costs for the Phase IV landfill shall be reviewed and updated as necessary. If revisions are required they shall be submitted to the Department within 90 days from the date of this approval.

The Department retains the jurisdiction to either require the submittal of additional information or to modify this approval at any time if, in the Department's opinion, conditions warrant further modifications. Unless specifically noted, the conditions of this approval do not supersede or replace any previous conditions of approval for this facility.

NOTIFICATION OF APPEAL RIGHTS

If you believe that you have the right to challenge this decision made by the Department, you should know that Wisconsin statues, administrative codes and case law establish time periods and requirements for reviewing Department decisions.

To seek judicial review of the Department's decision, sections 227.52 and 227.53, Stats. establish criteria for filing a petition for judicial review. Such a petition shall be filed with the appropriate circuit court and shall be served on the Department. The petition shall name the Department of Natural Resources as the respondent.

Dated: March 21, 2008

Department of Natural Resources
For the Secretary

David R. Lundberg
Waste Management Team Leader
West Central Region

Martin Herrick, P.E.
Environmental Engineer
West Central Region

FGD Approval! 12-14-09

# State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Jim Doyle, Governor
Matthew Frank, Secretary
Scott A. Humrickhouse, Regional Director

West Central Region Headquarters
1300 W. Clairemont Avenue
PO Box 4001
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TDD 715-839-2786

December 4, 2009

Mr. Robert Carothers
Dairyland Power Cooperative
JPM Station
500 Old State Highway 35
Alma, WI. 54610

FID # 606009360
Buffalo Co.
SW/APPRV File

Subject: Conditional Plan Modification to the Plan of Operation Approval for the Phase IV Landfill, Alma Off-Site Ash Disposal Facility, Town of Belvidere, Buffalo County, License # 4126.

Dear Mr. Carothers:

We have completed our review of your May 4, 2009 letter and April 15, 2009 addendum requesting to add another coal combustion byproduct and eliminate the annual coal testing for geocomposite liner (GCL) compatibility. The letter requests an expedited modification to the plan of operation for these items. The addendum which was prepared by RMT provides a leaching potential and GCL compatibility analysis of Sherco #3 flue gas desulfurization (FGD) scrubber material. The Sherco #3 FGD scrubber material is believed to be similar to the DPC Genoa Station Unit 3 FGD scrubber which is under construction. While the report was submitted as an expedited plan modification we are conditionally approving the addition of the FGD material and eliminating the annual GCL compatibility testing for the Phase IV Landfill.

Conditions have been included for characterization of the material at the time it is generated and payment of the plan review fee. This approval should be attached to your May 15, 2001 Plan of Operation Approval.

Please contact Martin Herrick at (608) 789-5518 if you have any questions regarding this approval.

Sincerely,

Thomas Woletz, P.E.
Air and Waste Leader
West Central Region

cc: Brian Kalvelage/Marty Herrick-LAX
Curt Madsen, RMT, 744 Heartland Trail 53717-1934, PO Box 8923, Madison, WI 53708-8923

BEFORE THE
STATE OF WISCONISN
DEPARTMENT OF NATURAL RESOURCES

CONDITIONAL PLAN OF OPERATION MODIFICATION
WASTE ADDITION
FOR
PHASE IV

DAIRYLAND POWER COOPERATIVE
ALMA OFF-SITE ASH DISPOSAL FACILITY
TOWN OF BELVIDERE, BUFFALO COUNTY,
LICENSE # 4126

## FINDINGS OF FACT

The Department finds that:

1. Dairyland Power Cooperative (DPC) owns and operates a nonhazardous solid waste disposal facility located in the NE1/4 of the NE1/4 of Section 19 and portions of Sections 18 and 20, Township 21 North, Range 12 West, Town of Belvidere, Buffalo County, Wisconsin.
2. The Department issued a conditional plan of operation approval for the facility on May 15, 2001.
3. On May 4, 2009 DPC submitted a letter to the Department requesting that the annual GCL compatibility testing be dropped and add the FGD material from the Genoa Station # 3 scrubber to the Phase IV landfill. The FGD material will be generated from the operation of new air pollution control equipment.
4. On December 3, 2009 the Department submitted invoice # 4206-9139 for $1650 to Dairyland Power Cooperative for plan review of the May 4, 2009 report and April 15, 2009 Addendum.

## CONCLUSIONS OF LAW

1. The Department has authority under s. 289.30(6)Stats. to modify a plan of operation approval if the modification would not inhibit compliance with the applicable portions of chs. NR 500-590, Wis. Adm. Code.
2. The Department has authority to approve a plan operation modification with special conditions if the conditions are needed to ensure compliance with the applicable portions of chs. NR 500-590, Wis. Adm. Code.
3. The conditions of approval set forth below are needed to ensure compliance with the applicable portions of chs. NR 500- 590, Wis. Adm. Code
4. In accordance with the foregoing, the Department has authority under ch. 289., Stats., to issue the following conditional plan of operation approval.

## CONDITIONS OF APPROVAL

1. Payment of the $1650 plan review fee, Invoice # 4206-9139, shall be made to the Department within 30 days from the date it was received.
2. The results of the FGD material characterization from DPC Genoa Station Unit 3 shall be submitted to the Department within 90 days of being generated. The characterization shall include but not be limited to the following analytics:
   a. Gradation with fraction greater than P200,
   b. Moisture Content,
   c. Total Metals per Table 1B in NR 538, Wis. Adm. Code,
   d. Water Leach Test per Table 2A in NR 538, Wis. Adm. Code, where constituents exceed the 20:1 ratio for totals to TCLP values in the NR 600, Wis. Adm. Code.

The Department retains the jurisdiction to either require the submittal of additional information or to modify this approval at any time if, in the Department's opinion, conditions warrant further modifications. Unless specifically noted, the conditions of this approval do not supersede or replace any previous conditions of approval for this facility.

## NOTIFICATION OF APPEAL RIGHTS

If you believe that you have a right to challenge this decision, you should know that Wisconsin statues, administrative codes and case law establish time periods and requirements for reviewing Department decisions.

To seek judicial review of the Department's decision, sections 227.52 and 227.53, Stats., establish criteria for filing a petition for judicial review. Such a petition shall be filed with the appropriate circuit court and shall be served on the Department. The petition shall name the Department of Natural Resources as the respondent.

Dated: December 4, 2009

DEPARTMENT OF NATURAL RESOURCES
For the Secretary

Thomas Woletz, P.E.
Air and Waste Leader
West Central Region

For Martin Herrick

Martin Herrick, P.E.
Environmental Engineer
West Central Region

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Jim Doyle, Governor
Matthew J. Frank, Secretary
Scott Humrickhouse, Regional Director

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January 29, 2010

Mr. Robert Carothers
Dairyland Power Cooperative
JPM Station
500 Old State Highway 35
Alma, WI. 54610

FID # 606009360
Buffalo Co.
SW/APPRV File

Subject: Construction Documentation Approval for Phase IV Cell 1 Final Cover Alma Off-Site Ash Disposal Facility, Town of Belvidere, Buffalo County, License # 4126.

Dear Mr. Carothers:

We have completed our review of your report entitled "Phase IV, Cell 1, Final Cover Construction Documentation Report, WDNR license No. 4126, Dairyland Power Cooperative Alma Off-site Ash Disposal Facility." The report was prepared by RMT and was dated January 2010. The report was received in the La Crosse Service Center on January 22, 2010. At this time we are approving the construction documentation for the Phase IV Cell 1 cap.

Conditions have been included for payment of the plan review and construction inspections invoice, inspection and repair of the topsoil and associated surface water control features.

This approval should be attached to your May 15, 2001 Plan of Operation Approval.

Please contact Martin Herrick at (608) 789-5518 if you have any questions regarding this approval.

Sincerely,

Thomas E. Woletz, P.E.
Air and Waste Leader
West Central Region

cc: Brian Kalvelage/Marty Herrick-LAX
Bill Kowalski, Dairyland Power Cooperative, 3200 East Avenue South, PO Box 817, La Crosse, WI 54602-0817
Curt Madsen, RMT, 744 Heartland Trail, Madison, WI 53717

BEFORE THE
STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES

CONSTRUCTION DOCUMENTATION APPROVAL
PHASE IV, CELL 1 CAP

FOR THE
DAIRYLAND POWER COOPERATIVE
ALMA OFF-SITE ASH DISPOSAL FACILITY
TOWN OF BELVIDERE, BUFFALO COUNTY,
LICENSE # 4126

FINDINGS OF FACT

The Department finds that:

1. Dairyland Power Cooperative (DPC) owns and operates a nonhazardous solid waste disposal facility located in the NE1/4 of the NE1/4 of Section 19 and portions of Sections 18 and 20, Township 21 North, Range 12 West, Town of Belvidere, Buffalo County, Wisconsin.

2. The Department issued a conditional plan of operation approval for the facility on May 15, 2001.

3. The Department issued a conditional plan modification to the May 15, 2001 Plan of Operation Approval on March 4, 2004 allowing the use of two feet of select fly ash to be substituted for the GCL (geocomposite liner) in the cap.

4. The Department issued a conditional plan modification to the May 15, 2001 Plan of Operation Approval on September 21, 2009 adding soil borrow areas for select granular fill, general fill and topsoil for the cap.

5. The Department issued conditional construction documentation approvals for the cell's 1 and 2A liners on March 11, 2002 and March 28, 2007 respectively.

6. The information submitted in connection with the construction documentation includes the following:

   a. A report entitled Phase IV, Cell 1, Final Cover Construction documentation report, WDNR License No. 4126, Dairyland Power Cooperative Alma Off-site Disposal Facility" and 11 associated engineering drawings dated January 2008.

7. Additional information considered in the review of the construction documentation;

   a. August 31, 2009 Dairyland Power Cooperative-Alma Offsite Disposal Facility (License #4126) Phase IV Disposal Area, Cell 1 Preconstruction Report,

8. Construction inspections were performed by the Department for the following on:

   a. Placement of select fly ash by Martin Herrick on July 9, 2009,
   b. Grading of select fly ash by Martin Herrick on August 20, 2009,
   c. Placing geomembrane by Martin Herrick on September 30, 2009,
   d. Placing drainage layer by Martin Herrick on October 12, 2009.

9. On January 28, 2010 the Department submitted invoice # 4206-9174 to Dairyland Power

Cooperative. The invoice included $ 1100 for review of the construction documentation and $2200 for four construction inspections.

## CONCLUSIONS OF LAW

1. The Department has authority under ss. 289.43(7) and 289.43(8), Stats., and ch. NR 516, Wis. Adm. Code, to require that the owner of a solid waste disposal facility demonstrate that the facility has been constructed in substantial compliance with the May 15, 2001 Conditional Plan of Operation Approval.

2. If the conditions of approval set forth below are complied with the applicant will have demonstrated that the facility has been constructed in substantial compliance with the NR 500 to NR 590 Series of the Wis. Adm. Code and the May 15, 2001 Conditional Plan of Operation Approval.

3. The Department has authority under s. 289.30(6), Stats., to modify a plan of operation approval if the modification would not inhibit compliance with the applicable portions of chs. NR 500- 590, Wis. Adm. Code

## CONDITIONS OF APPROVAL

The Department hereby approves the construction documentation for the Dairyland Power Cooperative Phase IV Cell 1 Cap at the Alma Off-Site Ash Disposal Facility subject to NR 500-590, Wis. Adm. Code, the May 15, 2001 Conditional Plan of Operation Approval and subsequent plan modifications and the following conditions:

1. Dairyland Power Cooperative shall inspect the Cell 1 cap after major storm events and on a monthly basis and make repairs as necessary.

2. Cleaning and restoration of the surface water control features shall be performed as necessary.

The Department retains the jurisdiction to either require the submittal of additional information or to modify this approval at any time if, in the Department's opinion, conditions warrant further modifications. Unless specifically noted, the conditions of this approval do not supersede or replace any previous conditions of approval for this facility.

## NOTIFICATION OF APPEAL RIGHTS

If you believe that you have the right to challenge this decision made by the Department, you should know that Wisconsin statues, administrative codes and case law establish time periods and requirements for reviewing Department decisions.

To seek judicial review of the Department's decision, sections 227.52 and 227.53, Stats. establish criteria for filing a petition for judicial review. Such a petition shall be filed with the appropriate circuit court and shall be served on the Department. The petition shall name the Department of Natural Resources as the respondent.

Dated: January 29, 2010

Department of Natural Resources
For the Secretary

Thomas E. Woletz, P.E.
Air and Waste Leader
West Central Region

For M.H.

Martin Herrick, P.E.
Environmental Engineer
West Central Region

**State of Wisconsin**
DEPARTMENT OF NATURAL RESOURCES
Wisconsin Department of Natural Resources
3550 Mormon Coulee Road
LaCrosse WI 54601

Scott Walker, Governor
Cathy Stepp, Secretary
Scott Humrickhouse, Regional Director
Telephone 608-789-9000
FAX 608-785-9990
TTY 608-785-9000

March 14, 2011

Mr. Robert Carothers
Dairyland Power Cooperative
JPM Station
500 Old State Highway 35
Alma, WI 54610

Subject: Conditional Plan Modification to Plan of Operation Approval for the Phase IV Cap, Alma Off-Site Disposal Facility, Town of Belvidere, Buffalo County, License # 4126

Dear Mr. Carothers:

We have completed our review of your plan modification request to delete electrical resistivity testing from the Phase IV landfill cap construction documentation. The request was made by letter dated March 3, 2011 which also included a Wisconsin Professional Engineer certification by Curt Madsen of RMT.

The Department concurs with your proposal as the landfill liner sections will be leak location tested in accordance with NR 516.07(2)(d), Wis. Adm. Code. The Department is approving your proposed plan modification with conditions for payment of the plan review fee and deletion of the cap leak location testing. This approval should be attached to your May 15, 2001 Plan of Operation Approval.

Please contact Martin Herrick at (608) 789-5518 if you have any questions regarding this approval.

Sincerely,

For J.S.

Jill Schoen, CHMM
Waste Program Supervisor
West Central Region

CC: Bill Kowalski – Dairyland Power Cooperative, 3200 East Avenue South, PO Box 817, La Crosse, WI 54602
Curt Madsen – RMT, Heartland Trail 53717-1934, PO Box 8923, Madison, WI 53708-8923

BEFORE THE
STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES

CONDITIONAL PLAN OF OPERATION MODIFICATION
PHASE IV CLOSURE PLAN

FOR THE

DAIRYLAND POWER COOPERATIVE
ALMA OFF-SITE ASH DISPOSAL FACILITY
TOWN OF BELVIDERE, BUFFALO COUNTY
LICENSE #4126

## FINDINGS OF FACT

The Department finds that:

1. Dairyland Power Cooperative (DPC) owns and operates a non hazardous solid waste disposal facility located in the NE ¼ of Section 19 and portions of Sections 18 and 20, Township 21 North, Range 12 West, Town of Belvidere, Buffalo County Wisconsin.
2. The Department issued a Conditional Plan of Operation Approval for the facility on May 15, 2001.
3. On March 3, 2011 DPC submitted a letter to Martin Herrick of the Department requesting a modification to the May 15, 2001 Plan of Operation Approval to delete the electrical resistivity leak location testing from the Phase IV geomembrane cap construction. The letter included a Wisconsin Professional Engineer certification by Curt Madsen of RMT.
4. NR 516.072(d), Wis. Adm. Code requires leak location testing be performed on geomembrane liners in landfills.
5. On March 10, 2011 the Department issued invoice #4206-9452 for $1650 to DPC for the plan review of the proposed plan modification.

## CONCLUSIONS OF LAW

1. The Department has authority under s. 289.30(6) Stats. to modify a plan of operation approval if the modifications would not inhibit compliance with the applicable portions of the NR 500 Series Wisconsin Administrative Code.
2. The Department has authority to approve a plan of operation modification with special conditions if the conditions are needed to ensure compliance with the applicable portions of the NR 500 Series Wisconsin Administrative Code.
3. The conditions of approval set forth below are needed to ensure compliance with the applicable portion of the NR 500 Series, Wisconsin Administrative Code.
4. In accordance with the foregoing, the Department has authority under ch.289., Stats., to issue the following conditional plan of operation approval modification.

## CONDITIONS OF APPROVAL

The Department hereby approves the proposed plan modification for the DPC Phase IV Cap at the Alma Off-Site Ash Disposal Facility subject to the NR 500 Series, Wis. Adm. Code, the May 15, 2001 Conditional Plan of Operation Approval and the following conditions:

1. Payment of invoice #4206-9452 shall be made to the Department within 30 days from the date of receipt.
2. Electrical resistivity leak location testing for the cap construction documentation of the Phase IV Landfill is rescinded.

The Department retains the jurisdiction to either require the submittal of additional information or to modify this approval at any time if, in the Department's opinion, conditions warrant further modifications. Unless specifically noted, the conditions of this approval do not supersede or replace any previous conditions of approval for this facility.

## NOTICE OF APPEAL RIGHTS

If you believe you have a right to challenge this decision made by the Department, you should know that Wisconsin statues and administrative codes establish time periods and requirements for reviewing Department decisions.

To seek judicial review of the Department's decision, sections 227.52 and 227.53, Stats., establish criteria for filing a petition for judicial review. You have 30 days after the decision is mailed or otherwise served by the Department to file your petition with the appropriate circuit court and serve the petition on the Department. The petition shall name the Department of Natural Resources as the respondent.

Dated: MARCH 14, 2011

Department of Natural Resources
For the Secretary

For J. S.

Jill Schoen, CHMM
Waste Program Supervisor
West Central Region

For M. H

Martin Herrick, P.E.
Environmental Engineer
West Central Region

**State of Wisconsin**
**DEPARTMENT OF NATURAL RESOURCES**
**Wisconsin Department of Natural Resources**
**PO Box 4001**
**Eau Claire, WI 54702**

**Scott Walker, Governor**
**Cathy Stepp, Secretary**
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January 20, 2012

Mr. Robert Carothers
Dairyland Power Cooperative
JPM Station
500 Old State Highway 35
Alma, WI 54610

FID# 606043900
Buffalo Co.
SW/APPRV File

Subject: Construction Documentation Approval for Phase IV Cell 2A Final Cover Alma Off-Site Ash Disposal Facility, Town of Belvidere, Buffalo County, License # 4126

Dear Mr. Carothers:

We have completed our review of your report entitled "Phase IV, Cell 2A, Final Cover Construction Documentation Report WDNR license No. 4126 Dairyland Power Cooperative Alma Off-Site Ash Disposal Facility." The report was prepared by TRC and was dated December 2011. The report was received in the La Crosse Service Center on January 09, 2012. At this time we are approving the construction documentation for the Phase IV Cell 2A cap.

Conditions have been included for payment of the plan review and construction inspections invoice, a plan sheet showing existing surface water management, inspection and repair of the topsoil and associated surface water control features.

This approval should be attached to your May 15, 2001 Plan of Operation Approval.

Please contact Martin Herrick at (608) 789-5518 if you have any questions regarding this approval.

Sincerely,

Jill Schoen

Jill Schoen, CHMM
Waste & Materials Management Program Supervisor
West Central Region

cc: Brian Kalvelage/Marty Herrick-LAX
Bill Kowalski-Dairyland Power Cooperative, 3200 East Avenue South, PO Box 817, La Crosse, WI 54602-0817
Curt Madsen - TRC, 708 Heartland Trail, Suite 3000, Madison, WI 53717

BEFORE THE
STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES

CONSTRUCTION DOCUMENTATION APPROVAL
PHASE IV, CELL 2A CAP

FOR THE
DAIRYLAND POWER COOPERATIVE
ALMA OFF-SITE ASH DISPOSAL FACILITY
TOWN OF BELVIDERE, BUFFALO COUNTY,
LICENSE # 4126

## FINDINGS OF FACT

The Department finds that:

1. Dairyland Power Cooperative (DPC) owns and operates a nonhazardous solid waste disposal facility located in the NE1/4 of the NE1/4 of Section 19 and portions of Sections 18 and 20, Township 21 North, Range 12 West, Town of Belvidere, Buffalo County, Wisconsin.

2. The Department issued a conditional plan of operation approval for the facility on May 15, 2001.

3. The Department issued a conditional plan modification to the May 15, 2001 Plan of Operation Approval on March 4, 2004 allowing the use of two feet of select fly ash to be substituted for the GCL (geocomposite liner) in the cap.

4. The Department issued a conditional plan modification to the May 15, 2001 Plan of Operation Approval on September 21, 2009 adding soil borrow areas for select granular fill, general fill and topsoil for the cap.

5. The Department issued conditional construction documentation approvals for the Phase IV cell's 1 and 2A liners on March 11, 2002 and March 28, 2007 respectively.

6. The Department issued a conditional construction documentation approval for the Phase IV Cell 1 cap on January 29, 2010.

7. The Department issued a conditional plan modification on March 14, 2011 allowing the deletion of the resistivity testing for the Phase IV cap.

8. The information submitted in connection with the construction documentation includes the following:

   a. A report entitled "Phase IV, Cell 2A, Final Cover Construction Documentation Report WDNR License No. 4126, Dairyland Power Cooperative Alma Off-Site Ash Disposal Facility" and ten associated engineering drawings dated December 2011."

9. Additional information considered in the review of the construction documentation:

   a. August 3, 2011 Dairyland Power Cooperative-Alma Offsite Disposal Facility (License #4126) Phase IV Disposal Area, Cell 2A Preconstruction Report,
   b. July 12, 2009 E-mail from Bill Kowlaski of DPC to Marty Herrick of the Department requesting the use of G-3 fly ash in the Phase IV cap,
   c. July 14, 2011 E-mail from Terry Halena of TRC to Marty of Herrick of the Department regarding cross seams in geomembrane panel placement,

d. July 21, 2011 E-mail from Terry Halena of TRC to Marty Herrick of the Department requesting to eliminate environmental stress crack resistance.

10. Construction inspections were performed by the Department for the following on:

a. Placement of the select fly ash by Martin Herrick on July 13, 2011,
b. Installation of the geomembrane by Martin Herrick on August 18, 2011,
c. Placement of the sand drainage blanket by Martin Herrick on August 26, 2011,
d. Placement of topsoil and seeding by Martin Herrick on September 21, 2011.

11. On January 12, 2012 the Department submitted invoice # 4206-9671 to Dairyland Power Cooperative. The invoice included $1100 for review of the construction documentation and $2200 for four construction inspections.

## CONCLUSIONS OF LAW

1. The Department has authority under ss. 289.43(7) and 289.43(8), Stats., and ch. NR 516, Wis. Adm. Code, to require that the owner of a solid waste disposal facility demonstrate that the facility has been constructed in substantial compliance with the May 15, 2001 Conditional Plan of Operation Approval.

2. If the conditions of approval set forth below are complied with the applicant will have demonstrated that the facility has been constructed in substantial compliance with the NR 500 to NR 590 Series of the Wis. Adm. Code and the May 15, 2001 Conditional Plan of Operation Approval.

3. The Department has authority under s. 289.30(6), Stats., to modify a plan of operation approval if the modification would not inhibit compliance with the applicable portions of chs. NR 500- 590, Wis. Adm. Code.

## CONDITIONS OF APPROVAL

The Department hereby approves the construction documentation for the Dairyland Power Cooperative Phase IV Cell 2A Cap at the Alma Off-Site Ash Disposal Facility subject to NR 500-590, Wis. Adm. Code, the May 15, 2001 Conditional Plan of Operation Approval and subsequent plan modifications and the following conditions:

1. Dairyland Power Cooperative shall inspect the Cell 2A cap after major storm events and on a monthly basis and make repairs as necessary.

2. Cleaning and restoration of the surface water control features shall be performed as necessary.

3. Payment of invoice #4206-9671 shall be made to the Department within 30 days of receipt.

4. A plan sheet showing the existing surface water management features shall be provided to the Department within 60 days from the date of this approval.

This approval is based on the information available to the Department as of the date of approval. If additional information, project changes or other circumstances indicate a possible need to modify this approval, the Department may ask you to provide further information relating to this activity. Likewise, you may request a modification of this approval based on additional information, project changes or other circumstances as provided for in state statues and administrative codes. Unless specifically noted, the conditions of this approval do not supersede or replace any previous conditions of approval for this facility.

NOTICE OF APPEAL RIGHTS

If you believe that you have a right to challenge this decision made by the Department, you should know that Wisconsin statues and administrative codes establish time periods and requirements for reviewing Department decisions.

To seek judicial review of the Department's decision, sections 227.52 and 227.53, Stats. establish criteria for filing a petition for judicial review. You have 30 days after the decision is mailed or otherwise served by the Department to file your petition with the appropriate circuit court and serve the petition on the Department. The petition shall name the Department of Natural Resources as the respondent.

Dated: January 20, 2012

DEPARTMENT OF NATURAL RESOURCES
For the Secretary

Jill Schoen, CHMM
Waste & Materials Management Program Supervisor
West Central Region

Martin Herrick, P.E.
Environmental Engineer
West Central Region

**State of Wisconsin**
**DEPARTMENT OF NATURAL RESOURCES**
**1300 W Clairemont Avenue**
**Eau Claire, WI 54701**

**Scott Walker, Governor**
**Cathy Stepp, Secretary**
Telephone 608-266-2621
Toll Free 1-888-936-7463
TTY Access via relay - 711

March 7, 2013

Mr. Robert Carothers
Dairyland Power Cooperative
JPM Station
500 Old State Highway 35
Alma, WI 54610

FID# 606043900
Buffalo Co.
SW/APPRV File

Subject: Construction Documentation Approval for Phase IV Cell 3A Liner Alma Off-Site Ash Disposal Facility, Town of Belvidere, Buffalo County, License # 4126

Dear Mr. Carothers:

We have completed our review of your report entitled "Phase IV, Cell 3A Liner Construction Documentation Report Dairyland Power Cooperative Alma Off-Site Ash Disposal Facility." The report was prepared by TRC and was dated January 2013. The report was received in the La Crosse Service Center on January 28, 2013. At this time we are approving the construction documentation for the Phase IV Cell 3A liner and you can begin filling in the cell.

Conditions have been included for payment of the plan review and construction inspections invoice, placement of four feet of ash by December 1, 2014, inspection and repair of the drainage blanket, associated surface water control features and review of the closure and long term care costs for the landfill.

This approval should be attached to your May 15, 2001 Plan of Operation Approval.

Please contact Martin Herrick at (608) 789-5518 if you have any questions regarding this approval.

Sincerely,

Jill Schoen

Jill Schoen, CHMM
Waste & Materials Management Program Supervisor
West Central Region

cc: Brian Kalvelage/Marty Herrick-LAX
Bill Kowalski-Dairyland Power Cooperative, 3200 East Avenue South, PO Box 817, La Crosse, WI 54602-0817
Curt Madsen - TRC, 708 Heartland Trail, Suite 3000, Madison, WI 53717

**BEFORE THE**
**STATE OF WISCONSIN**
**DEPARTMENT OF NATURAL RESOURCES**

**CONSTRUCTION DOCUMENTATION APPROVAL**
**PHASE IV, CELL 3A LINER**

**FOR THE**
**DAIRYLAND POWER COOPERATIVE**
**ALMA OFF-SITE ASH DISPOSAL FACILITY**
**TOWN OF BELVIDERE, BUFFALO COUNTY,**
**LICENSE # 4126**

## FINDINGS OF FACT

The Department finds that:

1. Dairyland Power Cooperative (DPC) owns and operates a nonhazardous solid waste disposal facility located in the NE1/4 of the NE1/4 of Section 19 and portions of Sections 18 and 20, Township 21 North, Range 12 West, Town of Belvidere, Buffalo County, Wisconsin.

2. The Department issued a conditional plan of operation approval for the facility on May 15, 2001.

3. The Department issued conditional construction documentation approvals for the Phase IV cell's 1, 2A and 2B liners on March 11, 2002, March 28, 2007 and March 21, 2008 respectively.

4. On June 20, 2012 Terry Halena of TRC sent an email to Martin Herrick of the Department requesting that the conformance testing for environmental stress crack resistance from the geomembrane vendor (GSE) be substituted for the requirement in Condition No. 5 of the Department's May 15, 2001 Conditional Plan of Operation Approval. On June 27, 2012 Martin Herrick of the Department sent a response email concurring.

5. On September 4, 2012 a geomembrane preconstruction meeting was held at the Phase IV Landfill.

6. The information submitted in connection with the construction documentation includes the following:

   a. A report entitled "Phase IV, Cell 3A Liner Construction Documentation Report Dairyland Power Cooperative Alma Off-Site Ash Disposal Facility," and sixteen associated engineering drawings dated January 2013.

7. Additional information considered in the review of the construction documentation:

   a. A report entitled "August 14, 2012 Dairyland Power Cooperative-Alma Offsite Disposal Facility (License #4126) Preconstruction Report: Liner Construction - Phase IV, Cell 3A,

   b. Department files for the Dairyland Power Cooperative – Alma Offsite Ash Disposal Facility, Phase IV.

8. Construction inspections were performed by the Department for the following on:
   a. Subbase preparation on June 13, 2012 by Martin Herrick,
   b. Low permeability barrier soils placement on September 4, 2012 by Martin Herrick,
   c. Geomembrane and GCL liner installation on September 21, 2012 by Martin Herrick,
   d. Sand Drainage Blanket and leachate collection system installation on November 26, 2012 by Martin Herrick.

9. On March 1, 2013 the Department submitted invoice #4206-10053 to Dairyland Power Cooperative. The invoice included $1100 for review of the construction documentation and $2200 for four construction inspections.

## CONCLUSIONS OF LAW

1. The Department has authority under ss. 289.43(7) and 289.43(8), Stats., and ch. NR 516, Wis. Adm. Code, to require that the owner of a solid waste disposal facility demonstrate that the facility has been constructed in substantial compliance with the May 15, 2001 Conditional Plan of Operation Approval.

2. If the conditions of approval set forth below are complied with the applicant will have demonstrated that the facility has been constructed in substantial compliance with the NR 500 to NR 590 Series of the Wis. Adm. Code and the May 15, 2001 Conditional Plan of Operation Approval.

3. The Department has authority under s. 289.30(6), Stats., to modify a plan of operation approval if the modification would not inhibit compliance with the applicable portions of chs. NR 500- 590, Wis. Adm. Code.

## CONDITIONS OF APPROVAL

The Department hereby approves the construction documentation for the Dairyland Power Cooperative Phase IV Cell 3A liner at the Alma Off-Site Ash Disposal Facility subject to NR 500-590, Wis. Adm. Code, the May 15, 2001 Conditional Plan of Operation Approval and subsequent plan modifications and the following conditions:

1. Dairyland Power Cooperative shall inspect the sand drainage blanket and liner of Phase IV Cell 3A after major storm events and on a monthly basis and make repairs as necessary. Inspection and repair of the sand drainage blanket and liner shall continue until enough material has been placed to prevent it from eroding.

2. The depth of wheel rutting from haul trucks placing the ash shall be used as a performance measure to limit the moisture content of the ash placed in Phase IV Cell, 3A. When ash is being placed no wheel ruts deeper than 2 inches shall be allowed.

3. Payment of invoice #4206-10053 shall be made to the Department within 30 days of receipt.

4. Dairyland Power Cooperative shall place four feet of ash on the bottom and initial 10 ft. of slope for the newly constructed cell by January 1, 2014.

5. Cleaning and restoration of the surface water control features shall be performed as necessary.

6. The closure and long term care costs for the Phase IV landfill shall be reviewed and updated as necessary. If revisions are required they shall be submitted to the Department within 90 days from the date of this approval.

This approval is based on the information available to the Department as of the date of approval. If additional information, project changes or other circumstances indicate a possible need to modify this approval, the Department may ask you to provide further information relating to this activity. Likewise, you may request a modification of this approval based on additional information, project changes or other circumstances as provided for in state statues and administrative codes. Unless specifically noted, the conditions of this approval do not supersede or replace any previous conditions of approval for this facility.

**NOTICE OF APPEAL RIGHTS**

If you believe that you have a right to challenge this decision made by the Department, you should know that Wisconsin statues and administrative codes establish time periods and requirements for reviewing Department decisions.

To seek judicial review of the Department's decision, sections 227.52 and 227.53, Stats. establish criteria for filing a petition for judicial review. You have 30 days after the decision is mailed or otherwise served by the Department to file your petition with the appropriate circuit court and serve the petition on the Department. The petition shall name the Department of Natural Resources as the respondent.

Dated: March 7, 2013

DEPARTMENT OF NATURAL RESOURCES
For the Secretary

Jill Schoen

Jill Schoen, CHMM
Waste & Materials Management Program Supervisor
West Central Region

Martin Herrick

Martin Herrick, P.E.
Environmental Engineer
West Central Region

**State of Wisconsin**
**DEPARTMENT OF NATURAL RESOURCES**
**Wisconsin Department of Natural Resources**
**1300 W Clairemont Avenue**
**Eau Claire, WI 54701**

**Scott Walker, Governor**
**Cathy Stepp, Secretary**
Telephone 608-266-2621
Toll Free 1-888-936-7463
TTY Access via relay - 711

December 2, 2013

Mr. Brian Treadway
Dairyland Power Cooperative
JPM Station 500 Old State Highway 35
Alma, WI 54610

FID # 606009360
Buffalo Co.
SW/APPRV FILE

Subject: Conditional Plan Modification to the Plan of Operation Approval for the Phase IV Landfill, Alma Off-Site Ash Disposal Facility, Town of Belvidere, Buffalo County, License #4126

Dear Mr. Treadway:

We have completed our review of your November 4, 2013 plan modification request to add waste sources to the Phase IV Alma Off-Site Ash Disposal Facility. The request was prepared by TRC Environmental Corporation (TRC) on behalf of Dairyland Power Cooperative (DPC) and was received in the La Crosse Service Center on November 6, 2013.

Conditions have been included for characterization of the material at the time it is generated and payment of the plan review fee. Note that while we are not including any conditions on the placement methods for the new materials added to the Phase IV Landfill we are recommending that they be placed in large horizontal lifts in order to provide additional time for the material to set up.

This approval should be attached to your May 15, 2001 Plan of Operation Approval. Please contact Martin Herrick at (608) 789-5518 if you have any questions regarding this approval.

Sincerely,

Jill Schoen

Jill Schoen, CHMM
Waste Program Supervisor
West Central Region

cc: Brian Kalvelage/Marty Herrick-LAX
Curt Madsen, TRC, 708 Heartland Trail, Suite 3000, Madison, WI 53717
Bill Kowalski-Dairyland Power Cooperative, 3200 East Avenue South, PO Box 817, LaCrosse, WI 54602

BEFORE THE
STATE OF WISCONISN
DEPARTMENT OF NATURAL RESOURCES

CONDITIONAL PLAN OF OPERATION MODIFICATION
WASTE ADDITION
FOR
PHASE IV
DAIRYLAND POWER COOPERATIVE
ALMA OFF-SITE ASH DISPOSAL FACILITY
TOWN OF BELVIDERE, BUFFALO COUNTY,
LICENSE # 4126

## FINDINGS OF FACT

The Department finds that:

1. Dairyland Power Cooperative (DPC) owns and operates a nonhazardous solid waste disposal facility located in the NE1/4 of the NE1/4 of Section 19 and portions of Sections 18 and 20, Township 21 North, Range 12 West, Town of Belvidere, Buffalo County, Wisconsin,
2. The Department issued a conditional plan of operation approval for the facility on May 15, 2001.
3. On November 4, 2013 TRC on behalf of DPC submitted a plan modification request to the Department to add the following waste streams from the respective sources:

| J. P. Madgett Power Plant (Alma, WI) | Genoa Unit 3 Power Plant (Genoa, WI) |
|---|---|
| Dry Sorbent Injection | Activated Carbon Injection |
| Activated Carbon Injection | Selective Non-Catalytic Reduction |
| Selective Catalytic Reduction | |

The submittal included a narrative and partial characterization of the respective wastes.

4. On November 26, 2013 the Department submitted invoice #4206-10259 for $1650 to DPC for plan review of the November 4, 2013 report.

## CONCLUSIONS OF LAW

1. The Department has authority under s. 289.30(6)Stats. to modify a plan of operation approval if the modification would not inhibit compliance with the applicable portions of chs. NR 500-590, Wis. Adm. Code.
2. The Department has authority to approve a plan operation modification with special conditions if the conditions are needed to ensure compliance with the applicable portions of chs. NR 500-590, Wis. Adm. Code.
3. The conditions of approval set forth below are needed to ensure compliance with the applicable portions of chs. NR 500- 590, Wis. Adm. Code
4. In accordance with the foregoing, the Department has authority under ch. 289., Stats., to issue the following conditional plan of operation approval.

## CONDITIONS OF APPROVAL

The Department hereby approves the proposed plan modification for the additional waste streams at the DPC Phase IV Alma Off-Site Ash Disposal Facility subject to the NR 500 Series, Wis. Adm. Code, the May 15, 2001 Conditional Plan of Operation Approval, subsequent modifications and the following conditions:

1. Payment of invoice # 4206-10259 shall be made to the Department within 30 days from the date of receipt.

2. At the time of generation the following waste streams shall be physically and chemically characterized

| J. P. Madgett Power Plant (Alma, WI) | Genoa Unit 3 Power Plant (Genoa, WI) |
|---|---|
| Dry Sorbent Injection | Activated Carbon Injection |
| Activated Carbon Injection | Selective Non-Catalytic Reduction |
| Selective Catalytic Reduction | |

The characterization shall include but not be limited to the following analytics:
a. Gradation with fraction greater than P200,
b. Moisture Content,
c. Total Metals per Table 1B in NR 538, Wis. Adm. Code,
d. Water Leach Test per Table 2A in NR 538, Wis. Adm. Code, where constituents exceed the 20:1 ratio for totals to TCLP values in the NR 600 Series, Wis. Adm. Code.

The results of the respective characterizations shall be submitted to the Department within 90 days from their initial generation.

This approval is based on the information available to the Department as of the date of approval. If additional information, project changes or other circumstances indicate a possible need to modify this approval, the Department may ask you to provide further information relating to this activity. Likewise, you may request a modification of this approval based on additional information, project changes, or other circumstances as provided for in state statues and administrative codes. Unless specifically noted, the conditions of this approval do not supersede or replace any previous conditions of approval for this facility.

## NOTICE OF APPEAL RIGHTS

If you believe that you have a right to challenge this decision made by the Department, you should know that Wisconsin statues and administrative codes establish time periods and requirements for reviewing Department decisions.

To seek judicial review of the Department's decision, sections 227.52 and 227.53, Stats. establish criteria for filing a petition for judicial review. You have 30 days after the decision is mailed or otherwise served by the Department to file your petition with the appropriate circuit court and serve the petition on the Department. The petition shall name the Department of Natural Resources as the respondent.

Dated: December 2, 2013

DEPARTMENT OF NATURAL RESOURCES
For the Secretary

Jill Schoen, CHMM
Waste Program Supervisor
West Central Region

Martin Herrick, P.E.
Environmental Engineer
West Central Region

**State of Wisconsin**
**DEPARTMENT OF NATURAL RESOURCES**
**Wisconsin Department of Natural Resources**
**1300 W Clairemont Avenue**
**Eau Claire, WI 54701**

**Scott Walker, Governor**
**Cathy Stepp, Secretary**
Telephone 608-266-2621
Toll Free 1-888-936-7463
TTY Access via relay - 711

August 19, 2014

Mr. Brian Treadway
Dairyland Power Cooperative
JPM Station 500 Old State Highway 35
Alma, WI 54610

FID # 606009360
Buffalo Co.
SW/APPR FILE

Subject: Conditional Plan Modification to the Plan of Operation Approval for the Phase IV Landfill, Alma Off-Site Ash Disposal Facility, Town of Belvidere, Buffalo County, License #4126

Dear Mr. Treadway:

We have completed our review of your June 30, 2014 expedited plan modification request to revise the sub-base under Cell 3B of the Phase IV Alma Off-Site Ash Disposal Facility. The request was prepared by TRC Environmental Corporation (TRC) on behalf of Dairyland Power Cooperative (DPC) and was received in the La Crosse Service Center on July 1, 2014.

Note that we are approving this as a conditional plan modification and not as an expedited plan modification approval because an exemption is being granted for this proposal in accordance with NR 514.09 9(1)(a), Wis. Adm. Code. A low hazard grant of exemption for the placement of the dredged material from the Mississippi River is being issued under a separate approval.

Conditions have been included for construction documentation of the dredged materials placement as liner sub-base and payment of the plan review fee.

This approval should be attached to your May 15, 2001 Plan of Operation Approval. Please contact Martin Herrick at (608) 789-5518 if you have any questions regarding this approval.

Sincerely,

Jill Schoen

Jill Schoen, CHMM
Waste & Materials Management Program Supervisor
West Central Region

cc: Brian Kalvelage/Marty Herrick-LAX
Curt Madsen, TRC, 708 Heartland Trail, Suite 3000, Madison, WI 53717
Bill Kowalski, Dairyland Power Cooperative, 3200 East Avenue South, PO Box 817, La Crosse, WI 54602

BEFORE THE
STATE OF WISCONISN
DEPARTMENT OF NATURAL RESOURCES

CONDITIONAL PLAN OF OPERATION MODIFICATION
LINER SUB BASE
FOR
PHASE IV, CELL 3B

DAIRYLAND POWER COOPERATIVE
ALMA OFF-SITE ASH DISPOSAL FACILITY
TOWN OF BELVIDERE, BUFFALO COUNTY,
LICENSE # 4126

## FINDINGS OF FACT

The Department finds that:

1. Dairyland Power Cooperative (DPC) owns and operates a nonhazardous solid waste disposal facility located in the NE1/4 of the NE1/4 of Section 19 and portions of Sections 18 and 20, Township 21 North, Range 12 West, Town of Belvidere, Buffalo County, Wisconsin,
2. The Department issued a conditional plan of operation approval for the facility on May 15, 2001.
3. On June 30, 2014 TRC on behalf of DPC submitted a plan modification request to the Department to revise the sub-base soils for Cell 3B of the Phase IV Landfill. The submittal included a narrative, characterization of the dredged material from the Mississippi River and 8 plan sheets.
4. On July 10, 2014 Bill Kowalski of Dairyland Power Cooperative requested a low hazard grant of exemption for the Alma Off-Site Ash Disposal Facility Phase IV Landfill to accept dredged material from the Grand Encampment storage facility located in the Mississippi River near Alma, Wisconsin. The dredged material would be substituted for the in-situ sub-base soils in Cell 3B.
5. On August 13, 2104 the Department submitted invoice # 4206-10472 for $ 1650 to DPC for plan review of the June 30, 2014 report.

## CONCLUSIONS OF LAW

1. The Department has authority under s. 289.30(6) Stats. to modify a plan of operation approval if the modification would not inhibit compliance with the applicable portions of chs. NR 500-590, Wis. Adm. Code.
2. The Department has authority to approve a plan operation modification with special conditions if the conditions are needed to ensure compliance with the applicable portions of chs. NR 500-590, Wis. Adm. Code.
3. The conditions of approval set forth below are needed to ensure compliance with the applicable portions of chs. NR 500- 590, Wis. Adm. Code
4. In accordance with the foregoing, the Department has authority under ch. 289, Stats., to issue the following conditional plan of operation approval.

## CONDITIONS OF APPROVAL

The Department hereby approves the proposed plan modification for the additional waste streams at the DPC Phase IV Alma Off-Site Ash Disposal Facility subject to the NR 500 Series, Wis. Adm. Code, the May 15, 2001 Conditional Plan of Operation Approval, subsequent modifications and the following conditions:

1. Payment of invoice # 4206-10472 shall be made to the Department within 30 days from the date of receipt.
2. Documentation of the placement of the sub-base materials shall be included with the Cell 3B liner construction documentation report.

This approval is based on the information available to the Department as of the date of approval. If additional information, project changes or other circumstances indicate a possible need to modify this approval, the Department may ask you to provide further information relating to this activity. Likewise, you may request a modification of this approval based on additional information, project changes, or other circumstances as provided for in state statues and administrative codes. Unless specifically noted, the conditions of this approval do not supersede or replace any previous conditions of approval for this facility.

## NOTICE OF APPEAL RIGHTS

If you believe that you have a right to challenge this decision made by the Department, you should know that Wisconsin statues and administrative codes establish time periods and requirements for reviewing Department decisions.

To seek judicial review of the Department's decision, sections 227.52 and 227.53, Stats. establish criteria for filing a petition for judicial review. You have 30 days after the decision is mailed or otherwise served by the Department to file your petition with the appropriate circuit court and serve the petition on the Department. The petition shall name the Department of Natural Resources as the respondent.

Dated: August 19, 2014

DEPARTMENT OF NATURAL RESOURCES
For the Secretary

Jill Schoen

Jill Schoen, CHMM
Waste & Materials Management Program Supervisor
West Central Region

JS for Martin Herrick

Martin Herrick, P.E.
Environmental Engineer
West Central Region

**State of Wisconsin**
**DEPARTMENT OF NATURAL RESOURCES**
**1300 W Clairemont Avenue**
**Eau Claire WI 54701**

COR - FILE:
P8

**Scott Walker, Governor**
**Cathy Stepp, Secretary**
Telephone 608-266-2621
Toll Free 1-888-936-7463
TTY Access via relay - 711

October 23, 2014

Mr. Brian Treadway
Dairyland Power Cooperative
JPM Station 500 Old State Highway 35
Alma WI 54615

FID#606043900
SW/APPR
Buffalo Co.

Subject: Grant of Exemption, Low Hazard Waste Dredged Material Disposal Site at the Phase IV Landfill, Alma Off-Site Ash Disposal Facility, Town of Belvidere, Buffalo County, License #4126

Dear Mr. Treadway:

The Department has reviewed and is approving your request to use low hazard dredge material as sub-base under the Alma Off-Site Phase IV Ash Disposal Facility. On July 10, 2014 the Department received an email request from Bill Kowalski of Dairyland Power Cooperative (DPC) for a low hazard grant of exemption in accordance with s. 289.43, Wis. Statutes. On August 12, 2014 a public notice was placed in the Buffalo County Journal for an informational hearing on the proposed disposal site. On August 27, 2014 an information meeting was held for the proposed disposal site.

Approximately 50,000 yards of dredged material will be placed as sub-base backfill for the exhumed low permeability soils, which will be used in DPC's future liner construction in Cells 3B and 4A of the Phase IV Landfill. The dredged material will occupy 2.76 acres of the landfill's 32.1 acre footprint. The Phase IV landfill is located in the NE ¼ of the NE ¼ of Section 19 and portions of Sections 18 and 20, Township 21N, Range 12W, Town of Belvidere, Buffalo County. The Phase IV Landfill is part of a 1113 acres parcel own by DPC. The dredge material is sediment from the U.S. Army Corps of Engineers Grand Encampment facility near Alma, Wisconsin.

This exemption is being granted under s. 289.43(8), Wis. Statutes., and is subject to conditions of the attached exemption document. Conditions have been included for payment of the plan review fee and operational activities associated with the placement of the dredged sediment material. Please note that this grant of exemption does not relieve you of the obligation to comply with all other applicable federal, state and local laws.

If you have any questions regarding this grant of exemption please contact Martin Herrick at (608) 789-5518.

Sincerely,

Jill Schoen, CHMM
Waste & Materials Management Program Manager
West Central Region

CC-LIST

## PROJECT SUMMARY

DPC has requested a low hazard exemption from the Department for the placement of up to 50,000 yards of dredged sediment from the Mississippi River on 2.76 acres of land located in the NE ¼ of the NE ¼ of Section 19, Portions of Section 18 and Portions of Section 20, Township 21N, 12W, Town of Belvidere, Buffalo County Wisconsin. The proposed disposal site is in the sub-base of the Phase IV landfill and is part of a 1113 acre parcel of land owned by DPC.

On July 10, 2014 DPC requested the low hazard exemption via email. Supplemental information was submitted prior to this date to other Department programs. On August 12, 2014 the Department published a notice for an informational hearing in the Buffalo County Journal for the proposed disposal of dredged material in the sub-base of the Phase IV Landfill. On August 27, 2014 the Department held an informational hearing on the proposed disposal site. Attendees included the public, Hoffman Construction, the U.S. Army Corps of Engineers and Jill Schoen, Sarah Strassman and Martin Herrick of the Department.

The dredged sediment is material from the U.S. Army Corps of Engineers 9 foot channel maintenance program on the Mississippi River. The sediment was previously dredged and stockpiled on the Grand Encampment site located in the Mississippi River near the marina in Alma, Wisconsin. The Grand Encampment material will be dredged to the river's shore and then transferred via trucks to the DPC property. The route taken for the trucks will be on State Highway 35. Trucks will be tarped when transporting on the highway. The proposed hours of operation are from 7:00 am to 6:00 pm Monday through Friday.

Prior to the initial dredging, the sediment was sampled in-situ in the Mississippi River. Maximum concentrations of [.18 ppm] PCBs, [.4 ppm] Hg, [28 ppm] Pb, and [11.2 ppm] As were detected. The averages of the mercury and lead samples are [.091] and [7.7] ppm respectively and mobilization of constituents from the dredged material is not expected. The dredged material is composed primarily of medium sized sand particles, with minimal amounts of coarse and fine grained material. The dredged material will undergo additional dewatering as a result of the second dredging process.

Placement of the sediment in the disposal site will be in accordance with Department's August 19, 2014 Conditional Plan Modification Approval and DPC's June 30, 2014 Plan of Operation Modification submittal. Stormwater management for the project is addressed by the Department's May 15, 2001 Plan of Operation Approval. Zoning for the project is addressed through Buffalo County's conditional use permit.

BEFORE THE
STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES

CONDITIONAL GRANT OF SOLID WASTE EXEMPTION
FOR
DISPOSAL OF DREDGED MATERIAL
LINER SUB BASE
FOR
PHASE IV, CELL 3B
DAIRYLAND POWER COOPERATIVE
ALMA OFF-SITE ASH DISPOSAL FACILITY
TOWN OF BELVIDERE, BUFFALO COUNTY
LICENSE #4126

FINDINGS OF FACT

The Department finds that:

1. Dairyland Power Cooperative (DPC) owns and operates a nonhazardous solid waste disposal facility located in the NE ¼ of the NE ¼ of Section 19 and portions of Sections 18 and 20, Township 21 N, Range 12W, Town of Belvidere, Buffalo County, Wisconsin. DPC is proposing to use approximately 2.76 acres of the facility's 32.1 acre footprint for disposal of nonhazardous dredged material. The total contiguous property is 1113 acres.

2. The U.S. Army Corps of Engineers (COE) has stockpiled approximately 600,000 yards of dredged sediment from the Mississippi River at their Grand Encampment facility located off shore near the Alma Marina in Alma, Wisconsin. The dredging is part of the COE 9 foot channel maintenance in the Mississippi River. The Grand Encampment site is used to consolidate and store material from multiple dredging locations prior to final disposal. Previously removal of the stockpiled sediment has occurred on 10 to 15 year intervals.

3. On July 10, 2014 Bill Kowalski of DPC requested a low hazard grant of exemption for Cell 3B of the Phase IV Alma Off-Site Ash Disposal Facility to accept dredged material from the Grand Encampment Storage Facility. DPC is proposing to substitute approximately 50,000 yards of sediment for the low permeability soils located below the Phase IV landfill liner. The exhumed low permeability soils will be used in the landfill's composite liner. The submittal included the following:

    a. A July 10, 2014 email with drawings from Bill Kowalski of DPC to Martin Herrick of the Department,

    b. COE sampling summary for the Grand Encampment, Table 6 contaminant data for pool 4 of the upper Mississippi River, which was received via email from Carrie Olson of the Department to Martin Herrick of the Department on January 21, 2014,

    c. A September 25, 2014 email with drawings from Bill Kowalski of DPC to Martin Herrick of the Department.

4. On August 12, 2014 the Department public noticed an informational hearing in the Buffalo County Journal in accordance with Ch. 289.54, Wis. Stats.

5. On August 19, 2014 the Department issued a Conditional Plan of Operation Modification for the Alma Off-Site Ash Disposal Facility Phase IV, Cell 3B liner sub-base approving the use of the dredged material.

6. On August 27, 2014 Martin Herrick of the Department held an informational meeting at the Buffalo County Courthouse to discuss the proposed low hazard grant of exemption. Staff from DPC, Hoffman Construction, and the COE were in attendance and provided background information on the project.

7. On October 23, 2014 the Department submitted invoice no. 4206-10519 for $550 to DPC for the review of the requested low hazard grant of exemption.

8. Additional documents considered in connection with the exemption request include the following:

   a. Department guidance on Dredged Material Disposal Approvals Public Meeting Requirement-Ch.289.54 Stats.,

   b. The Department's Waste and Materials Management site inspection by Martin Herrick on August 21, 2014.

9. Additional facts relevant to the exemption request include the following:

   a. For purposes of this document, the term "dredged material" means any material that is excavated or dredged from the bed of any waterway.

   b. Dredged material is considered a solid waste under Wisconsin Statues and case law. In accordance with s. 289, Wis. Stats, no person may operate a solid waste disposal facility unless the person obtains a written approval from the Department.

   c. Dredged material may contain contaminants that are harmful to human health and the environment.

10. The Department has considered the environmental impacts of the proposal and has complied with the requirements of ch. NR 150, Wis. Adm. Code, and s 1.22. Stats., and, consistent with social, economic, and other essential considerations, the Department has adopted all practical means to avoid or minimize environmental harm.

11. The proposal would not be within an area where there is a reasonable probability that the facility would cause:

    a) A significant adverse impact on wetlands as provided in Ch. NR 103, Wis. Adm. Code;

    b) A significant adverse impact on critical habitat areas;

    c) A detrimental effect on any surface water;

    d) A detrimental effect on groundwater quality, if the facility is designed, constructed and operated in accordance with the proposal and any conditions(s) set forth below.

12. If the conditions set forth below are complied with, the disposal of nonhazardous dredged material will not result in environmental pollution as defined in s. 289.01(8), Stats.

13. The Department has conducted a continuing review of the potential hazard to public health and the environment of solid waste disposal facilities in general as well as this specific proposal. Based upon this review, the Department finds that regulation under s. 289, Stats., is not warranted in light of the low potential hazard to public health or the environment.

## CONCLUSIONS OF LAW

1. Based on the foregoing, the Department has the authority under s. 289.43(7), Stats., and ss. NR 500.08(5), Wis. Adm. Code, to issue a grant of exemption if the exemption would not inhibit compliance with the applicable provisions of ch. 30, 31, 160, and 280 to 299, and ss. 1.11, 23.40, 59.692, 59.693, 60.627, 61.351, 61.354, 62.231, 62.234, and 87.30, Stats.

2. The Department has authority to approve a grant of exemption with conditions if the conditions are needed to ensure compliance with the applicable provisions of ch. 30, 31, 160, and 280 to 299, and ss. 1.11, 23.40, 59.692, 59.693, 60.267, 61.351, 61.354, 62.231, 62.234, and 87.30, Stats.

3. The conditions set forth below are needed to ensure compliance with the applicable provisions of ch. 30, 31, 160, and 280 to 299, and ss. 1.11, 23.40, 59.692, 59.693, 60.627, 61.351, 61.354, 62.231, 62.234 and 87.30 Stats.

In accordance with the foregoing, the Department has the authority under s. 289.43(8), Wis. Stats., and s. NR 500.08(4), Wis. Adm. Code, to issue the following conditional grant of exemption.

## CONDITIONAL GRANT OF EXEMPTION

The Department hereby exempts the dredged material disposal facility on the DPC Alma Off-Site Ash Disposal Facility Phase IV Cell 3 B liner sub-base from the feasibility report, plan of operation, and solid waste facility licensing requirements of ch. 289, Stats, and from the annual licensing fees imposed under ss. 289.41 and 289.61, Wis. Stats., and authorizes DPC to dispose of dredged material, subject to the following conditions:

1. Only nonhazardous dredged material from the COE Grand Encampment facility shall be disposed of at the property.

2. Within 60 days of completing the closure of the disposal area, a report shall be submitted to the Department containing, at a minimum, the following information:

   a. Volume of dredged material placed for the Cell 3B sub-base liner. - Volume placed from Randy

   b. Surveyed topographic plan drawings indicating the specific location of this material, recorded by horizontal and vertical coordinates, on this property. - Two maps that Randy can print for me.
   ?

3. DPC shall pay invoice no. 4206-10519 within 30 days of its receipt.

4. Access to the property shall be restricted, as necessary, through the use of natural barriers or fencing.

5. Dredged material shall be transported in manner preventing releases. Should releases occur, they shall be cleaned up, and the cause of the problem shall be rectified.

6. The dredged material disposal facility shall be operated, maintained and closed in a nuisance-free manner.

7. Fugitive dust shall be controlled in accordance with s. NR 415.04, Wis. Adm. Code.

8. No action related to the disposal of the dredged material may be taken which will cause a significant adverse impact on wetlands as provided in ch. NR 103, Wis. Adm. Code.

9. No action related to the disposal of dredged material may be taken which will cause a significant adverse impact on critical habitat areas, as defined in NR 500.03(62), Wis. Adm. Code.

10. No action related to the disposal of the dredged material may be taken which will cause a detrimental effect on any surface water, as defined in s. NR 500.03(62), Wis. Adm. Code.

11. No action related to the disposal of dredged material may be taken which will cause a detrimental effect on groundwater, as defined in s. NR 500.03(62), Wis. Adm. Code, or will cause or exacerbate an attainment or exceedance of any preventive action limit or enforcement standard at a point of standards application as defined in ch. NR 140, Wis. Adm. Code.

12. No action related to the disposal of dredged material may be taken which will cause an exceedance of a soil cleanup standard in ch. NR 720, Wis. Adm. Code.

13. This grant of exemption shall expire on December 31, 2017, unless the Department extends or rescinds the grant of exemption in writing prior to that date.

This approval is based on the information available to the Department as of the date of approval. If additional information, project changes, or other circumstances indicate a possible need to modify this approval, the Department may ask you to provide further information relating to this activity. Likewise, the Department accepts proposals to modify approvals, as provided for in state statutes and administrative codes.

NOTICE OF APPEAL RIGHTS

If you believe that you have a right to challenge this decision made by the Department, you should know that Wisconsin statutes, administrative codes establish time periods and requirements for reviewing Department decisions.

To seek judicial review of the Department's decision, sections 227.52 and 227.53, Stats. establish criteria for filing a petition for judicial review. You have 30 days after the decision is mailed or otherwise served by the Department to file your petition with the appropriate circuit court and serve the petition on the Department. The petition shall name the Department of Natural Resources as the respondent.

Dated: October 23, 2014

Jill Schoen

Jill Schoen, CHMM
Waste & Materials Management Program Manager
West Central Region

JS for Martin Herrick

Martin Herrick, P.E.
Environmental Engineer
West Central Region

**State of Wisconsin**
**DEPARTMENT OF NATURAL RESOURCES**
**1300 W Clairemont Avenue**
**Eau Claire, WI 54701**

**Scott Walker, Governor**
**Cathy Stepp, Secretary**
Telephone 608-266-2621
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November 11, 2015

Mr. Robert Carothers
Dairyland Power Cooperative
JPM Station
500 Old State Highway 35
Alma, WI 54610

FID# 606043900
Buffalo Co.
SW/APPRV File

Subject: Construction Documentation Approval for Phase IV Cell 3B Liner Alma Off-Site Ash Disposal Facility, Town of Belvidere, Buffalo County, License # 4126

Dear Mr. Carothers:

We have completed our review of your report entitled "Phase IV, Cell 3B Liner Construction Documentation Report Dairyland Power Cooperative Alma Off-Site Ash Disposal Facility." The report was prepared by TRC and was dated October 2015. The report was received in the La Crosse Service Center on October 27, 2015. At this time we are approving the construction documentation for the Phase IV Cell 3B liner and you can begin filling in the cell.

Conditions have been included for payment of the plan review and construction inspections invoice, placement of four feet of ash by December 1, 2016, inspection and repair of the drainage blanket, associated surface water control features and review of the closure and long term care costs for the landfill.

This approval should be attached to your May 15, 2001 Plan of Operation Approval.

Please contact Martin Herrick at (608) 789-5518 if you have any questions regarding this approval.

Sincerely,

Jill Schoen

Jill Schoen, CHMM
Waste & Materials Management Program Supervisor
West Central Region

cc: Brian Kalvelage/Marty Herrick-LAX
Bill Kowalski-Dairyland Power Cooperative, 3200 East Avenue South, PO Box 817, La Crosse, WI 54602-0817
Curt Madsen - TRC, 708 Heartland Trail, Suite 3000, Madison, WI 53717

**BEFORE THE**
**STATE OF WISCONSIN**
**DEPARTMENT OF NATURAL RESOURCES**

**CONSTRUCTION DOCUMENTATION APPROVAL**
**PHASE IV, CELL 3B LINER**

**FOR THE**
**DAIRYLAND POWER COOPERATIVE**
**ALMA OFF-SITE ASH DISPOSAL FACILITY**
**TOWN OF BELVIDERE, BUFFALO COUNTY,**
**LICENSE # 4126**

## FINDINGS OF FACT

The department finds that:

1. Dairyland Power Cooperative (DPC) owns and operates a nonhazardous solid waste disposal facility located in the NE1/4 of the NE1/4 of Section 19 and portions of Sections 18 and 20, Township 21 North, Range 12 West, Town of Belvidere, Buffalo County, Wisconsin.

2. On May 15, 2001, the department issued a conditional plan of operation approval for the facility.

3. On June 20, 2012, Terry Halena of TRC sent an email to Martin Herrick of the department requesting that the conformance testing for environmental stress crack resistance from the geomembrane vendor GSE be substituted for the requirement in Condition No. 5 of the department's May 15, 2001 Conditional Plan of Operation Approval. On June 27, 2012, Martin Herrick of the department sent a response email concurring.

4. On August 19, 2014, the department issued a Conditional Plan Modification to the May 15, 2001Plan of Operation Approval revising the sub-base of the Alma Off-Site Phase IV Liner to accept dredged sediments from the Mississippi River.

5. On October 23, 2014, the department issued a conditional grant of exemption to use low hazard dredge material as sub-base material under the Alma Off-Site Phase IV Liner.

6. On May 12, 2015, Martin Herrick of the department, via E-mail, concurred with DPC's request for reduced testing of the dredged sediments being placed under the Alma Off-Site Phase IV Landfill.

7. The information submitted in connection with the construction documentation includes the following:

   a. A report entitled " Dairyland Power Cooperative –Alma Off-Site Disposal Facility (License #4126) Preconstruction Report: Liner Construction –Phase IV, Cell 3B."

   b. A report entitled "Phase IV, Cell 3B Liner Construction Documentation Report Dairyland Power Cooperative Alma Off-Site Ash Disposal Facility," and thirteen associated engineering drawings dated October 2015.

   c. A letter dated October 7, 2015, from TRC on behalf of DPC to Martin Herrick of the department, documenting the placement of the dredged sediments under the Alma Off-Site Phase IV Landfill. The letter included three plan sheets.

8. Additional information considered in the review of the construction documentation:

   a. Department files for the Dairyland Power Cooperative – Alma Offsite Ash Disposal Facility, Phase IV.

9. Construction inspections were performed by the Department for the following on:

   a. Subbase preparation on April 23, 2015, by Martin Herrick,
   b. Low permeability barrier soils placement on July 9, 2015, by Martin Herrick,
   c. Geomembrane and GCL liner installation on August 5, 2015, by Martin Herrick,
   d. Sand Drainage Blanket and leachate collection system installation on August 21, 2015, by Martin Herrick.

10. On November 5, 2015, the department submitted invoice #4206-10794 to Dairyland Power Cooperative. The invoice included $1100 for review of the construction documentation and $2200 for four construction inspections.

## CONCLUSIONS OF LAW

1. The department has authority under ss. 289.43(7) and 289.43(8), Stats., and ch. NR 516, Wis. Adm. Code, to require that the owner of a solid waste disposal facility demonstrate that the facility has been constructed in substantial compliance with the May 15, 2001 Conditional Plan of Operation Approval.

2. If the conditions of approval set forth below are complied with the applicant will have demonstrated that the facility has been constructed in substantial compliance with the NR 500 to NR 590 Series of the Wis. Adm. Code and the May 15, 2001 Conditional Plan of Operation Approval.

3. The department has authority under s. 289.30(6), Stats., to modify a plan of operation approval if the modification would not inhibit compliance with the applicable portions of chs. NR 500- 590, Wis. Adm. Code.

## CONDITIONS OF APPROVAL

The department hereby approves the construction documentation for the Dairyland Power Cooperative Phase IV Cell 3B liner at the Alma Off-Site Ash Disposal Facility subject to NR 500-590, Wis. Adm. Code, the May 15, 2001 Conditional Plan of Operation Approval and subsequent plan modifications and the following conditions:

1. Dairyland Power Cooperative shall inspect the sand drainage blanket and liner of Phase IV Cell 3B after major storm events and on a monthly basis and make repairs as necessary. Inspection and repair of the, sand drainage blanket and liner shall continue until enough material has been placed to prevent it from eroding.

2. The depth of wheel rutting from haul trucks placing the ash shall be used as a performance measure to limit the moisture content of the ash placed in Phase IV Cell, 3B. When ash is being placed no wheel ruts deeper than 2 inches shall be allowed.

3. Payment of invoice #4206-10794 shall be made to the department within 30 days of receipt.

4. Dairyland Power Cooperative shall place four feet of ash on the bottom and initial 10 ft. of slope for the newly constructed cell by December 1, 2016.

5. Cleaning and restoration of the surface water control features shall be performed as necessary.

6. The closure and long term care costs for the Phase IV landfill shall be reviewed and updated as necessary. If revisions are required they shall be submitted to the Department within 90 days from the date of this approval.

This approval is based on the information available to the Department as of the date of approval. If additional information, project changes or other circumstances indicate a possible need to modify this approval, the Department may ask you to provide further information relating to this activity. Likewise, you may request a modification of this approval based on additional information, project changes or other circumstances as provided for in state statues and administrative codes. Unless specifically noted, the conditions of this approval do not supersede or replace any previous conditions of approval for this facility.

**NOTICE OF APPEAL RIGHTS**

If you believe that you have a right to challenge this decision made by the department, you should know that Wisconsin statues and administrative codes establish time periods and requirements for reviewing department decisions.

To seek judicial review of the Department's decision, sections 227.52 and 227.53, Stats. establish criteria for filing a petition for judicial review. You have 30 days after the decision is mailed or otherwise served by the department to file your petition with the appropriate circuit court and serve the petition on the department. The petition shall name the Department of Natural Resources as the respondent.

Dated: _____November 11, 2015_____

DEPARTMENT OF NATURAL RESOURCES
For the Secretary

Jill Schoen

_____
Jill Schoen, CHMM
Waste & Materials Management Program Supervisor
West Central Region

Martin Herrick

_____
Martin Herrick, P.E.
Environmental Engineer
West Central Region

**State of Wisconsin**
**DEPARTMENT OF NATURAL RESOURCES**
**Wisconsin Department of Natural Resources**
**3550 Mormon Coulee Road**
**LaCrosse WI 54601**

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**Cathy Stepp, Secretary**
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July 19, 2016

Mr. Brian Treadway
Dairyland Power Cooperative
JPM Station 500, Old State Highway 35
Alma, WI 54610

FID # 606009360
Buffalo Co.
SW/APPRV FILE

Subject: Conditional Plan Modification to the Plan of Operation Approval for the Phase IV Landfill, Alma Off-Site Ash Disposal Facility, Town of Belvidere, Buffalo County, License #4126

Dear Mr. Treadway:

We have completed our review of your June 13, 2016 plan modification request to revise the final cover for the Phase IV Disposal Area at the Alma Off-Site Ash Disposal Facility. The request, which was dated June 13, 2016, was prepared by TRC Environmental Corporation (TRC) on behalf of Dairyland Power Cooperative (DPC) and was received in the LaCrosse Service Center on June 16, 2016. The submittal included a narrative and attachments for the HELP model and a water budget for the Phase IV landfill.

The proposed revisions to the Phase IV Landfill cap include a test section of cap where the 2004 alternate cap revision is being modified by substituting 2 feet of moisture conditioned baghouse coal combustion residual(CCR) for the approved 2 feet of select fly ash. The test section is laterally limited to 2.8 acres of cap. For additional area to be capped with proposed configuration a successful demonstration of the test results and subsequent plan modification to the May 15, 2001 Plan of Operation will be required.

Conditions have been included for the lateral extent of the proposed area of capping, submittal of plan sheets delineating the proposed capping area, construction documentation and payment of the plan review fee.

This approval should be attached to your May 15, 2001 Plan of Operation Approval. Please contact Martin Herrick at (608) 789-5518 if you have any questions regarding this approval.

Sincerely,

Jill Schoen

Jill Schoen, CHMM
Waste Program Supervisor
West Central Region

cc: Brian Kalvelage/Marty Herrick-LAX
Curt Madsen, TRC, 708 Heartland Trail, Suite 3000, Madison, WI 53717
Mike McCullick-Dairyland Power Cooperative, 3200 East Avenue South, PO Box 817, LaCrosse, WI 54602

BEFORE THE
STATE OF WISCONISN
DEPARTMENT OF NATURAL RESOURCES

CONDITIONAL PLAN OF OPERATION MODIFICATION
FINAL CAP
FOR
PHASE IV LANDFILL

DAIRYLAND POWER COOPERATIVE
ALMA OFF-SITE ASH DISPOSAL FACILITY
TOWN OF BELVIDERE, BUFFALO COUNTY,
LICENSE # 4126

## FINDINGS OF FACT

The Department finds that:

1. Dairyland Power Cooperative (DPC) owns and operates a nonhazardous solid waste disposal facility located in the NE1/4 of the NE1/4 of Section 19 and portions of Sections 18 and 20, Township 21 North, Range 12 West, Town of Belvidere, Buffalo County, Wisconsin,
2. The department issued a conditional plan of operation approval for the facility on May 15, 2001.
3. On March 4, 2004 the department issued a conditional plan modification to the May 15, 2001 Plan Operation Approval revising the landfill cap whereby the Geocomposite Liner (GCL) and 6 inch grading layer were substituted with 2 feet of select fly ash.
4. On June13, 2016 TRC on behalf of DPC submitted a plan modification request to the department to revise the final cap for the Phase IV Landfill. The submittal included a narrative, a HELP model analysis and a water budget for the landfill.
5. On June 23, 2016, the department submitted invoice #4206 -109088 for $1650 to DPC for plan review of the June 13, 2016 report.

## CONCLUSIONS OF LAW

1. The department has authority under s. 289.30(6)Stats. to modify a plan of operation approval if the modification would not inhibit compliance with the applicable portions of chs. NR 500-590; Wis. Adm. Code.
2. The department has authority to approve a plan operation modification with special conditions if the conditions are needed to ensure compliance with the applicable portions of chs. NR 500-590, Wis. Adm. Code.
3. The conditions of approval set forth below are needed to ensure compliance with the applicable portions of chs. NR 500- 590, Wis. Adm. Code
4. In accordance with the foregoing, the department has authority under ch. 289., Stats., to issue the following conditional plan of operation approval.

## CONDITIONS OF APPROVAL

The department hereby approves the proposed plan modification for the additional barrier layer source for the final cap at the DPC Phase IV Alma Off-Site Ash Disposal Facility subject to the NR 500 Series, Wis. Adm. Code, the May 15, 2001 Conditional Plan of Operation Approval, subsequent modifications and the following conditions:

1. Payment of invoice #4206 -10988 shall be made to the department within 30 days from the date of receipt.
2. A plan sheet showing the proposed area to be capped for 2016 shall be submitted to the department with the geomembrane preconstruction report.
3. A maximum of 2.8 acres can be constructed with the proposed alternative cap.
4. When obtaining CCR samples for the permeameter testing the samples shall be from a discrete material and not composited.
5. The proctor curves shall be developed for discrete CCR materials and account for the moisture conditioning prior to and after placement in order to be representative of field conditions.

This approval is based on the information available to the department as of the date of approval. If additional information, project changes or other circumstances indicate a possible need to modify this approval, the department may ask you to provide further information relating to this activity. Likewise, you may request a modification of this approval based on additional information, project changes, or other circumstances as provided for in state statues and administrative codes. Unless specifically noted, the conditions of this approval do not supersede or replace any previous conditions of approval for this facility.

## NOTICE OF APPEAL RIGHTS

If you believe that you have a right to challenge this decision made by the department, you should know that Wisconsin statues and administrative codes establish time periods and requirements for reviewing department decisions.

To seek judicial review of the department's decision, sections 227.52 and 227.53, Stats. establish criteria for filing a petition for judicial review. You have 30 days after the decision is mailed or otherwise served by the department to file your petition with the appropriate circuit court and serve the petition on the department. The petition shall name the Department of Natural Resources as the respondent.

Dated: July 19, 2016

DEPARTMENT OF NATURAL RESOURCES
For the Secretary

Jill Schoen

Jill Schoen, CHMM
Waste Program Supervisor
West Central Region

JH for Martin Herrick

Martin Herrick, P.E.
Environmental Engineer
West Central Region

**State of Wisconsin**
**DEPARTMENT OF NATURAL RESOURCES**
**Wisconsin Department of Natural Resources**
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March 15, 2017

Mr. Brian Treadway
Dairyland Power Cooperative
JPM Station
500 Old State Highway35
Alma WI 54610

FID # 606009360
Buffalo Co.
SW/APPRV File

Subject: Construction Documentation Approval for Phase IV Area C Final Cover Alma Off-Site Ash Disposal Facility, Town of Belvidere, Buffalo County, License # 4126

Dear Mr. Treadway:

We have completed our review of your report entitled "Phase IV, Area C Final Cover Construction Documentation Report Dairyland Power Cooperative Alma Off-Site Ash Disposal Facility, License No. 4126, February 2017." The report was prepared by TRC and was dated February 2017. The report was received in the La Crosse Service Center on February 17, 2017. At this time we are approving the construction documentation for the Phase IV Area C cap.

Area C is a 2.8 acre test section of the landfill allowing a revised cap as conditioned by the department's July 19, 2016 conditional plan modification to the May 15, 2001 Plan of Operation Approval. Plan sheet 10 of 13 dated August 4, 2016, which was prepared by TRC, delineates Area C and the associated 2016 cap construction. The modification allowed a change to the 2004 alternate cap revision whereby two feet of moisture conditioned baghouse coal combustion residual is substituted for two feet of the previously approved select flyash. Note that a successful demonstration of this test and a plan modification will be required for this design to be implemented on the rest of the Phase IV landfill cap.

Conditions have been included for payment of the plan review and construction inspections invoice, inspection of the cap and maintenance of surface water control features and limiting the use of this design to Area C. This approval should be attached to your May 15, 2001 Plan of Operation Approval. Please contact Martin Herrick at (608) 789-5518 if you have any questions regarding this approval.

Sincerely,

Jill Schoen

Jill Schoen, CHMM
Waste Program Supervisor
West Central Region

cc: Marty Herrick-LAX
Leif Tolokken-Dairyland Power Cooperative, 3200 East Avenue South, PO Box 817, La Crosse, WI 54602-0817
Curt Madsen - TRC, 708 Heartland Trail, Suite 3000, Madison, WI 53717

BEFORE THE
STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES

CONSTRUCTION DOCUMENTATION APPROVAL
PHASE IV, AREA C CAP
FOR THE
DAIRYLAND POWER COOPERATIVE
ALMA OFF-SITE ASH DISPOSAL FACILITY
TOWN OF BELVIDERE, BUFFALO COUNTY,
LICENSE # 4126

FINDINGS OF FACT

The department finds that:

1. Dairyland Power Cooperative (DPC) owns and operates a nonhazardous solid waste disposal facility located in the NE1/4 of the NE1/4 of Section 19 and portions of Sections 18 and 20, Township 21 North, Range 12 West, Town of Belvidere, Buffalo County, Wisconsin,
2. The department issued a conditional plan of operation approval for the facility on May 15, 2001.
3. The department issued a conditional plan modification to the May 15, 2001 Plan of Operation Approval on March 4, 2004 allowing the use of two feet of select flyash to be substituted for the GCL (geocomposite liner) in the cap.
4. The department issued a conditional plan modification to the May 15, 2001 Plan of Operation Approval on September 21, 2009, adding soil borrow areas for select granular fill, general fill and topsoil for the cap.
5. The department issued a conditional plan modification on March 14, 2011, allowing the deletion of the resistivity testing for the Phase IV cap.
6. The department issued a conditional plan modification to the May 15, 2001 Plan of Operation Approval on July 19, 2016, allowing a substitution in the 2004 alternate cap revision whereby two feet of moisture conditioned baghouse coal combustion residual is substituted for two feet of approved select flyash. The plan modification allows a test of this design in the Area C cap for a lateral extent of 2.8 acres as shown in TRC's plan sheet 10 of 13 dated August 4, 2016.
7. The information submitted in connection with the construction documentation includes the following:
   a. A report entitled " Phase IV, Area C Final Cover Construction Documentation Report, Dairyland Power Cooperative Alma Off-Site Ash Disposal Facility License 4126, February 2017 " and ten associated engineering drawings dated February 2017.
8. Additional information considered in the review of the construction documentation;
   a. Dairyland Power Cooperative-Alma Offsite Disposal Facility (License #4126) Phase IV Disposal Area, Cell C Preconstruction Report, dated August 4, 2016,
   b. July 12, 2009 E-mail from Bill Kowlaski of DPC to Marty Herrick of the department requesting the use of G-3 fly ash n the Phase IV cap,
   c. July 14, 2011 E-mail from Terry Halena of TRC to Marty of Herrick of the department, regarding cross seams in geomembrane panel placement,
   d. July 21, 2011 E-mail from Terry Halena of TRC to Marty Herrick of the department, requesting to eliminate environmental stress crack resistance.
9. Construction inspections were performed by the department for the following on:
   a. Placement of the grading layer by Martin Herrick on August 11, 2016,
   b. Installation of the geomembrane by Martin Herrick on August 31, 2016,
   c. Placement of the sand drainage blanket by Martin Herrick on September 13, 2016,
   d. Placement of topsoil and seeding by Martin Herrick on October 4, 2016.

10. On March 3, 2017, the department submitted invoice #4206-1188 to Dairyland Power Cooperative. The invoice included $ 1100 for review of the construction documentation and $2200 for four construction inspections.

## CONCLUSIONS OF LAW

1. The department has authority under ss. 289.43(7) and 289.43(8), Stats., and ch. NR 516, Wis.
2. Adm. Code, to require that the owner of a solid waste disposal facility demonstrate that the facility has been constructed in substantial compliance with the May 15, 2001 Conditional Plan of Operation Approval.
3. If the conditions of approval set forth below are complied with the applicant will have demonstrated that the facility has been constructed in substantial compliance with the NR 500 to NR 590 Series of the Wis. Adm. Code and the May 15, 2001 Conditional Plan of Operation Approval.
4. The department has authority under s. 289.30(6), Stats., to modify a plan of operation approval if the modification would not inhibit compliance with the applicable portions of chs. NR 500- 590, Wis. Adm. Code

## CONDITIONS OF APPROVAL

The department hereby approves the construction documentation for the Dairyland Power Cooperative Phase IV Area C Cap at the Alma Off-Site Ash Disposal Facility subject to NR 500-590, Wis. Adm. Code, the May 15, 2001 Conditional Plan of Operation Approval and subsequent plan modifications and the following conditions:

1. Dairyland Power Cooperative shall inspect the Area C cap after major storm events and on a monthly basis and make repairs as necessary.
2. Cleaning and restoration of the surface water control features shall be performed as necessary.
3. Payment of invoice # 4206-11188 shall be made to the department within 30 days of receipt.
4. The substitution of the two foot moisture conditioned baghouse coal combustion residual for the select flyash in the Phase IV cap is only allowed for the area C test as delineated in TRC's plan sheet 10 of 13 dated August 4, 2016.

This approval is based on the information available to the department as of the date of approval. If additional information, project changes or other circumstances indicate a possible need to modify this approval, the department may ask you to provide further information relating to this activity. Likewise, you may request a modification of this approval based on additional information, project changes or other circumstances as provided for in state statues and administrative codes. Unless specifically noted, the conditions of this approval do not supersede or replace any previous conditions of approval for this facility.

## NOTICE OF APPEAL RIGHTS

If you believe that you have a right to challenge this decision made by the department, you should know that Wisconsin statues and administrative codes establish time periods and requirements for reviewing department decisions.

To seek judicial review of the department's decision, sections 227.52 and 227.53, Stats. Establish criteria for filing a petition for judicial review. You have 30 days after the decision is mailed or otherwise served by the department to file your petition with the appropriate circuit court and serve the petition on the department. The petition shall name the Department of Natural Resources as the respondent.

Dated: ___March 15, 2017_____

DEPARTMENT OF NATURAL RESOURCES
For the Secretary

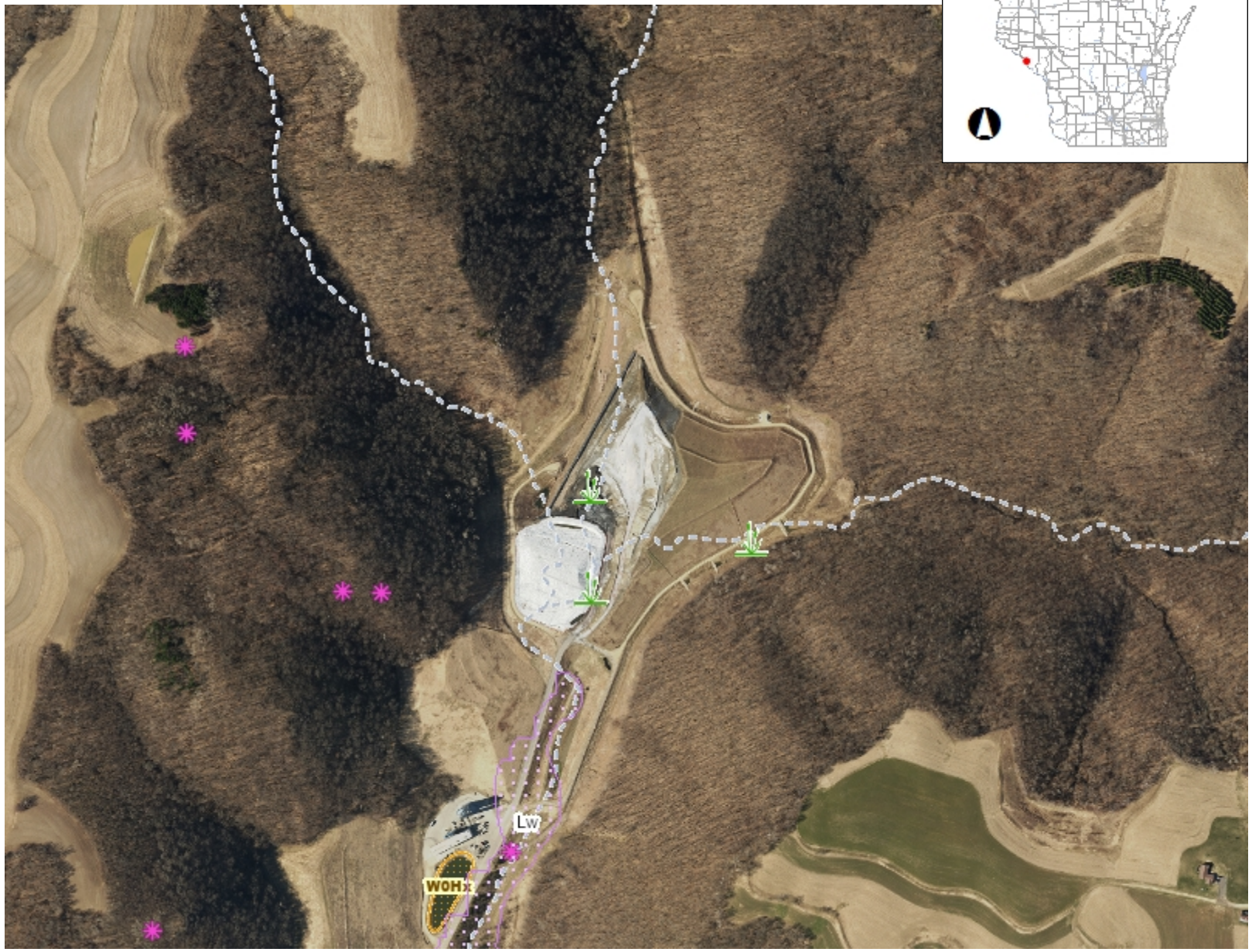
Jill Schoen, CHMM
Waste Program Supervisor
West Central Region

Martin Herrick, P.E.
Environmental Engineer
West Central Region

# Appendix C: Performance Standards Demonstrations

# Wetland Demonstrations

# DPC Project Area Surface Water Data Viewer Map



## Legend

- Wetland Indicators
- Wetland Class Areas
- Wetland Class Points
  - Dammed pond
  - Excavated pond
  - Filled/drained wetland
  - Wetland too small to delineate
  - Filled excavated pond
- Filled Points
- Wetland Class Areas
- Filled Areas
- Wetland Class Areas
- Wetland Class Points
  - Dammed pond
  - Excavated pond
  - Filled/drained wetland
  - Wetland too small to delineate
  - Filled excavated pond
- Filled Points
- Wetland Class Areas
- Filled Areas
- Wetland Identifications and Confirmations
- NRCS Wetspots
- Rivers and Streams
- Intermittent Streams
- Lakes and Open water
- Index to EN_Image_Basemap_Leaf_Off

## Notes

0.3 0 0.13 0.3 Miles

NAD_1983_HARN_Wisconsin_TM

1: 7,920

DISCLAIMER: The information shown on these maps has been obtained from various sources, and are of varying age, reliability and resolution. These maps are not intended to be used for navigation, nor are these maps an authoritative source of information about legal land ownership or public access. No warranty, expressed or implied, is made regarding accuracy, applicability for a particular use, completeness, or legality of the information depicted on this map. For more information, see the DNR Legal Notices web page: http://dnr.wi.gov/legal/

# Non-Navigable Stream Determination

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

2004 Highland Avenue
Eau Claire, WI 54701-4348
TELEPHONE 715/839-3777
TELEFAX 715/839-1605

WISCONSIN
DEPT. OF NATURAL RESOURCES

George E. Meyer
Secretary

October 26, 1994

File Ref: 4400

Mr. John Toepfer
Dairyland Power Cooperative
P.O. Box 817
3200 East Avenue South
LaCrosse, WI 54601

SUBJECT: Initial Site Inspection - Proposed Dairyland Power Cooperative Solid Waste Disposal Facility

Dear Mr. Toepfer:

On August 18, RMT, Inc. provided the Department with a written request on behalf of Dairyland Power Cooperative for an initial site inspection for a proposed coal ash solid waste disposal facility. The proposed site is located in the NE¼ of the NE¼ of Section 19, Township 21N, Range 12W, and the SE¼ of the SE¼ of Section 18, Township 21 North, Range 12 West, Buffalo County, Wisconsin.

Copies of correspondence from the State Historical Society and the Bureau of Endangered Resources indicate the proposed location complies with the requirements of Wisconsin's historic preservation laws and that no endangered threatened, special concern species, natural communities nor any state natural areas would be impacted by the project.

An initial site inspection of the property was completed on August 24 in the company of representatives from RMT, Inc. and you. The property was also inspected on September 22 by personnel from the Department's Water Regulations and Zoning program. Purpose of the inspection was to determine navigability of ephemeral waterways near the proposed project location. As a result of the site inspections, it was determined that the ephemeral waterways are non-navigable and that no Chapter 30 permits are necessary and that the proposed project locations meet the location and performance standards specified in ss NR 504.04 Wisc. Admin. Code. Dairyland Power Cooperative may proceed with citing and licensing the proposed coal ash landfill in accordance with the Department's solid waste management rules and s. 144.44 Wisc. Stats.

If you have any questions, please feel free to contact me at (715) 839-3768.

Sincerely,

Jack S. Tritt

Jack S. Tritt
Waste Management Specialist

JST/jh

c.: Dave Lundberg
Sue Fisher - SW/3
Curt Madsen - RMT, Inc.
Chairman, Town of
Buffalo County Zoning Administrator

Date: May 11, 1995

COPY

File Number 21-12-18(19,20,24,30)-14

Application Number 95-28

THIS CERTIFIES THAT A

SPECIAL USE PERMIT

HAS BEEN ISSUED TO:

DAIRYLAND POWER CO

IN COMPLIANCE WITH REQUIREMENTS OF THE BUFFALO COUNTY ZONING ORDINANCE FOR:

ASH DISPOSAL SITE

Located at: ___ ¼ ___ ¼ Sec.s: 18, 19, 20, 24, 30 T. 21 N. R. 12 W. Subdivision —

Town of: Belvidere Zoning District Agriculture

With the Following Conditions:

1. Landfill site is approved for areas referred to as Phases 1, 2, & 3 in the DNR landfill permit located in the NE 1/4 and NW of SW 1/4 of Section 19, T. 21 N., R. 12 W., Town of Belvidere.
2. Materials other than those approved of in Dairyland Power's DNR landfill permit cannot be deposited.
3. Continuous reclamation will be practiced.
4. Contingent upon the Buffalo County Board approving rezone #95-27 from the Recreation to Agriculture District.

Nathan Sampson
Zoning Administrator

12

# Appendix D: Locational Criteria Demonstration

# 2018 Location Restriction Demonstration

# Location Restrictions Demonstrations

## Alma Off-Site Disposal Facility, Phase IV Landfill
## Buffalo County, Wisconsin

**May 2018**

*Prepared For*
*Dairyland Power Cooperative*


Jonathan N. Hotstream, P.E., P.G.
Senior Geological Engineer

Todd Martin
Principal Project Manager





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2. Location Restrictions ..... 2
   - 2.1 §257.60 – Placement Above the Uppermost Aquifer ..... 2
   - 2.2 §257.61 – Wetlands ..... 3
   - 2.3 §257.62 – Fault Areas ..... 4
   - 2.4 §257.63 – Seismic Impact Zones ..... 4
   - 2.5 §257.64 – Unstable Areas ..... 4

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Appendix B Supporting Material for §257.61
Appendix C Supporting Material for §257.62
Appendix D Supporting Material for §257.63
Appendix E Supporting Material for §257.64

# Revision History

| REVISION NUMBER | REVISION DATE | SECTION REVISED | SUMMARY OF REVISIONS |
|---|---|---|---|
| | | | |
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# Section 1
# Introduction

This location restrictions demonstrations report (Report) was prepared by TRC Environmental Corporation (TRC) on behalf of Dairyland Power Corporation (DPC) for the Alma Off-Site Disposal Facility, Phase IV Landfill (Landfill) where coal combustion residuals (CCR) are disposed. The 32.1 acre Landfill is located in the NE ¼ of the NE ¼ of Section 19 and portions of Sections 18 and 20, T21N, R12W, the W ½ of the NE ¼, Section 23, T26N, R7E, Town of Belvidere, Buffalo County, Wisconsin (refer to Figure 1). DPC owns and operates the permitted Landfill in compliance with the Plan of Operation (POO) (RMT, 2000) approved by the Wisconsin Department of Natural Resources (WDNR).

The purpose of this Report is to demonstrate the compliance of the existing Landfill footprint and planned future lateral expansions to the Landfill with the location restrictions required by the U.S. Environmental Protection Agency's (USEPA) CCR rule, Title 40 Code of Federal Regulations (40 CFR) Parts 257 and 261 Subpart D-"Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments" (Federal Register §257.60 through §257.64). Currently, Cells 1 through 3 of the Landfill have been constructed and have received CCR. Future lateral expansions include Cell 4A and Cell 4B (refer to Figure 2). These two cells compose the lateral expansions in this Report. This document includes information from site permitting data, previously completed work, a desktop study, and engineering calculations to evaluate the Landfill concerning its location above the uppermost aquifer (§257.60), wetlands (§257.61), fault areas (§257.62), seismic impact zones (§257.63), and unstable areas (§257.64).

Supporting documents are provided in appendices to this report. Such documents include components of the Feasibility Report (FR), Plan of Operation (POO), and environmental monitoring data which were reviewed to evaluate site setting and conditions.

# Section 2
# Location Restrictions

The location restrictions required by the federal CCR rule are presented below with a demonstration to show compliance with each restriction. The location restrictions address separation from the uppermost aquifer, wetlands, fault areas, seismic impact zones, and unstable areas. Supporting information for the demonstrations are attached as appendices to this report.

## 2.1 §257.60 – Placement Above the Uppermost Aquifer

The federal CCR rule requires that the Landfill lateral expansions must be constructed with a base that is located no less than 5 feet above the upper limit of the uppermost aquifer or must demonstrate that there will not be intermittent, recurring, or sustained hydraulic connection between any portion of the base of the Landfill. To determine the proximity of the upper limit of the uppermost aquifer in relation to the base of the lateral expansions, groundwater elevation data for the monitoring wells surrounding the Landfill for the period between November 1995 and September 2017 were reviewed to determine the upper limit of the uppermost aquifer. The upper limit of the uppermost aquifer was compared to the proposed subbase grades of the lateral expansions in the approved POO.

Data from seven groundwater monitoring wells and piezometers installed between 1994 and 1997 located at the south side (wells W-100/W-100R, W-100A/W-100AR, and W-105), west side (well W-42), east side (wells W-102 and W-102A), and north side (well W-107) of the Landfill indicate that the observed groundwater elevation in the uppermost aquifer has been relatively constant over a 22 year period (1995 through 2017; Appendix A). The Landfill design grades and slopes at the upgradient and downgradient locations were reviewed to determine the distance between the subbase grades (bottom of liner grades) and the upper limit of the groundwater elevation. The Landfill grades slope from the north to the south, following the site topography. The south end subbase grade is a minimum elevation of 782 feet Mean Sea Level (MSL), and the north end subbase grade is a minimum elevation of 862 feet MSL (Appendix A).

Based on the monitoring results, the maximum groundwater elevation of the south side wells was 737.97 feet MSL (W-100/W-100R in June 2001), and the maximum groundwater elevation of the north side well was 831.82 feet MSL (W-107 in September 2017). The engineering cross sections from the POO were included in Appendix A to present the bottom of the Landfill in comparison to the groundwater level. The groundwater level monitoring indicates that the

groundwater levels shown on POO cross sections are representative of the current conditions. These comparisons show that there is over 5 feet of separation between the bottom of the Landfill and the observed upper limit of the uppermost aquifer.

Based on this evaluation, the future lateral expansions of the Landfill will be constructed with a base that is greater than 5 feet above the upper limit of the uppermost aquifer. Therefore, the future lateral expansions of Landfill are in compliance with the requirements of §257.60.

## 2.2 §257.61 – Wetlands

The federal CCR rule requires that the Landfill lateral expansions cannot be located in wetlands. To determine if the Landfill, and therefore planned lateral expansions, are located in a wetland, the approved FR for the Landfill and more recent sources were reviewed.

Section 7 of the FR (Appendix B) approved by the WDNR contains an Ecological Assessment which concluded no wetlands are known to be present within the approved Landfill footprint. In addition the Feasibility Determination (Appendix B) noted that "ephemeral waterways, which flow in direct response to precipitation, route surface water from the uplands and steep slopes into the central valley," and "the nearest wetlands are located approximately 1 mile south of the proposed site along the Mississippi River."

The WDNR Surface Water Data Viewer (2017) and hydric soil classifications from the United States Department of Agriculture (2017) were consulted to determine the presence of potential additional wetlands in the area. Wetlands were not identified in the area of the lateral expansions. The water data viewer identifies wetlands too small to map within the existing landfill footprint which is not representative of the current conditions since the landfill has been constructed in these areas. The soil types within the proposed lateral expansions were mapped as 'not hydric' (Appendix B). The mapped soil types, Norden silt loam, worthen silt loam, churchtown silt loam, and Urne fine sandy loam, have a hydric rating of zero, and are well drained (Appendix B). These soil units, except for the Worthen silt loam, have steep slopes that range from 12 to 45 percent. These soil conditions suggest there are not wetland soils and flat or nearly flat areas where ponding would occur. The WDNR surface Water Data Viewer shows intermittent streams in the area of the landfill which supports the conclusion of the Feasibility Determination. The hydric rating map, shows one stream to the east of the existing landfill which has been previously diverted around the existing landfill. Therefore, this desktop study indicates the lateral expansions of the Landfill comply with the requirements of §257.61. A wetlands delineation will be performed if requested by the regulatory agencies to confirm the conclusions of this desktop study.

## 2.3 §257.62 – Fault Areas

The federal CCR rule requires that the Landfill lateral expansions must not be located within 200 feet of the outermost damage zone of a fault that has had displacement in Holocene time (11,700 years ago to present). To determine recent fault activity in the area, the subsurface exploration data and USGS Earthquake Fault Map were reviewed.

The subsurface investigation performed in the FR included rock coring. Faulting was not observed in the rock cores (Appendix C). Additionally, the USGS Quaternary Earthquake Fault Map (Appendix C) does not map faults occurring within the past 1.6 million years in the region of the Landfill or lateral expansions.

No evidence of active faulting during the Holocene within 200 feet of the Landfill has been identified; therefore, the lateral expansions comply with the requirements of §257.62.

## 2.4 §257.63 – Seismic Impact Zones

Federal CCR rule §257.63 requires that lateral expansions must not be located in seismic impact zones. The USGS Earthquake Hazards Program was consulted to determine the earthquake hazard for the site.

The 2015 National Earthquake Hazards Reduction Program (NEHRP) U.S. seismic design maps website (USGS 2015; Appendix D) indicates a mapped peak ground acceleration of 0.023g. Using a site adjustment factor of 1.6 based on the peak ground acceleration, and subsurface conditions, a design peak ground acceleration of 0.036g was calculated (Appendix D). This design peak ground acceleration is below the 0.1g lower limit specified by the federal CCR rule for seismic impact zones; therefore, this site is not located in a seismic impact zone as defined in §257.53. Because the site is not located in a seismic impact zone, the lateral expansions comply with the requirements of §257.63.

## 2.5 §257.64 – Unstable Areas

The federal CCR rule states that existing CCR units and lateral expansions may not be located in an unstable area. Risks presented by unstable areas caused by soil conditions, geologic or geomorphologic features, and human made features must be evaluated to be in compliance with the federal CCR rule. This analysis was performed by evaluating the results of the geotechnical exploration within the Landfill footprint during the siting and evaluation of the Landfill design.

A siting study was performed in the FR application to evaluate the potential for unstable conditions. The geotechnical exploration performed for the FR observed silt and lean clay

overlying medium to dense silty sand and sand to termination of soil borings, which ranged up to depths of 152 feet below the ground surface (Appendix C). Weathered bedrock consisting mainly of sandstone or dolomite were encountered in some borings. Within the footprint of the Landfill, the dolomite bedrock has been weathered away and the soils are underlain by sandstone. These observations do not suggest unstable foundation conditions considering the existing conditions and lateral expansions.

The Landfill design was performed by a professional engineer applying generally accepted good engineering practices. Global slope stability calculations were performed indicating acceptable factors of safety for critical slopes (RMT, 2000 POO; Appendix E). The subgrade of the existing Landfill was graded and prepared to provide suitable subgrade conditions according to the project specifications under the observation of an engineer's representative. The construction was performed and documented in accordance with the plans and specifications and certified by a professional engineer in the State of Wisconsin (RMT, 2001; RMT, 2008; TRC, 2013; and TRC, 2015).

Similar subgrade conditions are expected based on site activities and the results of the siting study. During construction, the subgrade for the lateral expansions will be prepared in a similar manner to comply with the POO.

Based on these analyses, the existing Landfill and lateral expansions are not located in an unstable area and comply with the requirements of §257.64.

# Section 3
# Conclusions

Based upon the demonstrations provided in this report, the existing Landfill and planned future lateral expansions are in compliance with the location restrictions required by the CCR rule. No additional action or justification is required after this document has been placed in the operating record, posted to the publicly accessible website, and government notifications have been provided.

# Section 4
# References


Lundberg, D.R. Waste Management Team Leader, Wisconsin Department of Natural Resources, to Johnston, George, Dairyland Power Cooperative. 1999. *Feasibility Determination for the Proposed Dairyland Power Cooperative Phase IV Ash Disposal Facility, Town of Belvidere, Buffalo County, Wisconsin. License No. 4126.* September 10. [letter].

RMT. 1997. Feasibility Report for the Phase IV Ash Disposal Area. September 19, 1997.

RMT. 2000. Plan of Operation for the Phase IV Ash Disposal Area. October 19, 2000.

RMT. 2001. Phase IV, Cell 1 Liner Construction Documentation Report. November 2001.

RMT. 2007. Phase IV, Cell 2A Liner Construction Documentation Report. January 2007.

RMT. 2008. Phase IV, Cell 2B Liner Construction Documentation Report. January 2008.

RMT. 2015. Construction Documentation Report, Phase IV, Cell 3B Liner Construction Letter Report. November 2015.

TRC. 2013. Phase IV, Cell 3A Liner Construction Documentation Report. January 2013.

TRC. 2015. Phase IV, Cell 3B Liner Construction Documentation Report. October 2015.

United States Department of Agriculture. 2017. Soil Survey Staff, Natural Resources Conservation Service, Web Soil Survey. Available online at http://websoilsurvey.nrcs.usda.gov/. Accessed [01/30/2017].

United States Geological Survey (USGS). 2015. U.S. Seismic Design Maps: 2015 National Earthquake Hazards Reduction Program Provisions. Available Online at http://earthquake.usgs.gov/designmaps/beta/us/. Accessed [04/06/2017].

Wisconsin Department of Natural Resources (WDNR). 2017. "Surface Water Data Viewer." Available online at https://dnr.wi.gov/topic/surfacewater/swdv/. Accessed [3/1/2018].

# Engineer's Certifications

Pursuant to 40 CFR 257 Subpart D and by means of this certification I attest that:

(i) I am familiar with the requirements of the CCR rule (40 CFR §257);

(ii) the information in this demonstration is in accordance with current, good, and accepted engineering practices;

(iii) the existing Landfill complies with the location restriction for unstable areas (40 CFR §257.64);

(iv) the proposed lateral expansions within the footprint presented in the Plan of Operation (RMT, 2000) comply with the location restrictions of 40 §CFR 257.60 through 40 CFR §257.64.

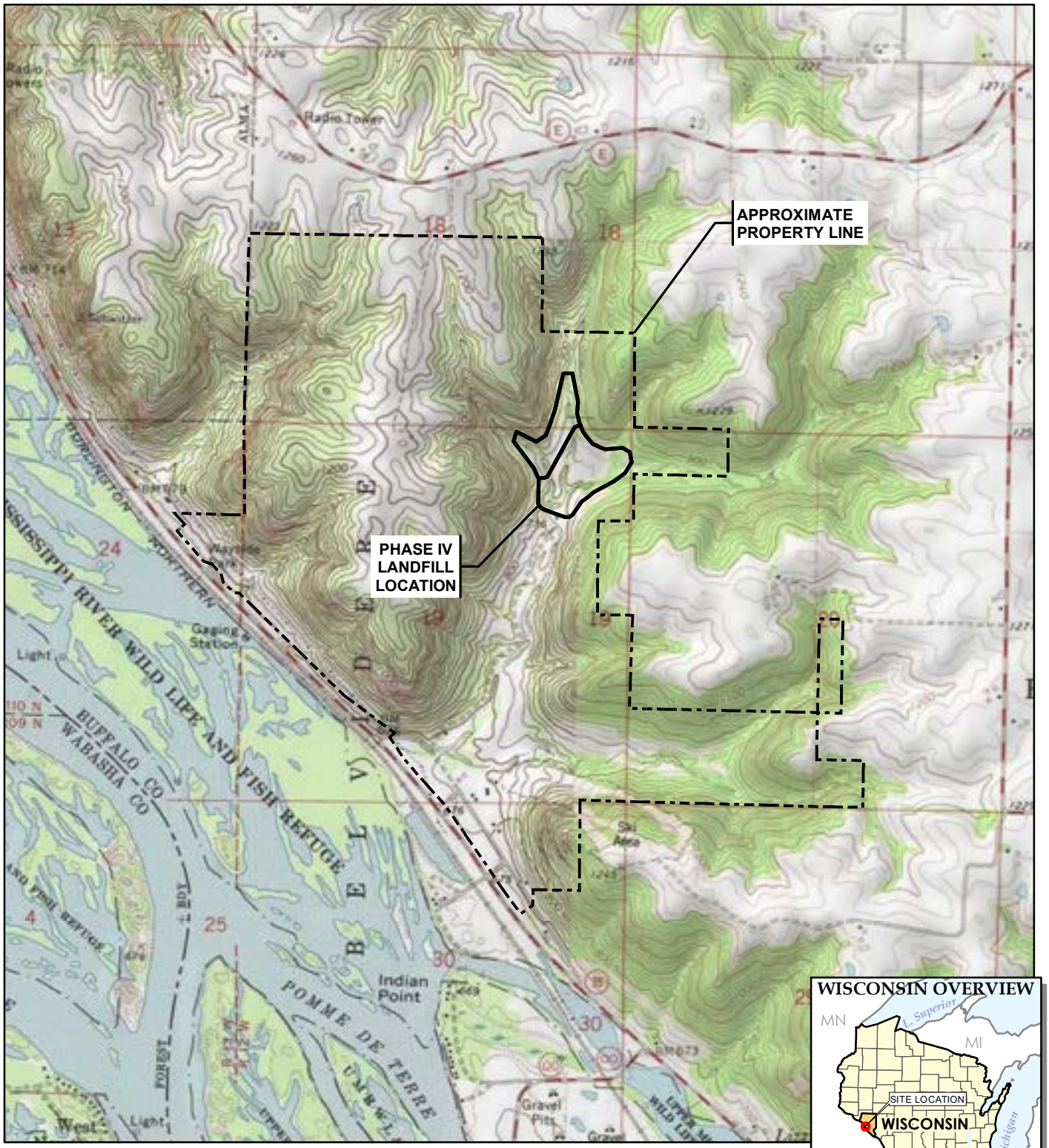
For the purpose of this document, "certify" and "certification" shall be interpreted and construed to be a "statement of professional opinion." The certification is understood and intended to be an expression of my professional opinion as a Wisconsin licensed professional engineer, based upon knowledge, information, and belief. The statement(s) of professional opinion are not and shall not be interpreted or construed to be a guarantee or a warranty of the analysis herein.

Jonathan Hotstream

Signature of Registered Professional Engineer

Registration No. 42745-6 State: Wisconsin

WISCONSIN
JONATHAN N.
HOTSTREAM
E-42745
MADISON
WI
5/22/2018
PROFESSIONAL ENGINEER




BASE MAP FROM USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE SERIES.

N

1 " = 2,000 '
1:24,000

0 2,000 4,000 FEET

TRC

708 Heartland Trail
Suite 3000
Madison, WI 53717
Phone: 608.826.3600

*TRC - GIS*

PROJECT:

**DAIRYLAND POWER COOPERATIVE**
**ALMA OFF-SITE DISPOSAL FACILITY, PHASE IV LANDFILL LOCATIONS RESTRICTIONS DEMONSTRATIONS**
**BUFFALO COUNTY, WISCONSIN**

TITLE:

**SITE LOCATION MAP**

| | |
|---|---|
| DRAWN BY: | R. SUEMNICHT |
| CHECKED BY: | J. HOTSTREAM |
| APPROVED BY: | T. MARTIN |
| DATE: | MAY 2018 |
| PROJ. NO.: | 243332.0003 |
| FILE: | 243332-004slm.mxd |

**FIGURE 1**

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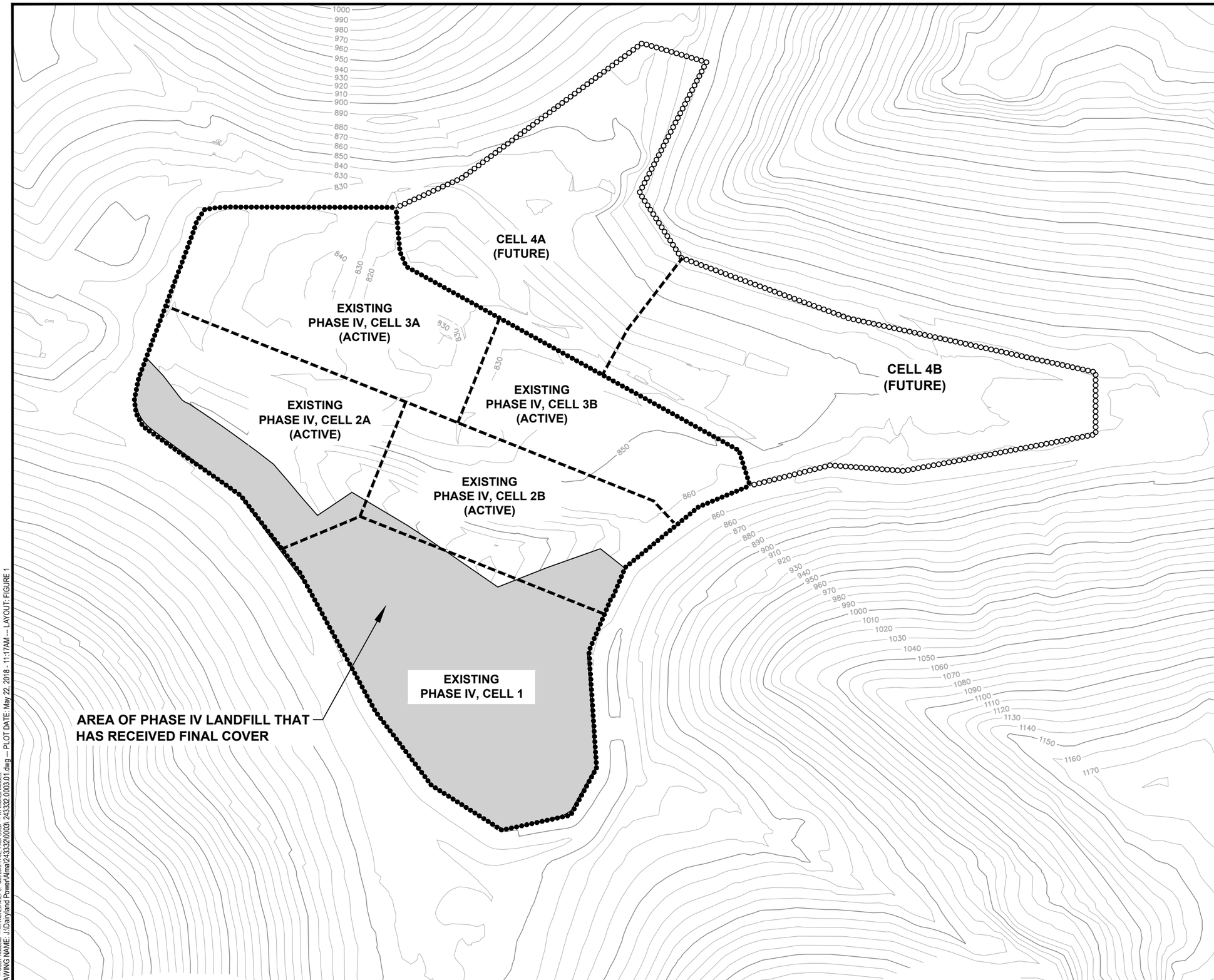



## LEGEND

- 890 — EXISTING 10' CONTOUR
- LIMITS OF CCR DISPOSAL (EXISTING LANDFILL)
- LIMITS OF LATERAL EXPANSION
- PHASE LINE

## NOTES

1. THE BASE MAP WAS MODIFIED FROM THE CELL 3B LINER CONSTRUCTION DOCUMENTATION REPORT (OCTOBER, 2016).
2. THE HORIZONTAL DATUM IS REFERENCED TO THE WISCONSIN STATE PLANE COORDINATE SYSTEM, CENTRAL ZONE, NORTH AMERICAN DATUM 1983, US SURVEY FEET.
3. VERTICAL DATUM IS NORTH AMERICAN VERTICAL DATUM 1988. CONTOUR INTERVAL IS 10 FEET.

0 200 400
SCALE IN FEET

PROJECT:
**LOCATION RESTRICTIONS DEMONSTRATIONS**
**ALMA OFF-SITE PHASE IV LANDFILL**
**BUFFALO COUNTY, WISCONSIN**

TITLE:
**EXISTING CONDITIONS**

| | | | |
|---|---|---|---|
| DRAWN BY: | L. STORMER | PROJ NO.: | 243332.0003 |
| CHECKED BY: | J HOTSTREAM | **FIGURE 2** | |
| APPROVED BY: | T. MARTIN | | |
| DATE: | MAY 2018 | | |

TRC
708 Heartland Trail
Suite 3000
Madison, WI 53717
Phone: 608.826.3600

FILE NO.: 243332.0003.01.dwg

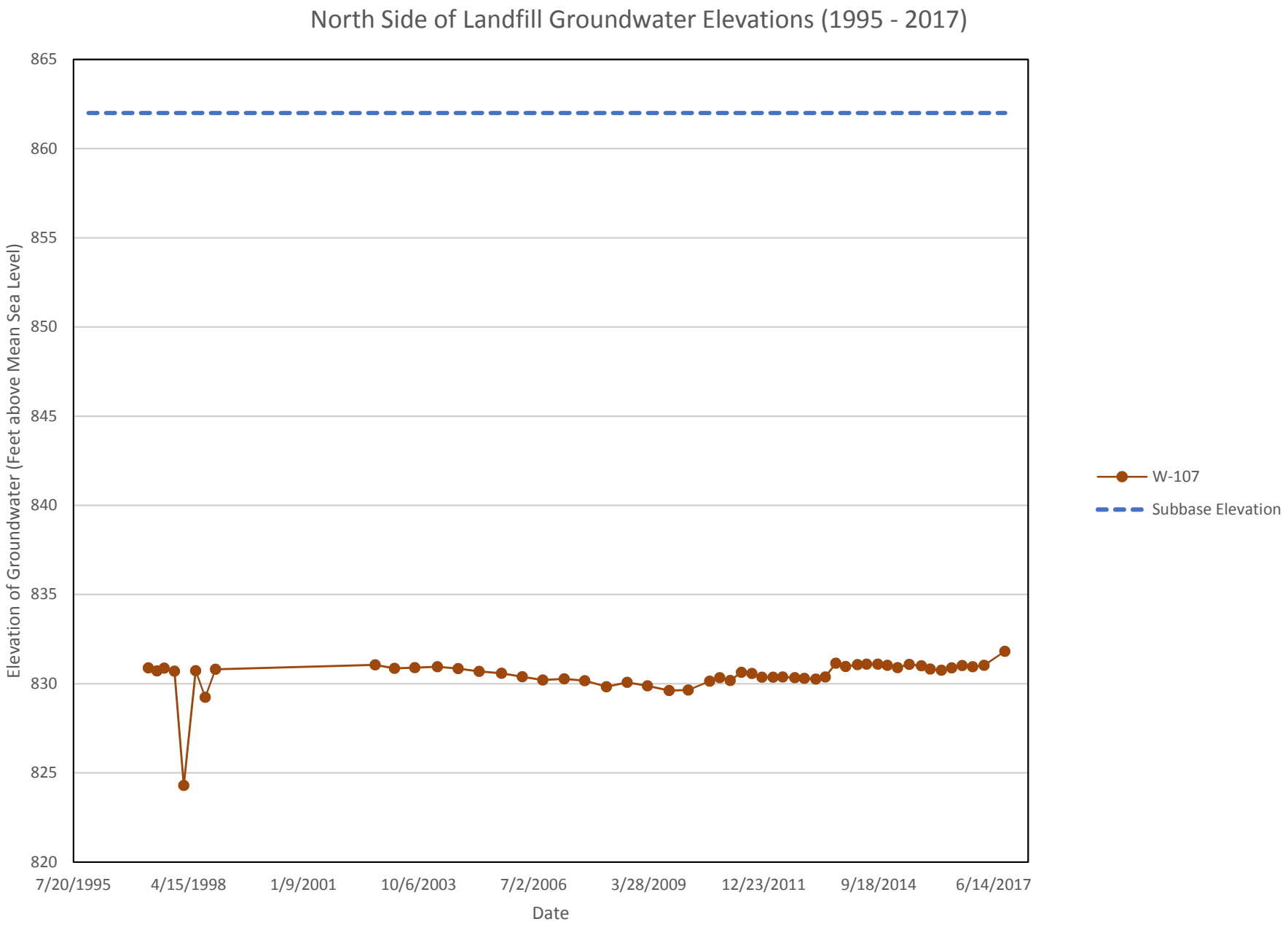
11x17 --- USER: ABleecker --- ATTACHED XREFS: bmc 2016-11-02; PROPOSED --- ATTACHED IMAGES:
DRAWING NAME: J:\Dairyland Power\Alma\243332\0003\ 243332.0003.01.dwg --- PLOT DATE: May 22, 2018 - 11:17AM --- LAYOUT: FIGURE 1
Version: 2017-10-21

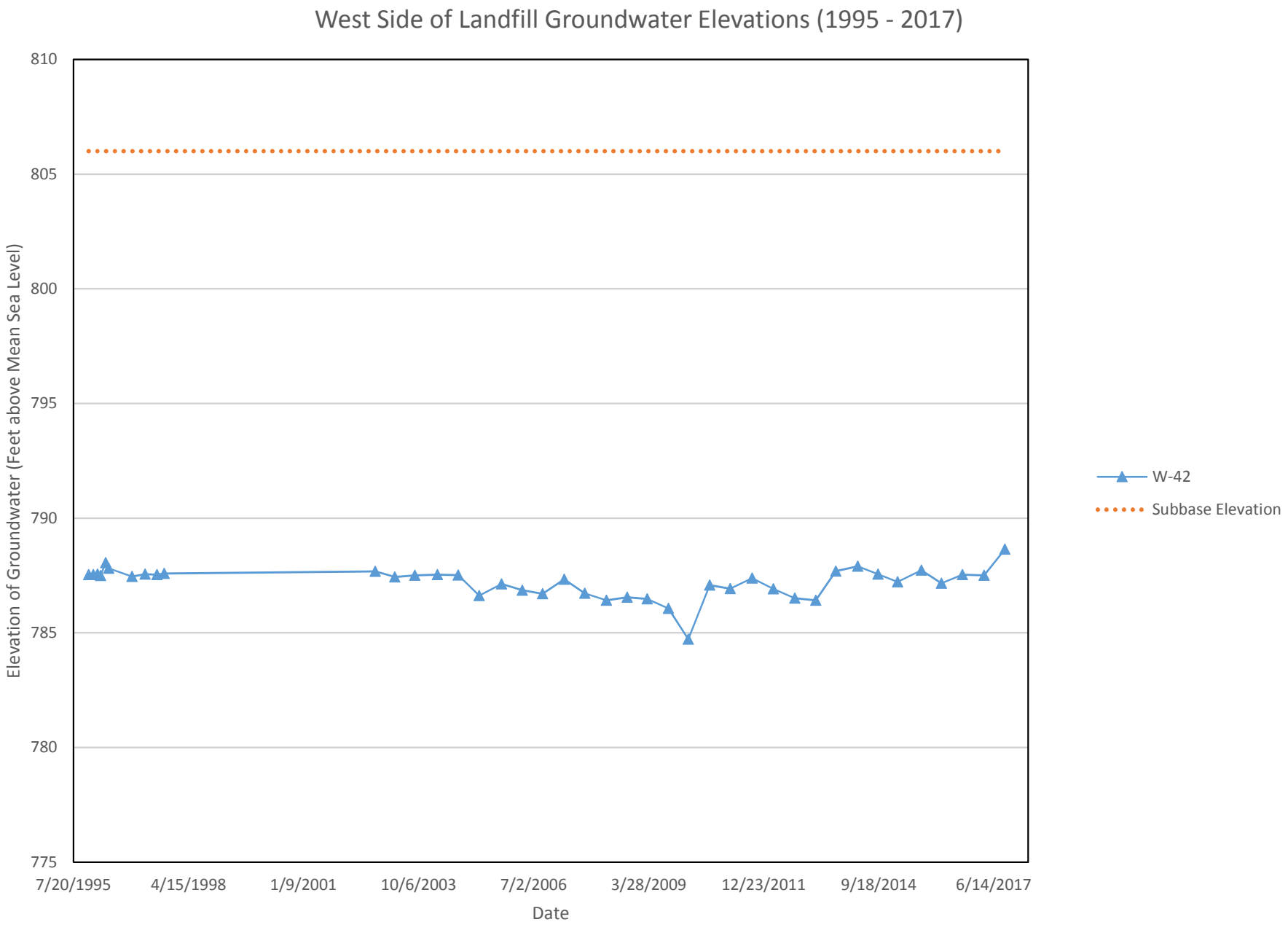
# Appendix A
# Supporting Material for §257.60

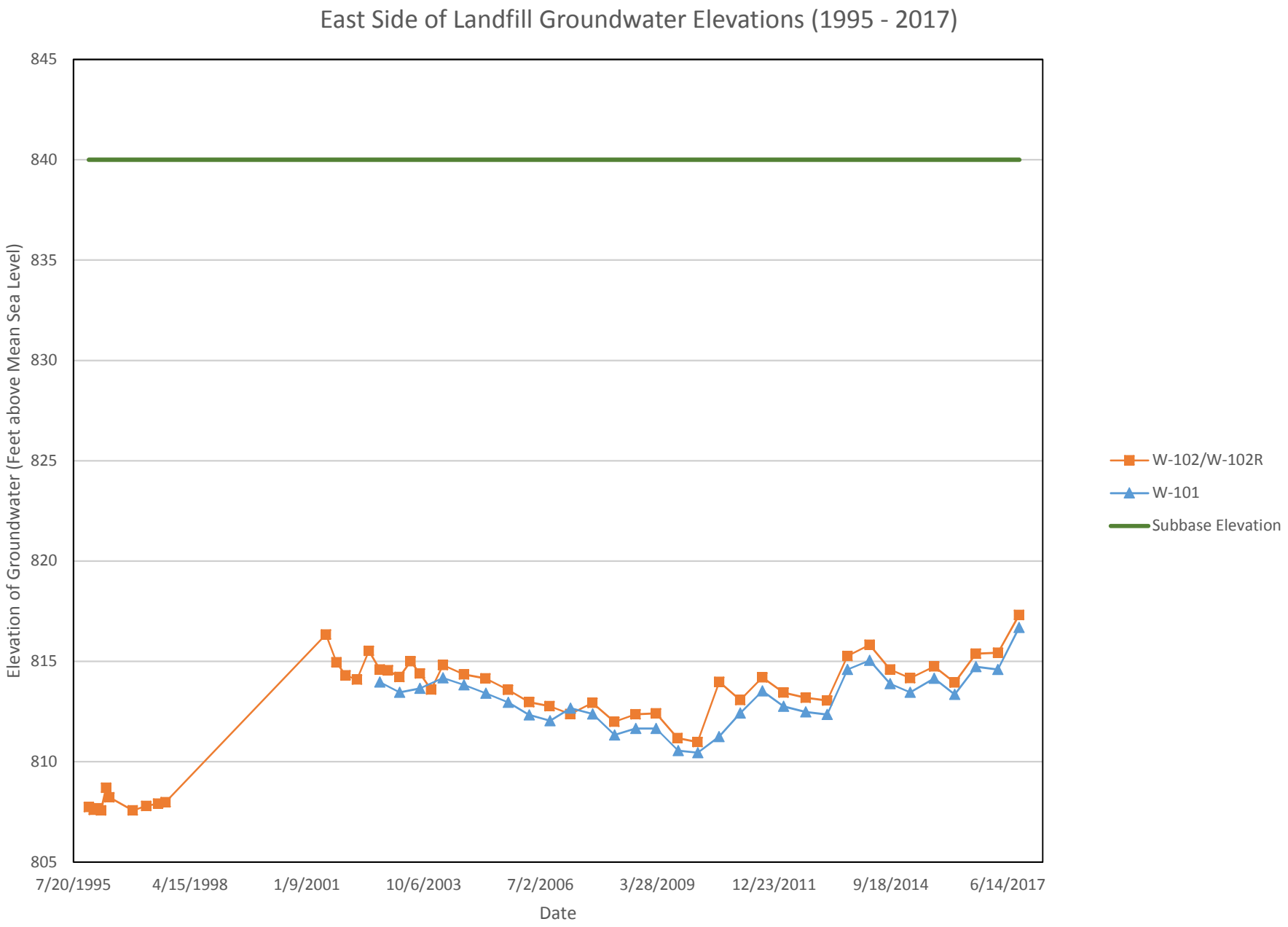
## Table of Contents

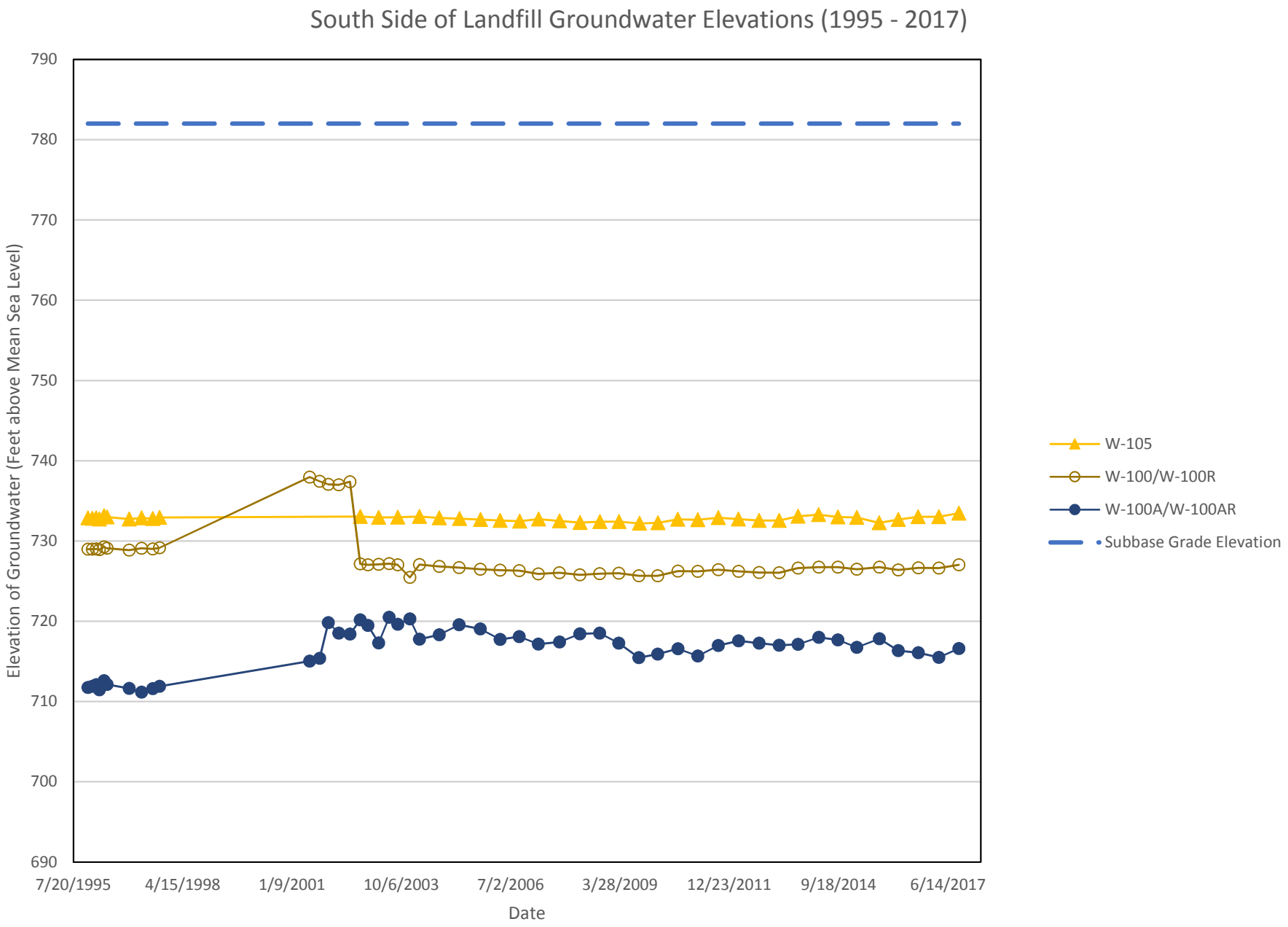

- Appendix A-1: Groundwater Elevations (1995-2017)
- Appendix A-2: Landfill Subbase Grades (RMT 2000)

# Appendix A-1
# Groundwater Elevations (1995-2017)


North Side of Landfill Groundwater Elevations (1995 - 2017)
Elevation of Groundwater (Feet above Mean Sea Level)
865
860
855
850
845
840
835
830
825
820
7/20/1995
4/15/1998
1/9/2001
10/6/2003
7/2/2006
3/28/2009
12/23/2011
9/18/2014
6/14/2017
Date
W-107
Subbase Elevation


West Side of Landfill Groundwater Elevations (1995 - 2017)
Elevation of Groundwater (Feet above Mean Sea Level)
810
805
800
795
790
785
780
775
7/20/1995
4/15/1998
1/9/2001
10/6/2003
7/2/2006
3/28/2009
12/23/2011
9/18/2014
6/14/2017
Date
W-42
Subbase Elevation


East Side of Landfill Groundwater Elevations (1995 - 2017)
Elevation of Groundwater (Feet above Mean Sea Level)
845
840
835
830
825
820
815
810
805
7/20/1995
4/15/1998
1/9/2001
10/6/2003
7/2/2006
3/28/2009
12/23/2011
9/18/2014
6/14/2017
Date
W-102/W-102R
W-101
Subbase Elevation


South Side of Landfill Groundwater Elevations (1995 - 2017)
Elevation of Groundwater (Feet above Mean Sea Level)
790
780
770
760
750
740
730
720
710
700
690
7/20/1995
4/15/1998
1/9/2001
10/6/2003
7/2/2006
3/28/2009
12/23/2011
9/18/2014
6/14/2017
Date
W-105
W-100/W-100R
W-100A/W-100AR
Subbase Grade Elevation

# Appendix A-2
# Landfill Subbase Grades (RMT 2000)

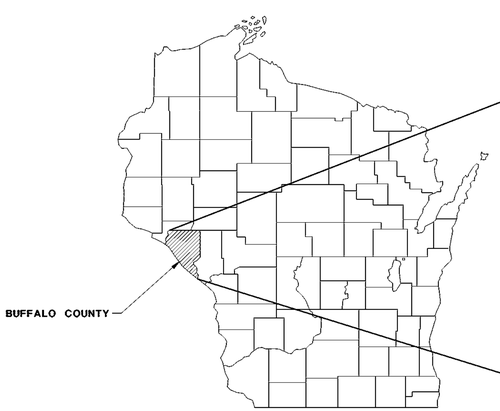
# DAIRYLAND POWER COOPERATIVE

## PLAN OF OPERATION
## PHASE IV DISPOSAL AREA
## ALMA OFF-SITE ASH DISPOSAL FACILITY

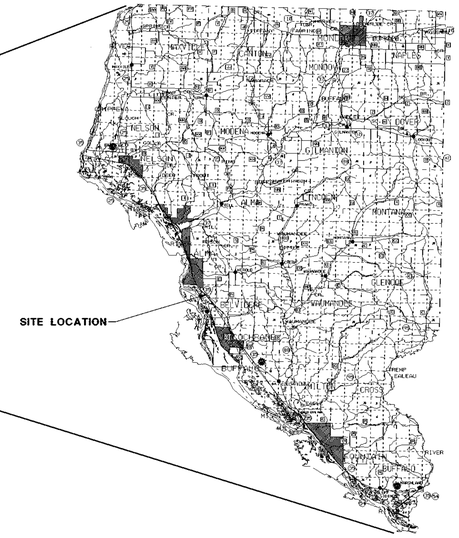
**PREPARED FOR:** DAIRYLAND POWER COOPERATIVE
LACROSSE, WISCONSIN

**PREPARED BY:** RMT, INC.
MADISON, WISCONSIN

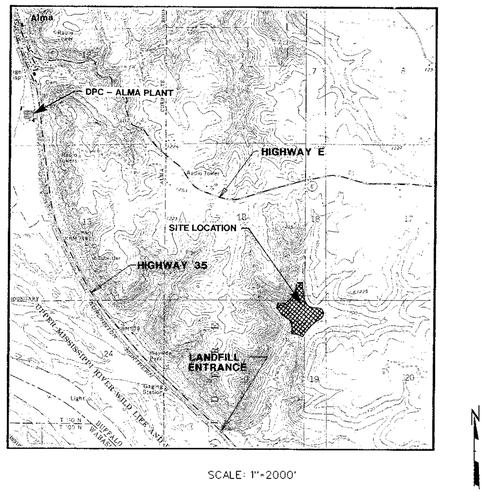
**DATE:** OCTOBER 2000




WISCONSIN




BUFFALO COUNTY




SCALE: 1"=2000'

MAP SOURCE: U.S.G.S. CREAM AND ALMA 7.5' QUADRANGLES, DATE 1974.

SITE LOCATION

## INDEX


| SHEET NUMBER | SHEET TITLE |
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| 2 | STANDARD LEGEND AND NOTES |
| 3 | EXISTING CONDITIONS MAP |
| 4 | PROPOSED SUBBASE GRADES |
| 5 | PROPOSED BASE GRADES |
| 6 | PHASING PLAN- CELL I ACTIVE |
| 7 | PHASING PLAN- CELL I CLOSED<br>CELL 2A ACTIVE |
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| 14 | LONG TERM CARE PLAN |
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| 17 | DETAILS- LINER AND COLLETION PIPES |
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| 19 | DETAILS- FINAL COVER |
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NOTE: THESE PLANS ARE ACCOMPANIED BY A REPORT OF THE SAME TITLE. THESE DOCUMENTS ARE INTERRELATED AND ARE INTENDED TO BE USED AND REVIEWED TOGETHER.
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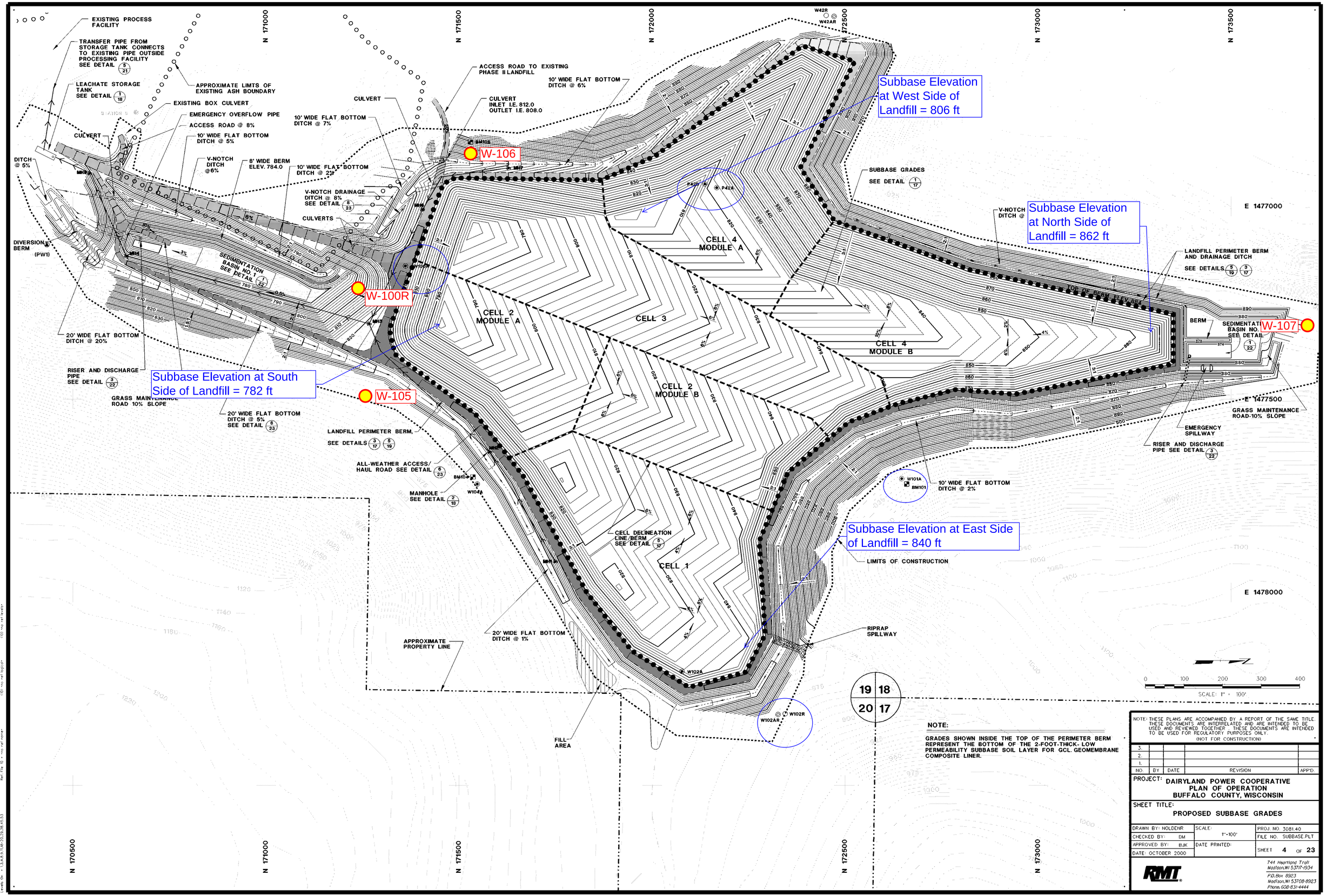
RMT
744 Heartland Trail
Madison, WI 53717-1934
P.O. Box 8923
Madison, WI 53708-8923
Phone: 608-831-4444



RMT COMPUTER AIDED DESIGN & DRAFTING




**NOTE:**

GRADES SHOWN INSIDE THE TOP OF THE PERIMETER BERM REPRESENT THE BOTTOM OF THE 2-FOOT-THICK- LOW PERMEABILITY SUBBASE SOIL LAYER FOR GCL GEOMEMBRANE COMPOSITE LINER.

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| NO. | BY | DATE | REVISION | APP'D |
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| 3. | | | | |
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PROJECT: DAIRYLAND POWER COOPERATIVE
PLAN OF OPERATION
BUFFALO COUNTY, WISCONSIN

SHEET TITLE:
PROPOSED SUBBASE GRADES

| | | |
|---|---|---|
| DRAWN BY: NOLDENR | SCALE: 1"=100' | PROJ. NO. 3081.40 |
| CHECKED BY: DM | | FILE NO. SUBBASE.PLT |
| APPROVED BY: BJK | DATE PRINTED: | SHEET 4 OF 23 |
| DATE: OCTOBER 2000 | | |

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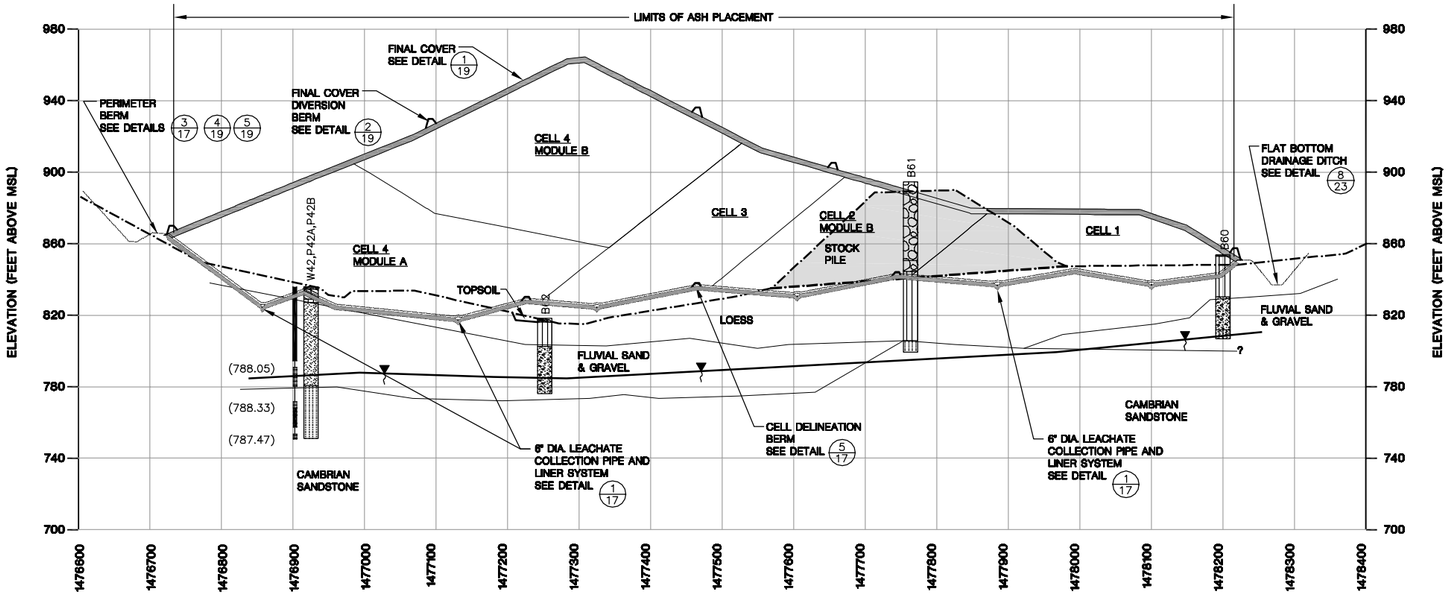
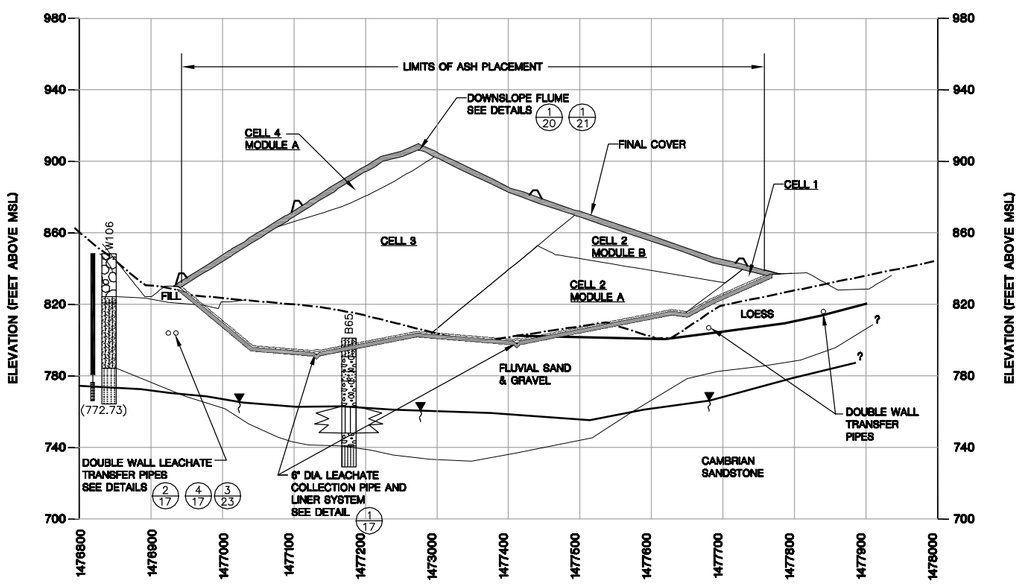
744 Heartland Trail
Madison, WI 53717-1934
P.O. Box 8923
Madison, WI 53708-8923
Phone: 608-831-4444

RMT COMPUTER AIDED DESIGN & DRAFTING




## CROSS SECTION 172200N




## CROSS SECTION 171700N

### LEGEND

- PROPOSED FINAL COVER/BASE LINER
- 6" DIA. PERFORATED GRADIENT CONTROL/ LEACHATE COLLECTION PIPE
- APPROXIMATE DIVERSION BERM LOCATION
- MAIN GRADIENT CONTROL TRANSFER PIPE
- (745.03) WATER TABLE OR PIEZOMETRIC ELEVATION
- UNIT B AND C BOUNDARY
- B61 BORING OR WELL NUMBER
- EXISTING GROUND SURFACE
- WATER TABLE LINE
- STRATIGRAPHIC BOUNDARY, DASHED WHERE INFERRED

WELL CONSTRUCTION

- WELL SEAL
- WELL CASING
- WELL SCREEN

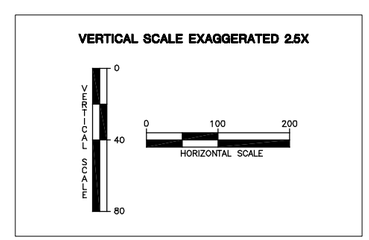
LITHOLOGIC UNITS (USCS CLASSIFICATION)

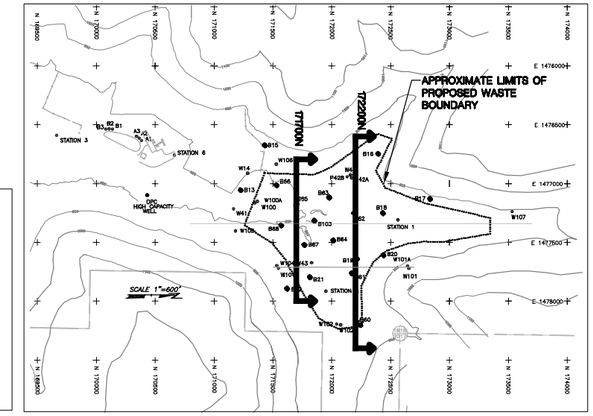
- TOPSOIL
- FILL
- SILT (ML)
- CLAY (CL)
- SILTY CLAY (CL)
- CLAYEY SILT (ML)
- SAND (SP)
- POORLY GRADED GRAVEL
- SILTY GRAVEL WITH SAND (GM)
- SILTY SAND WITH GRAVEL (SM)
- SILTY SAND (SM)
- SANDSTONE
- DOLOMITE
- SANDY SILT

### NOTES

1. EXISTING GROUND SURFACE TAKEN FROM PLAN SHEET 3.
2. ELEVATION REFERENCED TO USGS MEAN SEA LEVEL (MSL) DATUM, 1929.
3. GROUNDWATER ELEVATIONS BASED ON MEASUREMENTS OBTAINED BY DPC ON APRIL 26, 1996.
4. THE STRATUM LINES ARE BASED ON INTERPOLATION BETWEEN BORINGS AND ON INFORMATION CONTAINED ON THE HIGHWATER TABLE CONTOUR MAP (PLAN SHEET 12) AND THE TOP OF COMPETENT BEDROCK CONTOUR MAP (PLAN SHEET 13) IN THE FEASIBILITY REPORT, AND ON THE BOTTOM OF LOESS EXISTING CONDITIONS (FIGURE 2) SHEET INCLUDED IN THE APRIL 30, 1999, SUPPLEMENTAL INFORMATION TO SUPPORT FEASIBILITY DETERMINATION. ACTUAL SUBSURFACE CONDITOINS BETWEEN BORINGS MAY VARY. CORRELATIONS ARE SHOWN IN MORE DETAIL IN FEASIBILITY REPORT PLAN SHEETS 4–10 (RMT, SEPTEMBER 1997).
5. SOIL BORINGS AND WELLS HAVE BEEN PROJECTED ONTO THE CROSS SECTION.
6. SEE SHEET 4 FOR SUBBASE GRADES, SHEET 5 FOR BASE GRADES AND SHEET 12 FOR FINAL GRADES.

(SEE SHEET 2 FOR STAN ES AND LEGEND)




## CROSS SECTION LOCATOR MAP

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PROJECT: DA — COOPERATIVE PLAN OF OPERATION BUFFALO COUNTY, WISCONSIN

SHEET TITLE: ENGINEERING CROSS SECTIONS 171700N AND 172200N

| | | |
|---|---|---|
| DRAWN BY: DEFOEJ | SCALE: HORIZ. 1"=100' VERT. 1"=40' | PROJ. NO. 3081.40 |
| CHECKED BY: DM | | FILE NO. 30814001.DWG |
| APPROVED BY: BJK | DATE PRINTED: | SHEET 15 OF 23 |
| DATE: OCTOBER 2000 | | |

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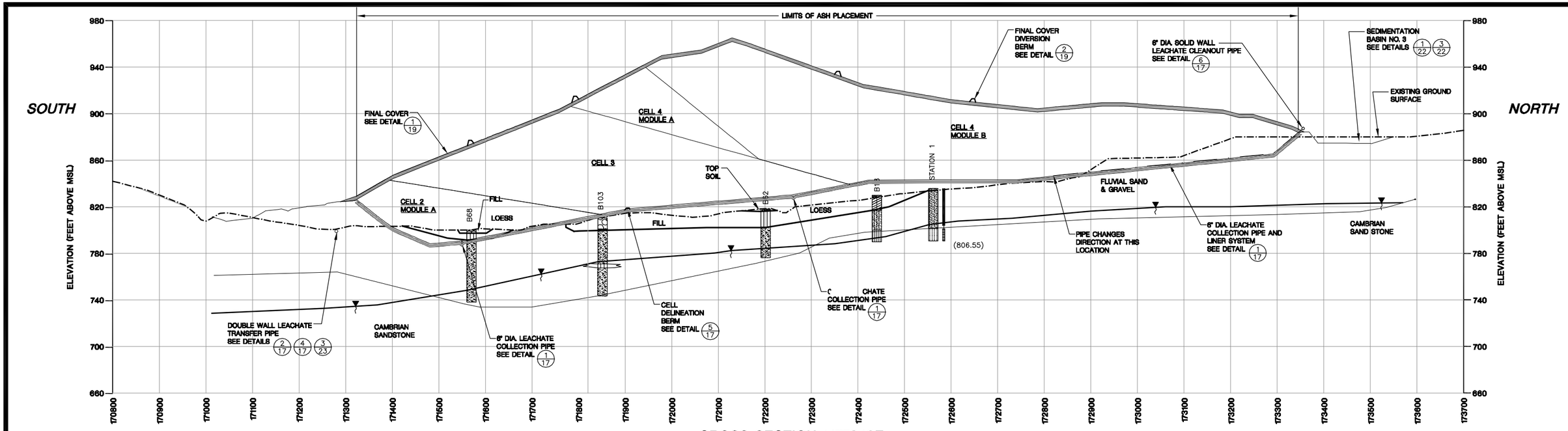
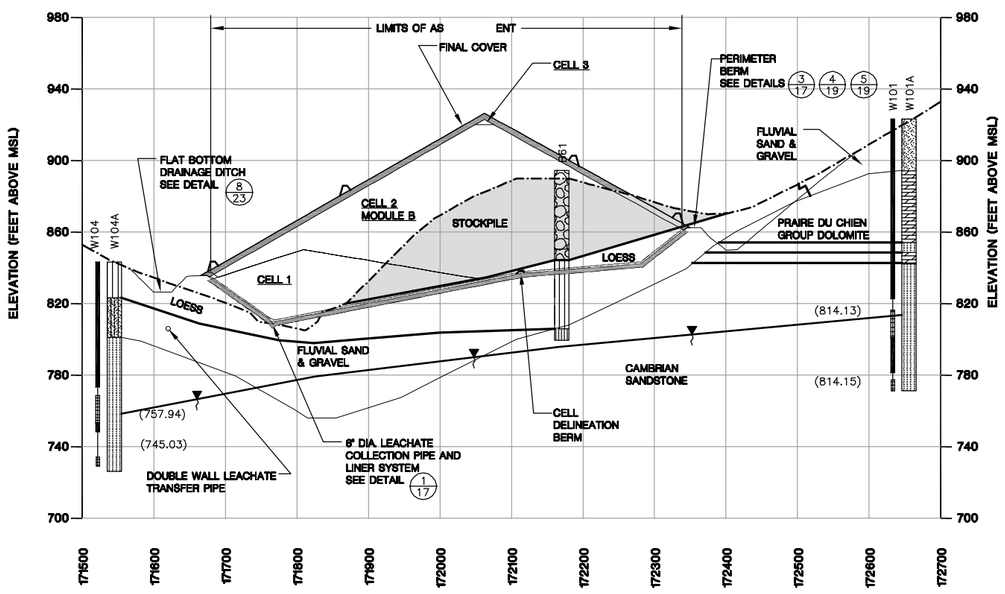
Madison, WI 53708–8923
Phone: 608/831–4444

$$SCALE$$
$$STOTB$$
$$STOTBB$$
$$STOTBBB$$
Attached Xref's: No xref's Attached.
ACC_DATA
$$USER$$
$$USERR$$
$$PWD$$
$$PWDR$$
$$LOTSTYLE$$
RMT COMPUTER AIDED DESIGN & DRAFTING




## CROSS SECTION 1477340E




## CROSS SECTION 1477710E

**LEGEND**

- PROPOSED FINAL COVER/BASE LINER
- 6" DIA. PERFORATED GRADIENT CONTROL/ LEACHATE COLLECTION PIPE
- APPROXIMATE DIVERSION BERM LOCATION
- MAIN GRADIENT CONTROL TRANSFER PIPE
- (745.03) WATER TABLE OR PIEZOMETRIC ELEVATION
- UNIT B AND C BOUNDARY
- B61 BORING OR WELL NUMBER
- EXISTING GROUND SURFACE
- WATER TABLE LINE
- STRATIGRAPHIC BOUNDARY, DASHED WHERE INFERRED

WELL CONSTRUCTION

- WELL SEAL
- WELL CASING
- WELL SCREEN

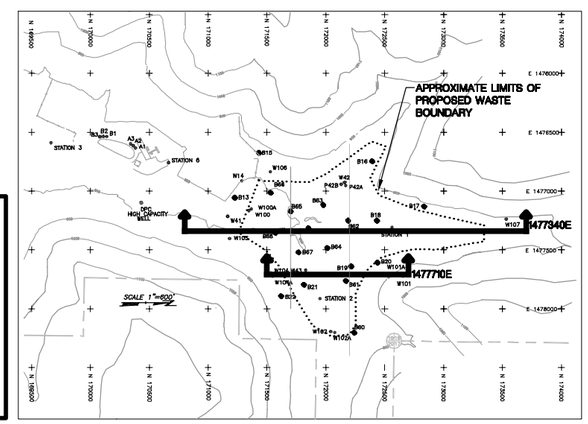
LITHOLOGIC UNITS (USCS CLASSIFICATION)

- TOPSOIL
- FILL
- SILT (ML)
- CLAY (CL)
- SILTY CLAY (CL)
- CLAYEY SILT (ML)
- SAND (SP)
- POORLY GRADED GRAVEL
- SILTY GRAVEL WITH SAND (GM)
- SILTY SAND WITH GRAVEL (SM)
- SILTY SAND (SM)
- SANDSTONE
- DOLOMITE
- SANDY SILT

**VERTICAL SCALE EXAGGERATED 2.5X**

VERTICAL SCALE: 0, 40, 80

HORIZONTAL SCALE: 0, 100, 200




**CROSS SECTION LOCATOR MAP**

**NOTES**

1. EXISTING GROUND SURFACE TAKEN FROM PLAN SHEET 3.
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6. SEE SHEET 4 FOR SUBBASE GRADES, SHEET 5 FOR BASE GRADES AND SHEET 12 FOR FINAL GRADES.

**(SEE SHEET 2 FOR STANDARD NOTES AND LEGEND)**

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PROJECT: **DAIRLYAND POWER COOPERATIVE PLAN OF OPERATION BUFFALO COUNTY, WISCONSIN**

SHEET TITLE: **ENGINEERING CROSS SECTIONS 1477340E AND 1477710E**

| | | |
|---|---|---|
| DRAWN BY: DEFOEJ | SCALE: HORIZ. 1"=100 VERT. 1"=40' | PROJ. NO. 3081.40 |
| CHECKED BY: DM | | FILE NO. 30814002.DWG |
| APPROVED BY: BJK | DATE PRINTED: | SHEET 16 OF 23 |
| DATE: OCTOBER 2000 | | |

RMT
744 Heartland Trail
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$$SCALE$$
$$ROTATE$$
$$XREFS$$
Attached XREFs: No xref's Attached.
Date: $$DATE$$
$$USER$$
$$DWG$$
$$PLOTTER$$
RMT COMPUTER AIDED DESIGN & DRAFTING

# Appendix B
# Supporting Material for §257.61

## Table of Contents


- Appendix B-1: Feasibility Determination (Lundberg, 1999)
- Appendix B-2: Excerpts from Feasibility Report (RMT, 1997)
- Appendix B-3: WDNR Surface Water Data Viewer Map
- Appendix B-4: USDA Hydric Rating Map

# Appendix B-1
# Feasibility Determination (Lundberg, 1999)

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Tommy G. Thompson, Governor
George E. Meyer, Secretary
Scott A. Humrickhouse, Regional Director

West Central Region Headquarters
1300 W. Clairemont Avenue
PO Box 4001
Eau Claire, Wisconsin 54702-4001
Telephone 715-839-3700
FAX 715-839-6076
TDD 715-839-2786

September 10, 1999

Mr. George Johnston
Dairyland Power Cooperative
3200 East Avenue South, P.O. Box 817
La Crosse, WI 54602-0817

FID# 606009360
License # 4126
Buffalo County
SW
Approval

Subject: Feasibility Determination for the Proposed Dairyland Power Cooperative Phase IV Ash Disposal Facility, Town of Belvidere, Buffalo County, Wisconsin. License No. 4126

Dear Mr. Johnston:

We have determined that the proposed Phase IV disposal area, Alma Off-Site Ash Disposal Facility is feasible, subject to certain conditions; and that it should provide for satisfactory solid waste disposal. We have also determined that the Wisconsin Environmental Policy Act requirements have been met through the preparation of an Environmental Assessment. An Environmental Impact Statement is not needed for this project.

This favorable determination entitles you to submit a plan of operation, which meets the conditions set forth in the feasibility report and subsequent addenda, the attached determination and chapter NR 514, Wis. Adm. Code. This determination does not guarantee that we will approve a plan of operation, or license your proposed facility. When preparing your plan of operation, we advise you to carefully review the requirements of chs. NR 500 through 538, Wis. Adm. Codes.

Dairyland Power Cooperative requested an exemption to s. NR 504.04(3)(f), Wis. Adm. Code, for one (1) water supply well (PW-1) located downgradient and within 1,200 feet of the limits of filling for the proposed Phase IV development. This water supply well is approximately 410 feet deep and is cased to a depth of 113 feet below the ground surface. Due to its location downgradient of the proposed landfill no exemption will be granted for this well. This well must be abandoned in accordance with ch. NR 812.26, Wis. Adm. Code, prior to waste placement in the Phase IV development. If an exemption request is made to the Department outlining non-potable uses for this well which can be independently confirmed prior to waste placement in the Phase IV development, an exemption may be considered at that time.

Dairyland Power Cooperative requested an exemption to the locational criteria of s. NR 504.04(3)(f), Wis. Adm. Code, for a proposed high capacity well (PW-2). This well would be located a minimum of 250 feet from the limits of waste and situated hydraulically upgradient/sidegradient of the proposed Phase IV development. The well design would include steel casing down to an elevation of at least 650 M.S.L. which would place the bottom of casing approximately 170 feet below the top of bedrock. The remainder of the well would be constructed as an open borehole in the bedrock and would extend to between 450 and 500 feet below the ground surface. For these reasons the Department is granting this exemption to the separation distance in s. NR 812.08(4)(g)(1), and the locational criteria in s. NR 504.04(3)(f), Wis. Adm. Code.

Dairyland Power Cooperative requested an exemption to s. NR 512.11(3), Wis. Adm. Code, regarding the submittal of a bedrock piezometric map. It has been shown that the groundwater flow direction is the same in the fluvial sand and gravel as it is in the underlying Cambrian Sandstone and the water table intersects both the unconsolidated sediment and bedrock. For these reasons the Department is granting this exemption.

Dairyland Power Cooperative requested an exemption under s. NR 140.28, Wis. Adm. Code, for a number of monitoring wells based on the background quality data. We have granted groundwater quality exemptions at specific monitoring wells where elevated concentrations of certain parameters have been detected during the four (4) rounds of background groundwater sampling. The following criteria as established in s. NR 507.18(2)(b), Wis. Adm. Code, were used to determine if granting groundwater quality exemptions were appropriate:

1. Any of the values from the background sampling exceed a parameter's enforcement standard (ES), or
2. Two or more of the values exceed a parameter's preventive action limit (PAL), or
3. The average of a parameter's value is greater that the PAL.

Landfill owners must perform baseline groundwater monitoring in accordance with s. NR 507.18, Wis. Adm. Code and report any exceedances to Wisconsin's groundwater standards. At sixteen (16) different monitoring locations the groundwater data indicated elevated concentrations above the ch. NR 140, Wis. Adm. Code, groundwater standards for the parameters listed in ch. NR 507, Table 3. We have granted exemptions to the State's groundwater quality standards for specific monitoring wells where elevated concentrations of certain parameters have been detected. Alternate concentration limits (ACLs) will need to be established in accordance with s. NR 705.29 for these wells and parameters. To determine what these ACLs shall be, this approval requires that more baseline data be collected in order to have at least eight (8) rounds of data for the calculations. Elevated concentrations of sulfate at Sta. 6 are related to filling and housekeeping activities of the now closed Phase II area. The Department will grant an exemption to the groundwater standard for sulfate at Sta. 6 for the proposed Phase IV development and allow an ACL to be calculated. However, no calculated ACL for sulfate may be applied to existing landfil phases 1, 2, and 3 (license number 2927, FID number 606009360). Dairyland Power Cooperative must continue to monitor the sulfate concentrations at this well location.

Dairyland Power Cooperative requested and exemption to s. NR 507.21, Wis. Adm. Code, for leachate quality monitoring since the leachate will be disposed at the Dairyland Power Cooperative waste water treatment plant in Alma, Wisconsin. Leachate analytical data provides pertinent information regarding conditions within the landfill. Further, in your October 7, 1998, "Additional Information requested for Feasibility Determination" report was a letter dated September 24, 1998 from the alternate leachate disposal facility – La Crosse Wastewater Utility. In this letter, the La Crosse Wastewater Utility specified that they be routinely provided with leachate analytical data. Therefore, an exemption for leachate quality monitoring will not be granted.

Dairyland Power Cooperative requested an exemption to s. NR 512.15(2)(b), Wis. Adm. Code, for the number of samples analyzed from each clay borrow source test pit. Due to the relatively thin nature of the clay deposit at the on-site borrow source, only one sample was collected and analyzed from most of the test pits. This clay will not be needed if the proposal for a geosynthetic clay liner (GCL) is approved for the liner and cover. For these reasons the Department is granting this exemption.

The proposed Phase IV development will be situated within a valley at the juncture of four surface water drainage ways. The bluff top land surrounding this landfill location is approximately 450 feet above the valley. In a heavy precipitation storm event, the amount and velocity of run-off water flowing from the uplands down into this valley can become quite significant. The landfill owner should be aware a potential exists for high velocity water flows from the higher elevations to erode and/or washout surface water controls during the different phases of construction. It will be imperative that the surface water structures are assessed and repaired, if necessary, as quickly as possible following any heavy storms.

If you have any questions regarding this determination, please contact Mark Stephenson, Hydrogeologist at (608) 785-9983; Marty Herrick, Environmental Engineer, at (608) 789-5518; or Jack Tritt, Waste Management Specialist from our Eau Claire office at (715) 839-3768.

Sincerely,

David R. Lundberg
Waste Management Team Leader
West Central Region

cc: Mark A. Osten, RMT Inc., 744 Heartland Trail, P.O. Box 8923, Madison, WI 53708-8923
Paul Huebner – WA/3
Dennis Mack – WA/3
Chuck Leveque – LC/5
Mark Stephenson – La Crosse
Marty Herrick – La Crosse
Jack Tritt – WCR
Jack Connelly/Bureau File – WA/3
Jim Pardee – EA/6
Patti Cronin – Waste Facility Siting Board
Sandra Ebert – Buffalo County Clerk, P.O. Box 58, Alma, WI 54610
Lyle Hofer – Town of Belvidere Clerk, P.O. Box 216, Cochrane, WI 54622
Nathan D. Sampson – Zoning Administrator, P.O. Box 492, Alma, WI 54610-0492

# PROJECT SUMMARY
## GENERAL SITE INFORMATION

Proposed Facility Name: Dairyland Power Cooperative Phase IV Ash Disposal Area

Authorized Contact: Mr. George Johnston
Dairyland Power Cooperative
P.O. Box 817
3200 East Avenue South
La Crosse, Wisconsin 54601
(608) 787-1322

Site Location and Area: Dairyland Power Cooperative (DPC) is proposing to site and develop a noncontiguous coal ash disposal area (Phase IV) at their existing Alma off-site disposal facility. This disposal facility would be located in the NE1/4 of the NE1/4 of Section 19 and portions of Section 18 and 20, Township 21 North, Range 12 West, Town of Belvidere, Buffalo County, Wisconsin. The proposed limits of filling would cover 32.1 acres within a parcel of 1,113 acres owned by DPC. The proposed site is located adjacent, but not connected to, DPC's current off-site ash disposal facility. The site is located approximately 4,000 ft. east of State Trunk Highway (STH) "35" and 3,200 ft. south of County Road "E". The area surrounding the proposed disposal site is generally sparsely populated agricultural land. Access to the facility is along a private entrance road from STH 35.

One water supply well is located within 1200 feet of the proposed limits of fill. This well would be abandoned prior to waste placement in the Phase IV development.

Proposed Capacity and Site Life: The proposed Phase IV disposal area has a design capacity of approximately 3,011,000 cubic yards. The estimated site life is 13.9 years but may be influenced by the demand for both fly ash and bottom ash as beneficial reuse materials.

Proposed Service Area, Waste Types and Leachate Characteristics: The proposed site will be owned and operated as a private industrial solid waste disposal facility. Waste disposal will, for the most part, be limited to fly ash and bottom ash from the burning of coal. This material will be produced at the Alma Units 1 – 5, the John P. Madgett (JPM), and the Genoa Station No.3 generating facilities owned and operated by DPC. A small quantity (less than 1% of the total waste stream) of asbestos from power plant renovations and waste water treatment plant sludge from DPC's Alma power generating station will also be disposed at this site. The chemical characteristics of the leachate produced within the site are expected to be the same as for the existing Phase III.

Present Land Use and Zoning: DPC is currently using a portion of their property for coal ash disposal operations in Phases I through III. Phases I, II, and III are located 1,000 feet, 100 feet, and 1,400 feet respectively to the south/southwest of the proposed landfill footprint. Phase I was closed in 1993. Phase II was closed in October 1997. Phase III is approximately 7 acres in size and depending on ash generation rates and anticipated beneficial reuse demands, is expected to reach capacity by the year 2004. The 1,113 acre parcel is zoned as an agricultural district as is the surrounding land.

Topography and Hydrology: The site is located within the Mississippi River drainage basin in a valley, at the juncture of four surface water drainage-ways. The lower (southern) end of the valley is currently being used for ash disposal under previous approvals. The bluff top land surrounding this site is primarily used for agricultural purposes and extends roughly 450 feet above the valley floor where the landfill would be situated.

Ephemeral waterways, which flow only in direct response to precipitation, route surface water from the uplands and steep slopes into the central valley. These waters then flow through ditches and culverts toward the Mississippi River located approximately 1 mile south. The nearest wetlands are located approximately 1 mile south of the proposed site along the Mississippi River.

Regional and Site Specific Geology: The surficial soil at the proposed site generally consists of a sand and silty sand with lenses of gravel. Additionally, several borings contained layers of finer grained soil including silt and clay ranging from a few feet to as much as 40 feet in thickness. The sandy soil typically extends to bedrock at depths ranging from 15 to 60 feet below the existing ground surface. The sandy soil is primarily the result of fluvial deposition; however, some of the sand near the bedrock surface appears to be the result of *in situ* weathering of the sandstone bedrock.

Bedrock in the area is composed of the Prairie du Chien Group Dolomite, which acts as a cap rock overlying Cambrian Sandstone. In the proposed landfill footprint, however, the Prairie du Chien has been removed by erosion.

Cambrian Sandstone underlies the unconsolidated sediment in the landfill footprint. This bedrock type is fine-grained with interbedded lenses of dark brown sandstone and calcareous, shaley partings. The bedrock surface mimics the surface topography only at higher relief. The top of bedrock is substantially deeper in the central portion of the landfill footprint than along the valley slope area.

Hydrogeology: The groundwater table beneath the site is present both within the unconsolidated sandy sediment and within the sandstone bedrock. The overlying sand and gravel aquifer is hydraulically connected to the sandstone bedrock. The depth to groundwater varies from 27.5 feet in the northeastern portion of the site to 110 feet below ground surface on the northern end of the site. The minimum separation between the proposed subbase grades and the high water table is approximately 30 feet. Groundwater flows into the central portion of the valley and then toward the Mississippi River approximately 1 mile south/southwest of the site.

The *in situ* hydraulic conductivity of the fluvial sand and gravel across the site ranges from $5.3 \times 10^{-3}$ to $2.8 \times 10^{-4}$ cm/sec. The geometric mean horizontal hydraulic conductivity in this unit is approximately $1.4 \times 10^{-3}$ cm/sec. The in situ hydraulic conductivity in the Cambrian Sandstone ranged from $2.5 \times 10^{-5}$ to $1.0 \times 10^{-2}$ cm/sec. The geometric mean horizontal hydraulic conductivity within the geologic unit is $1.1 \times 10^{-3}$ cm/sec.

Baseline groundwater quality results, for indicator parameters and public health and welfare parameters for the proposed site were provided as part of the feasibility report. In one or more wells installed at the site the concentrations of lead, manganese, nitrogen (nitrate + nitrite), selenium and sulfate attained or exceeded the preventive action limit (PAL) or enforcement standard (ES) established in ch. NR 140, Wis. Adm. Code. The Department is granting an exemption under s. NR 140.28, Wis. Adm. Code for the baseline exceedances of the parameters

listed above at these monitoring wells. Calculations of PAL's for detection parameters and alternative concentration limits (ACLs) for wells granted exemptions to the groundwater standards, should be prepared in accordance with chs. NR 507.27 and NR 507.29, Wis. Adm. Code. As part of the plan of operation, Dairyland Power Cooperative should propose PALs for detection monitoring parameters and ACLs for the parameters granted exemption to the groundwater standards.

Proposed Design: The proposed Phase IV ash disposal facility would be developed in 4 phases with filling beginning in a 6 acre tract along the east central portion of the site and generally progressing westward. The proposed area of ash disposal would cover approximately 32 acres and provide 3,011,000 cubic yards of design capacity.

The proposed surface water control system is designed for a 100-year, 24-hour storm event. Surface water control will include the phased construction beginning prior to landfill construction of the permanent surface water controls around the site perimeter supplemented with temporary surface water controls where necessary.

The proposed design would include a geosynthetic clay liner (GCL) installed over a 2-foot thick, low permeability subbase and overlain by a 60-mil high density polyethylene (HDPE) geomembrane. The low permeability subbase soil would come from on-site material excavated within the Phase IV footprint.

An alternate liner design was included in the feasibility report. This alternate design included a 4-foot thick compacted clay liner in lieu of the GCL. The HDPE geomembrane would be installed over the clay liner and tested in accordance with ss. NR 504.06 (2) (a) and (f), Wis. Adm. Code.

Regardless of which liner type is installed, a leachate collection system would be constructed in an overlying coarse-grained drainage layer material. Leachate that would accumulate in a collection tank would be recycled for the purpose of sluicing ash waste into the disposal area. Excess leachate will be trucked to Dairyland Power's own wastewater treatment plant at the Alma, Wisconsin generation station or to the alternate treatment plant (La Crosse Wastewater Utility) in the City of La Crosse, Wisconsin. This landfill would not be classified as a zone of saturation landfill because the minimum separation between the subbase grades and the high water table is approximately 30 feet.

Final cover would consist of a 6-inch soil grading layer over the ash, followed by a GCL, a 40-mil very flexible polyethylene (VFPE) geomembrane, a 1-foot sand drainage layer, a 1-foot general soil cover layer and a 6-inch topsoil layer. Final grades are designed at a maximum of 4H:1V slope

An alternate final cover design was also included in the feasibility report. This alternate design consists of a 2-foot thick compacted clay layer in lieu of the grading layer, GCL and geomembrane in accordance with NR 504.07, Wis. Adm. Code. A 2.5-foot thick general soil cover layer would be placed over the clay followed by a 6-inch thick layer of topsoil.

The ash to be disposed at this site is biologically inert; thus, a gas management system was not included in the project design.

The planned final use for the Phase IV ash disposal area will be as open green space.

Environmental Monitoring: The proposed ash landfill would include an environmental monitoring program to measure groundwater levels and quality, surface water quality and leachate quantity and quality. Samples would be taken semi-annually from groundwater monitoring wells installed at various depths and locations around the site. Leachate head wells and the leachate collection tank will also be monitored on a regular basis. All environmental monitoring data including groundwater, leachate quality and leachate head measurements and surface water monitoring would be reported to the Department electronically on diskettes.

Groundwater analysis would include those parameters specified in NR 507, Appendix 1, Table 2, Wis. Adm. Code. Leachate analysis would include those parameters specified in NR 507, Appendix 1, Table 4, Wis. Adm. Code.

BEFORE THE STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES

DETERMINATION OF SITE FEASIBILITY
DAIRYLAND POWER COOPERATIVE
PHASE IV ASH DISPOSAL FACILITY
TOWN OF BELVIDERE, BUFFALO COUNTY, WISCONSIN
WDNR LICENSE # 4126

FINDINGS OF FACT

The Department finds that:

1) Dairyland Power Cooperative (DPC) has proposed to construct and operate an ash disposal landfill in the NE1/4 of the NE1/4 of Section 19 and portions of Sections 18 and 20, Township 21 North, Range 12 West, Town of Belvidere, Buffalo County, Wisconsin.

2) The proposed ash disposal facility is intended to serve the needs of DPC as a private industrial solid waste disposal facility. Waste disposal at this site will consist of fly and bottom ash which is produced at the Alma Units 1 – 5, the John P. Madgett (JPM), and the Genoa Station No. 3 (G-3) power generation facilities owned and operated by DPC.

3) The proposed ash disposal landfill would have a design capacity of 3,011,000 cubic yards with an approximate operational life of 13.9 years.

4) The Department made an initial site inspection of the proposed site on August 24, 1994.

5) On April 25, 1995, the Department received an Initial Site Report (ISR) dated April 1995, and submitted by RMT, Inc., on behalf of DPC.

6) On July 17, 1995, the Department determined that the ISR was complete and issued an opinion that the proposed site may have potential for development as an industrial solid waste disposal facility.

7) The Department considered the following documents in its review of the feasibility of the proposed ash disposal landfill:

   (a) A Feasibility Report, dated September 19, 1997, and received by the Department on September 19,1997, prepared by RMT, Inc., on behalf of DPC.

   (b) A DPC Feasibility Report Clarification dated November 25, 1997, and received by the Department on November 26, 1997, prepared by RMT, Inc., on behalf of DPC.

   (c) A Feasibility Report Addendum – Geotechnical Testing Results dated December 15, 1997, and received by the Department on December 16, 1997, prepared by RMT, Inc., on behalf of DPC.

(d) An Additional Information Requested for Feasibility Determination report dated October 7, 1998, and received by the Department on October 8, 1998, prepared by RMT, Inc., on behalf of DPC.

(e) A Supplemental Information to Support Feasibility Determination report dated April 30, 1999 and received by the Department on May 3, 1999, prepared by RMT, Inc., on behalf of DPC.

(f) A Request for Approval of High Capacity Well Location report dated August 19, 1999, and received by the Department on August 20, 1999, prepared by RMT, Inc., on behalf of DPC.

8) The Feasibility Report review fee of $20,000 was received by the Department on October 28,1997.

9) On June 22, 1998, the Department determined that the Feasibility Report was complete; however, additional information was requested to aid in the feasibility determination.

10) On January 5, 1999 and January 27, 1999, the Department requested additional information to aid in the feasibility determination.

11) A public notice under s. 289.25 (3) Stats., was published in The Buffalo County Journal on July 2, 1998. The Department did not receive any responses to the public notice.

12) The proposed landfill expansion would not be located within:

(a) 1,000 feet of any navigable lake, pond, or flowage;

(b) 300 feet of a navigable river or stream;

(c) a floodplain;

(d) 1,000 feet of the nearest edge of the right-of-way of any state trunk highway, interstate, federal aid primary highway, or the boundary of any public park;

(e) 10,000 feet of any airport runway end used or planned to be used by turbojet aircraft or within 5,000 feet of any airport runway end used by piston type aircraft or within an area where the design or operation of the landfill would pose a significant bird hazard to aircraft;

(f) within 200 feet of a fault that has had displacement in Holocene time;

(g) within a seismic impact zone; or

(h) within an unstable area.

13) The proposed limits of fill of the ash disposal landfill would be located within 1,200 feet of the DPC high-capacity water supply well (PW-1) for which an exemption to s. NR 504.04 (3) (f), Wis. Adm. Code, was requested. The Department has determined that the exemption is

not warranted and that this well must be abandoned prior to waste placement in the Phase IV disposal area.

14) A new well (PW-2) is proposed for construction and would be located a minimum of 250 feet hydraulically upgradient/sidegradient to the Phase IV disposal area. An exemption to s. NR 504.04 (3) (f), Wis. Adm. Code is requested for this well. The Department has determined that the exemption is warranted because of the proposed design and location.

15) The proposed ash disposal landfill, if designed, constructed, and operated in accordance with the feasibility report and the conditions set forth below, would not be within an area where there is a reasonable probability that the facility will cause:

    (a) a significant adverse impact on wetlands as provided in ch. NR 103, Wis. Adm. Code;

    (b) a significant adverse impact on critical habitat areas;

    (c) a detrimental effect on any surface water;

    (d) a detrimental effect on groundwater quality;

    (e) the migration of explosive concentrations of gases in any facility structure or in the soil or air beyond the facility boundary; or

    (f) the emission of any hazardous air contaminants in excess of standards contained in s. NR 445.03, Wis. Adm. Code.

16) The Department considered the following information while reviewing the need for exemptions to groundwater standards at this facility:

    (a) baseline groundwater monitoring data provided in the Feasibility Report and Addenda to the Feasibility Report;

    (b) well construction details and boring logs provided in the Feasibility Report;

    (c) well location plan sheets and water table maps provided in the Feasibility Report and Addenda to the Feasibility Report;

    (d) the landfill design specifications provided in the Feasibility Report and Addenda to the Feasibility Report as conditioned herein.

17) Based on an examination of site conditions, the Department finds the following:

    (a) Groundwater concentrations of arsenic, lead, manganese, nitrogen (nitrate + nitrite), selenium, silver and sulfate at the site area are found at concentrations exceeding the ch. NR 140, Wis. Adm. Code, groundwater standards. These exceedances are due to baseline groundwater quality associated with natural hydrogeologic conditions or substances released by other human activities on, or near, the proposed facility.

(b) The elevated concentrations of sulfate at Station 6 reflects groundwater quality related to the Phase II ash disposal area.

18) Based on an examination of the groundwater quality data for the proposed facility for substances of public health concern, and the information listed in Findings of Fact 16 and 17, the Department finds the following:

(a) Mean baseline concentrations above the preventive action limit (PAL) but below the enforcement standard (ES) established for the following substances of public health concern were observed in groundwater samples from the monitoring wells listed below:

| SUBSTANCE | WELL NUMBER |
|---|---|
| lead | W-100A, W-101 |
| nitrogen (nitrate + nitrite) | W-100, W-100A, W-107 |
| selenium | Sta. 6, W-100, W-100A, W-102A, W-104A |

(b) The mean concentration of samples analyzed for arsenic in well W-107 does not attain the PAL established in NR 140, Wis. Adm. Code.

(c) The mean concentration of samples analyzed for manganese in monitoring wells W-42. W-100A, W-104A, and W-107 do not attain the PAL established in NR 140, Wis. Adm. Code. Therefore, the requested exemption to the groundwater standard for manganese is not necessary.

(d) The concentration of silver in the duplicate sample obtained from Station 1, on February 14, 1996, was not detected in the regular sample obtained from Station 1, on the same date and was not detected more than once during the sampling period. Therefore, an exemption to the groundwater standard for this well is not necessary.

(e) The proposed facility will not cause the concentration of lead, nitrogen (nitrate + nitrite) and selenium to exceed the ES for these substances at a point of standards application because of the landfill design.

(f) The proposed facility is designed to achieve the lowest possible concentrations for lead, nitrogen (nitrate + nitrite) and selenium which are technically and economically feasible.

19) Based on an examination of the groundwater quality data for the proposed facility for substances of public welfare concern and Findings of Fact 16 and 17 above, the Department finds the following:

(a) Mean baseline concentrations above the ES established for the following substance of public welfare concern was observed in groundwater samples from the monitoring well listed below:

| SUBSTANCE | WELL NUMBER |
|---|---|
| sulfate | Sta. 6 |

(b) The proposed facility is designed to achieve the lowest possible concentration of sulfate, which is technically and economically feasible.

(c) The anticipated increase in the concentration of sulfate does not present a threat to public health or welfare because of the landfill design.

20) Granting the exemptions that are set forth below will not inhibit compliance with the Wisconsin solid waste management standards in chs. NR 500 through 538, Wis. Adm. Code.

21) Neither the applicant, not any person owning a 10% or greater legal or equitable interest in the applicant or in the assets of the applicant:

(a) is in noncompliance with a plan approval or order issued by the Department for a solid or hazardous waste facility in Wisconsin;

(b) owns or previously owned a 10% or greater legal or equitable interest in a person, or in the assets of a person, who is not in compliance with a plan approval or order issued by the Department for a solid or hazardous waste facility in Wisconsin.

22) The Department has complied with the requirements of chs. NR 150, Wis. Adm. Code, and s. 1.11, Stats., and has adopted all practical means to avoid or minimize environmental harm consistent with social, economic and other essential considerations.

23) The special conditions set forth below are needed to assure that the facility will not pose a substantial hazard to public health or welfare.

## CONCLUSIONS OF LAW

1. The proposal will comply with the applicable requirements of chs. NR 500 through 538, Wis. Adm. Code, provided that the conditions of the feasibility determination set forth below are met.

2. The procedural requirements of ss. 1.11 and 289.21 to 289.29, Stats., have been complied with.

3. The Department has the authority to determine that a site is feasible with special conditions, if the conditions are needed to ensure compliance with chs. NR 500 through 538, Wis. Adm. Code.

4. The Department has the authority to deny a landfill design that does not meet the requirements of s. NR 140.28 and s. NR 504.06 (1), Wis. Adm. Code.

5. The Department has the authority under s. NR 140.28, Wis. Adm. Code, and ss. 160.19 (8) and (9), Stats., to grant exemptions to the groundwater standards for lead, nitrogen (nitrate + nitrite), selenium and sulfate.

6. The Department has the authority under s. NR 504.04 (2), Wis. Adm. Code, to grant exemptions to the location criterion of s. NR 504.04 (3) (f), Wis. Adm. Code, regarding the siting of a solid waste land disposal facility within 1,200 feet of any private water supply well.

7. The Department has the authority under s. NR 812.43 (1), Wis. Adm. Code, to grant variances to the location criterion of s. NR 812.08 (4) (g) (1), Wis. Adm. Code, regarding private water supply wells located within 1,200 feet of a proposed landfill.

8. As provided for under s. 289.28 (1), Stats., sufficient need for the proposed ash disposal facility has been established.

9. In accordance with the foregoing, the Department has the authority under s. 289, Stats., to issue the following grant of exemptions, determination of need and design capacity, and conditional feasibility determination.

## GRANT OF EXEMPTIONS

1. Dairyland Power Cooperative (DPC) has demonstrated circumstances which warrant an exemption to the groundwater standards for lead, nitrogen (nitrate + nitrite), selenium and sulfate in ch. NR 140, Wis. Adm. Code as specified in s. NR 140.28, Wis. Adm. Code. Therefore, the Department grants an exemption to allow the landfill expansion to be developed in an area where a preventive action limit or enforcement standard has been attained or exceeded. Exemptions are, therefore, granted for these parameters and the wells listed in Findings of Facts 18 and 19. DPC must establish alternative concentration limits (ACLs) for the wells and substances listed in Findings of Facts 18 and 19 when sufficient rounds of baseline groundwater quality samples have been collected. These alternative concentration limit calculations must be presented to the Department for approval prior to waste placement in the Phase IV ash disposal area. The sulfate concentration found in Sta. 6 is related to filling activities associated with the now close Phase II area. An ACL may be calculated and applied for sulfate concentrations at Sta. 6 associated only with the proposed Phase IV development. The calculated ACL for Sta. 6 may not be applied to the other ash disposal landfills (Phases I, II, or III, License No. 2927, FID No. 606009360) at the Alma, Wisconsin off-site facility.

2. Dairyland Power Cooperative has demonstrated circumstances which warrant an exemption from s. NR 504.04 (3) (f), Wis. Adm. Code and a variance from s. NR 812.08 (4) (g) (1), Wis. Adm. Code, to allow construction of a solid waste landfill where the proposed limits of filling are within 1,200 feet of any private water supply well. An exemption is hereby granted for the proposed well (PW-2) provided that the conditions set forth in the August 27, 1999 variance approval letter from the Department of Natural Resources, Bureau of Drinking Water and Groundwater are met.

3. Dairyland Power Cooperative has demonstrated circumstances which warrant an exemption from s. NR 512.11 (3), Wis. Adm. Code, regarding the submittal of a bedrock piezometric map. An exemption is hereby granted.

4. Dairyland Power Cooperative has demonstrated circumstances which warrant an exemption from s. NR 512.15 (2) (b), Wis. Adm. Code, for the number of samples analyzed from each clay borrow source test pit. An exemption is hereby granted.

## DETERMINATION OF NEED AND DESIGN CAPACITY

The Department hereby determines as follows:

1. There is sufficient need within the anticipated service area for the proposed Dairyland Power Cooperative, Phase IV Ash Disposal Area in the Town of Belvidere, Buffalo County, Wisconsin.

2. A design capacity of 3,011,000 cubic yards for the proposed Phase IV Ash Disposal Facility will provide for an expected operational life of approximately 13.9 years.

## CONDITIONAL FEASIBILITY DETERMINATION

The Department hereby determines that the proposed Dairyland Power Cooperative, Phase IV Disposal Area, Alma Off-Site Ash Disposal Facility, Town of Belvidere, Buffalo County, Wisconsin is environmentally feasible and has the potential for use as an industrial solid waste disposal landfill. This determination is contingent on the fact that the following conditions are complied with and the Plan of Operation is prepared in accordance with chs. NR 500 through NR 538, Wis. Adm. Codes.

GENERAL:

1. The maximum design capacity of the proposed Dairyland Power Cooperative, Phase IV Ash Disposal Area shall not exceed 3,011,000 cubic yards.

2. The Plan of Operation, at a minimum, shall comply with the requirements of chs. NR 500 through 538, Wis. Adm. Code, the Feasibility Report, and conditions of this approval. Additionally, supporting justification shall be provided if the plan differs from the provisions of the Administrative Code.

FACILITY DESIGN:

3. This Feasibility Determination is in part based on the use of a geosynthetic clay liner (GCL). The GCL is a new technology and installation, quality assurance (QA) and quality control (QC) standards have not been codified in the NR 500 series, Wis. Adm. Code. Consequently the Bureau of Waste Management's "Guidance for the Use of Geosynthetic Clay Liners (GCLs) at Solid Waste Facilities" should be followed as well as the manufacturers recommendations when submitting final design for the GCL in the Plan of Operation. The compatibility of the anticipated waste stream with respect to the GCL has been addressed in the Feasibility Report. If waste stream characteristics change from those presented in the Feasibility Report then the compatibility of those changes may have to be readdressed.

ENVIRONMENTAL MONITORING:

4. A minimum of 8 rounds of baseline groundwater sampling data, which represent background groundwater conditions, shall be provided for the substances and wells requiring an exemption from the groundwater standards of ch. NR 140, Wis. Adm. Code. The results of this monitoring, justification for use or removal of any baseline monitoring results in the calculation of alternative concentration limits (ACL) and the ACL calculations shall be submitted with the Plan of Operation.

5. The facility environmental monitoring plan, including groundwater, leachate, and surface water shall be included in the Plan of Operation and shall be consistent with that outlined in the environmental monitoring section of the attached feasibility summary. Detection monitoring shall comply with ch. NR 507, Wis. Adm. Code, including using the analytical methods specified in Appendix II.

6. A revised sampling plan shall be included in the Plan of Operation. The plan shall comply with ch. NR 507.16, Wis. Adm. Code. The months of sampling and order of sampling wells shall be defined in the sampling plan.

7. Detection leachate monitoring shall be conducted in accordance with ch. NR 507, Appendix I, Table 4. The months of sampling shall be defined in the sampling plan.

8. The environmental monitoring program shall meet the requirements of NR 507, Wis. Adm. Code, or provide justification for not doing so. The monitoring points assigned to the Phase IV ash disposal area are detailed in Attachment A, Tables 1, 2 and 3.

9. As part of the Plan of Operation, Dairyland Power Cooperative shall provide a plan to protect existing monitoring devices during construction of the Phase IV ash disposal area.

10. Dairyland Power Cooperative shall propose inspection of erosion control measures on a regular basis and/or following major precipitation events. Include a timeline for making any necessary repairs.

11. As part of the Plan of Operation, Dairyland Power Cooperative shall specify the sequencing of erosion control and stormwater control structures with regard to landfill sequencing.

12. As part of the Plan of Operation, Dairyland Power Cooperative shall include a timeline for proper abandonment of water supply well PW-1, or justification for continued use of this well. If the Department does not approve continued use as a non-potable water supply, the well shall be abandoned on accordance with ch. NR 812.26, Wis. Adm. Code prior to waste placement in the Phase IV development.

The Department retains the jurisdiction either to require the submittal of additional information or to modify this approval at any time if, in the Department's opinion, conditions warrant further modifications.

## NOTICE OF APPEAL RIGHTS

If you believe you have a right to challenge this decision, you should know that Wisconsin statutes and administrative rules establish time periods within which requests to review Department decisions must be filed.

For judicial review of a decision pursuant to sections 227.52 and 227.53, Stats., you have 30 days after the decision is mailed, or otherwise served by the Department, to file your petition with the appropriate circuit court and serve the petition on the Department. Such a petition for judicial review shall name the Department of Natural Resources as the respondent.

This notice is provided pursuant to section 227.48(2), Stats.

Dated Sept. 10, 1999

DEPARTMENT OF NATURAL RESOURCES
For the Secretary

David R. Lundberg
Waste Management Team Leader
West Central Region

Mark Stephenson / DRL
Mark Stephenson
Plan Review Hydrogeologist

## ATTACHMENT "A"

## TABLE 1

ENVIRONMENTAL MONITORING SUMMARY
DAIRYLAND POWER COOPERATIVE PHASE IV ASH DISPOSAL AREA

ASH DISPOSAL LANDFILL DETECTION MONITORING, FILTERED SAMPLES:

| WELL NAME | DNR I.D. # | WUWN | Selenium Dissolved 1145 | Alkalinity Total 39036 | Boron Dissolved 1020 | COD 341 | Specific Conduct. 94 | Field pH 400 | Ground-water Temp. 10 | Ground-water Elevation 72020 | Hardness Total 22413 | Sulfate Dissolved 946 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Station 1 | 1 | BX385 | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Station 2 | 2 | BX386 | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| Station 6 | 16 | IM717 | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| W-42 | 17 | LO914 | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| P-42A | 18 | LO915 | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| P-42B | 19 | LO916 | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| W-43 | 20 | LO917 | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| W-100 | 21 | LO918 | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| W-100A | 22 | LO919 | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| W-101 | 23 | LO920 | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| W-101A | 24 | LO921 | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| W-102 | 25 | LO922 | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| W-102A | 26 | LO923 | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| W-104 | 27 | LO924 | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| W-104A | 28 | LO925 | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| W-105 | 29 | LO926 | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| W-106 | 30 | LO927 | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |
| W-107 | 31 | LO928 | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA |

WUWN = Wisconsin Unique Well Number
SA = Semi-Annual Sampling

## TABLE 2

HIGH CAPACITY WATER SUPPLY WELL
MONITORING SUMMARY

| WELL NAME | DNR I.D. # | WUWN | Selenium Total 1147 | Alkalinity Unfilter 410 | Boron Total 1022 | COD Unfiltered 340 | Specific. Conduct. 94 | Field pH 400 | Ground-water Temp. 10 | Hardness Unfiltered 900 | Sulfate Total 945 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PW-2 | * | NG834** | SA | SA | SA | SA | SA | SA | SA | SA | SA |

WUWN = Wisconsin Unique Well Number
* - To be assigned upon completion of well installation

** - Well number assigned by Dept. of Natural Resources, Bureau of Drinking Water and Groundwater in a letter dated August 27, 1999 to Dairyland Power Cooperative.

SA = Semi-Annual Sampling

**TABLE 3**

LEACHATE MONITORING SUMMARY

LEACHATE COLLECTION SYSTEM, UNFILTERED SAMPLES

| PARAMETER | PARAMETER # | FREQUENCY |
|---|---|---|
| $BOD_5$ | 310 | SA |
| Field Conductivity | 94 | SA |
| Field pH | 400 | SA |
| Alkalinity, Total | 410 | SA |
| Boron, Total | 1022 | SA |
| Cadmium, Total | 1027 | SA |
| Chloride | 940 | SA |
| COD, Total | 340 | SA |
| Hardness, Total | 900 | SA |
| Iron, Total | 74010 | SA |
| Lead, Total | 1051 | SA |
| Manganese, Total | 1055 | SA |
| Mercury, Total | 71900 | SA |
| Selenium, Total | 1147 | SA |
| Sulfate | 945 | SA |
| Total Suspended Solids | 150 | SA |
| *Leachate Volume Pumped | 32 | MONTHLY |

SA = Semi-Annually

* = The volume of the leachate removed shall be recorded at least monthly (reported semi-annually).

# Appendix B-2
# Excerpts from Feasibility Report (RMT, 1997)

# FEASIBILITY REPORT

## DAIRYLAND POWER COOPERATIVE
## PHASE IV DISPOSAL AREA
## ALMA OFF-SITE ASH DISPOSAL FACILITY
## TOWN OF BELVIDERE
## BUFFALO COUNTY, WISCONSIN

**Prepared For**
**Dairyland Power Cooperative**

**Prepared By**
**RMT, Inc.**
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September 1997

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# Section 7
# Ecological Assessment

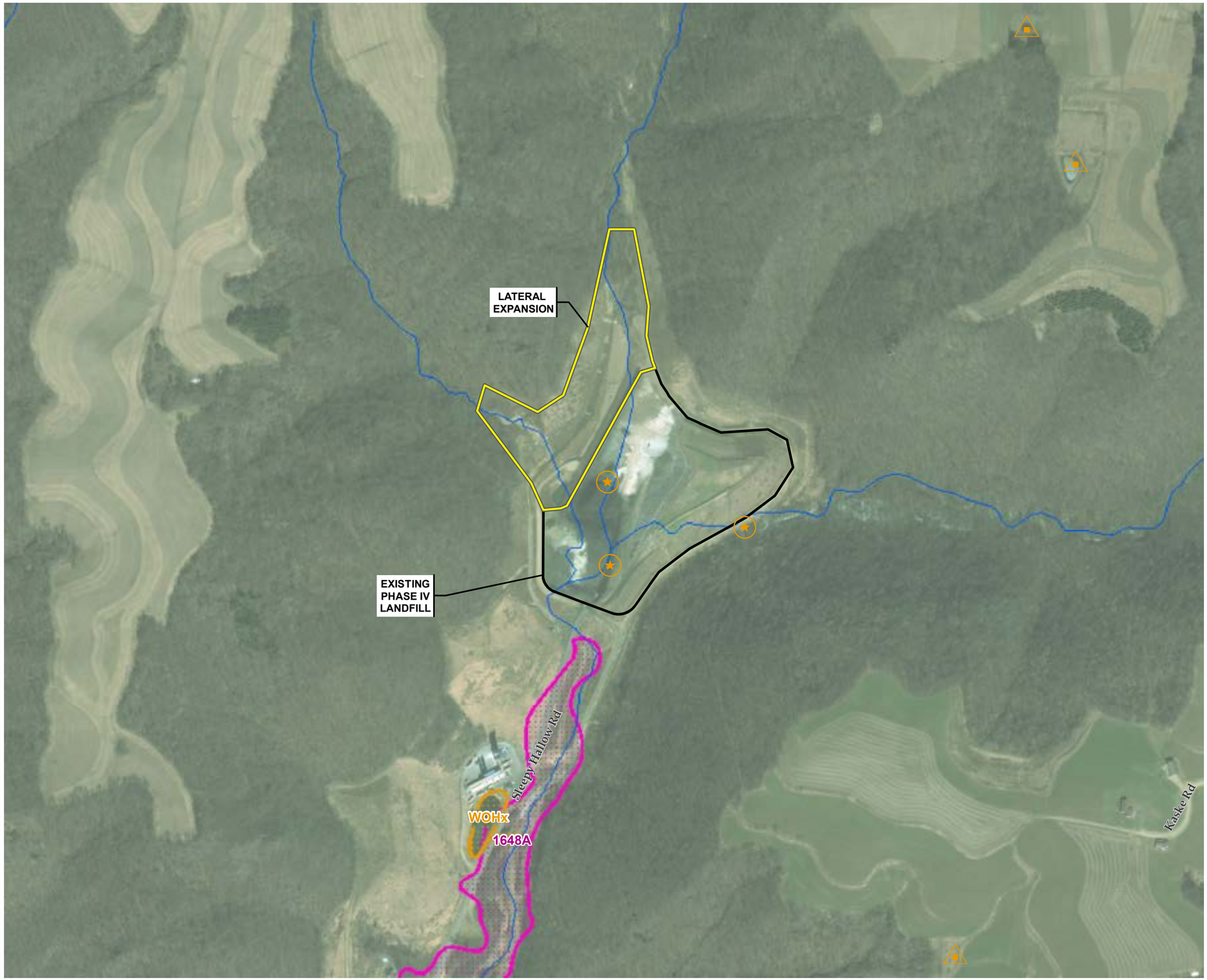
## 7.1 Wetlands

The proposed site is located in an upland area with no perennial streams, and is located approximately 2 miles north of the Mississippi River. No wetlands are known to be present on or near the site. The nearest wetlands are located adjacent to the Mississippi River. The WDNR was approached on the need to conduct a wetlands inventory. On February 20, 1997, Brad Wolbert (WDNR) indicated that he had spoken with the wetlands staff and that no wetlands inventory would be required (Appendix A).

## 7.2 Critical Habitat

In letters dated September 22, 1994, and August 20, 1997 (Appendix A), the WDNR Bureau of Endangered Resources (BER) indicated that their "Natural Heritage Inventory" data files contain no occurrence records of Endangered, Threatened, or Special concern species or natural communities, nor any State Natural Areas for the proposed landfill site or clay borrow area.

# Appendix B-3
# WDNR Surface Water Data Viewer Map




## LEGEND

- EXISTING LANDFILL LIMITS
- LATERAL EXPANSION BOUNDARY
- WETLAND CLASS AREAS
- WETLAND INDICATORS
- FILLED/DRAINED WETLAND
- WETLAND TOO SMALL TO DELINEATE
- WDNR STREAM/RIVER

## NOTES

1. BASE MAP IMAGERY FROM ESRI/DIGITAL GLOBE, 2017.
2. WWI WETLANDS FROM WDNR SURFACE WATER DATA VIEWER.
3. NHD FLOWLINE DATA ACQUIRED FROM USGS.

N

0 500 1,000 Feet

1 " = 500 '

1:6,000

PROJECT: DAIRYLAND POWER COOPERATIVE
ALMA OFF-SITE DISPOSAL FACILITY, PHASE IV LANDFILL
LOCATIONS RESTRICTIONS DEMONSTRATIONS
BUFFALO COUNTY, WISCONSIN

TITLE: WATERBODY MAP

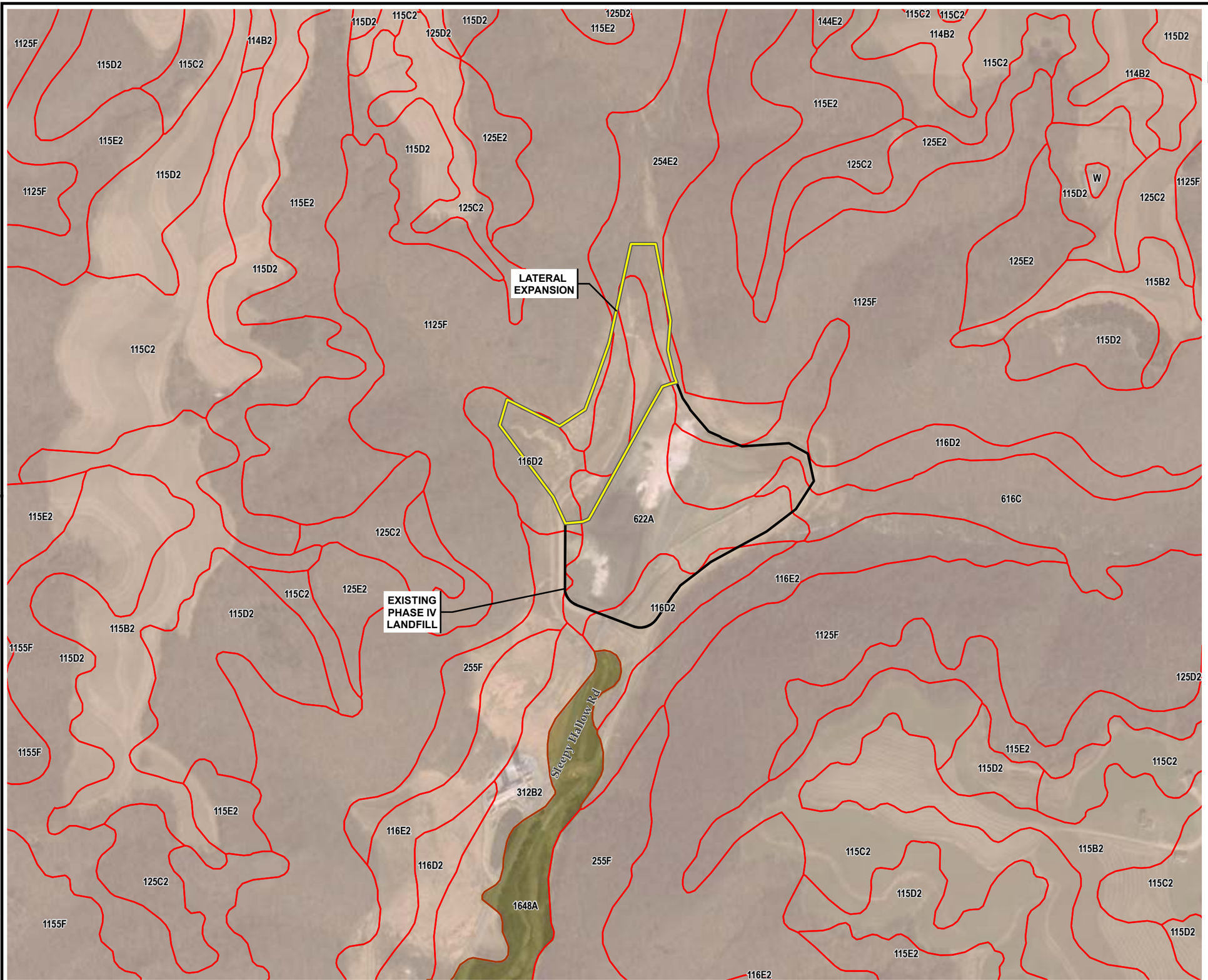
| | | | |
|---|---|---|---|
| DRAWN BY: | B. DEEGAN | PROJ. NO.: | 243332.0004 |
| CHECKED BY: | J. HOTSTREAM | | |
| APPROVED BY: | T. MARTIN | | FIGURE 1 |
| DATE: | MAY 2018 | | |

TRC
708 Heartland Trail
Suite 3000
Madison, WI 53717
Phone: 608.826.3600

FILE NO.: 243332-002.mxd

TRC - GIS
Coordinate System: NAD 1983 StatePlane Wisconsin Central FIPS 4802 Feet (Foot US)
Map Rotation: 0
Plot Date: 5/14/2018, 10:31:51 AM by BDEEGAN -- LAYOUT: ANSI B(11"x17")
Path: E:\DairylandPower\AlmaWI\2018_243332\243332-002.mxd

# Appendix B-4
# USDA Hydric Rating Map




## LEGEND

EXISTING LANDFILL LIMITS

LATERAL EXPANSION BOUNDARY

**HYDRIC SOIL PERCENTAGE**

0 %

96 %

## NOTES

1. BASE MAP IMAGERY FROM ESRI/DIGITAL GLOBE, 2017.
2. SOILS DATA ACQUIRED FROM USDA/NRCS SSURGO SOILS DATABASE.

N

0 500 1,000 Feet

1 " = 500 '

1:6,000

PROJECT: DAIRYLAND POWER COOPERATIVE
ALMA OFF-SITE DISPOSAL FACILITY, PHASE IV LANDFILL
LOCATIONS RESTRICTIONS DEMONSTRATIONS
BUFFALO COUNTY, WISCONSIN

TITLE: **SOILS MAP**

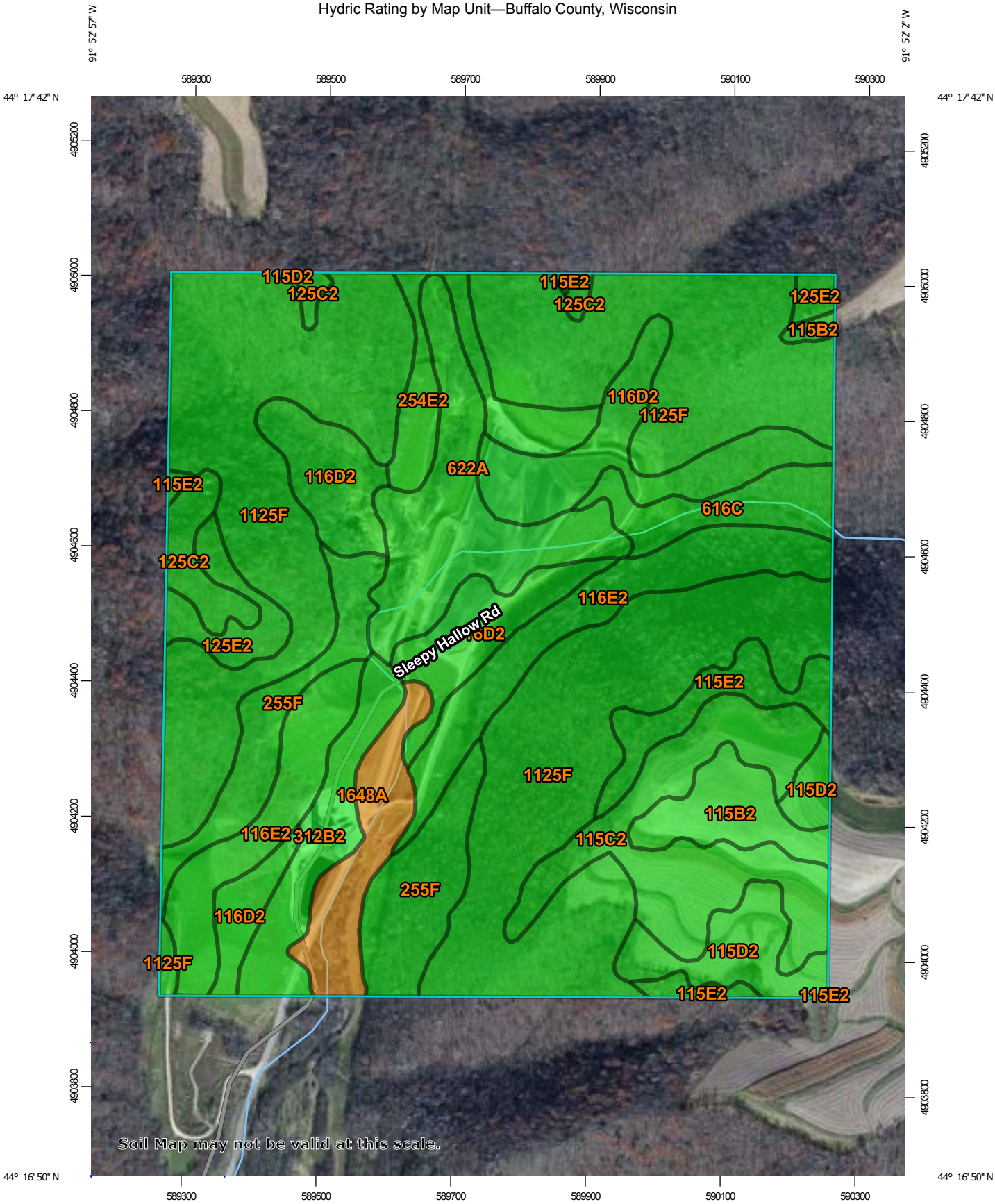
| | | | |
|---|---|---|---|
| DRAWN BY: | B. DEEGAN | PROJ. NO.: | 243332.0004 |
| CHECKED BY: | J. HOTSTREAM | | |
| APPROVED BY: | T. MARTIN | | **FIGURE 2** |
| DATE: | MAY 2018 | | |

TRC
708 Heartland Trail
Suite 3000
Madison, WI 53717
Phone: 608.826.3600

FILE NO.: 243332-003.mxd

TRC - GIS
Coordinate System: NAD 1983 StatePlane Wisconsin Central FIPS 4802 Feet (Foot US)
Map Rotation: 0
Plot Date: 5/14/2018, 10:33:48 AM by BDEEGAN – LAYOUT: ANSI B(11"x17")
Path: E:\DairylandPower\AlmaWI\2018_243332\243332-003.mxd

# Hydric Rating by Map Unit—Buffalo County, Wisconsin




Map Scale: 1:7,780 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 100 200 400 600

Feet: 0 350 700 1400 2100

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 15N WGS84

## MAP LEGEND

**Area of Interest (AOI)**

Area of Interest (AOI)

**Soils**

**Soil Rating Polygons**

Hydric (100%)

Hydric (66 to 99%)

Hydric (33 to 65%)

Hydric (1 to 32%)

Not Hydric (0%)

Not rated or not available

**Soil Rating Lines**

Hydric (100%)

Hydric (66 to 99%)

Hydric (33 to 65%)

Hydric (1 to 32%)

Not Hydric (0%)

Not rated or not available

**Soil Rating Points**

Hydric (100%)

Hydric (66 to 99%)

Hydric (33 to 65%)

Hydric (1 to 32%)

Not Hydric (0%)

Not rated or not available

**Water Features**

Streams and Canals

**Transportation**

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

**Background**

Aerial Photography

## MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Buffalo County, Wisconsin
Survey Area Data: Version 10, Sep 28, 2016

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Nov 1, 2010—Nov 2, 2010

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

# Hydric Rating by Map Unit

| Hydric Rating by Map Unit— Summary by Map Unit — Buffalo County, Wisconsin (WI011) | | | | |
|---|---|---|---|---|
| **Map unit symbol** | **Map unit name** | **Rating** | **Acres in AOI** | **Percent of AOI** |
| 115B2 | Seaton silt loam, ridge phase, 2 to 6 percent slopes | 0 | 6.8 | 2.6% |
| 115C2 | Seaton silt loam, driftless ridge, 6 to 12 percent slopes, moderately eroded | 0 | 18.0 | 6.8% |
| 115D2 | Seaton silt loam, driftless ridge, 12 to 20 percent slopes, moderately eroded | 0 | 8.2 | 3.1% |
| 115E2 | Seaton silt loam, driftless valley, 20 to 30 percent slopes, moderately eroded | 0 | 6.9 | 2.6% |
| 116D2 | Churchtown silt loam, 12 to 20 percent slopes, moderately eroded | 0 | 27.6 | 10.5% |
| 116E2 | Churchtown silt loam, 20 to 30 percent slopes, moderately eroded | 0 | 21.7 | 8.3% |
| 125C2 | Pepin silt loam, 6 to 12 percent slopes, moderately eroded | 0 | 4.8 | 1.8% |
| 125E2 | Pepin silt loam, 20 to 30 percent slopes, moderately eroded | 0 | 5.0 | 1.9% |
| 254E2 | Norden silt loam, 20 to 30 percent slopes, moderately eroded | 0 | 7.2 | 2.7% |
| 255F | Urne fine sandy loam, 30 to 45 percent slopes | 0 | 16.2 | 6.2% |
| 312B2 | Festina silt loam, 2 to 6 percent slopes, moderately eroded | 0 | 8.5 | 3.2% |
| 616C | Chaseburg silt loam, 4 to 12 percent slopes, occasionally flooded | 0 | 6.3 | 2.4% |
| 622A | Worthen silt loam, 0 to 2 percent slopes, occasionally flooded | 0 | 16.4 | 6.2% |
| 1125F | Dorerton, very stony-Elbaville complex, 30 to 60 percent slopes | 0 | 101.0 | 38.4% |

| Hydric Rating by Map Unit— Summary by Map Unit — Buffalo County, Wisconsin (WI011) | | | | |
|---|---|---|---|---|
| **Map unit symbol** | **Map unit name** | **Rating** | **Acres in AOI** | **Percent of AOI** |
| 1648A | Northbend-Ettrick silt loams, 0 to 3 percent slopes, frequently flooded | 96 | 8.1 | 3.1% |
| **Totals for Area of Interest** | | | **262.8** | **100.0%** |

## Description

This rating indicates the percentage of map units that meets the criteria for hydric soils. Map units are composed of one or more map unit components or soil types, each of which is rated as hydric soil or not hydric. Map units that are made up dominantly of hydric soils may have small areas of minor nonhydric components in the higher positions on the landform, and map units that are made up dominantly of nonhydric soils may have small areas of minor hydric components in the lower positions on the landform. Each map unit is rated based on its respective components and the percentage of each component within the map unit.

The thematic map is color coded based on the composition of hydric components. The five color classes are separated as 100 percent hydric components, 66 to 99 percent hydric components, 33 to 65 percent hydric components, 1 to 32 percent hydric components, and less than one percent hydric components.

In Web Soil Survey, the Summary by Map Unit table that is displayed below the map pane contains a column named 'Rating'. In this column the percentage of each map unit that is classified as hydric is displayed.

Hydric soils are defined by the National Technical Committee for Hydric Soils (NTCHS) as soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (Federal Register, 1994). Under natural conditions, these soils are either saturated or inundated long enough during the growing season to support the growth and reproduction of hydrophytic vegetation.

The NTCHS definition identifies general soil properties that are associated with wetness. In order to determine whether a specific soil is a hydric soil or nonhydric soil, however, more specific information, such as information about the depth and duration of the water table, is needed. Thus, criteria that identify those estimated soil properties unique to hydric soils have been established (Federal Register, 2002). These criteria are used to identify map unit components that normally are associated with wetlands. The criteria used are selected estimated soil properties that are described in "Soil Taxonomy" (Soil Survey Staff, 1999) and "Keys to Soil Taxonomy" (Soil Survey Staff, 2006) and in the "Soil Survey Manual" (Soil Survey Division Staff, 1993).

If soils are wet enough for a long enough period of time to be considered hydric, they should exhibit certain properties that can be easily observed in the field. These visible properties are indicators of hydric soils. The indicators used to make onsite determinations of hydric soils are specified in "Field Indicators of Hydric Soils in the United States" (Hurt and Vasilas, 2006).

References:

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18.

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service. U.S. Department of Agriculture Handbook 436.

Soil Survey Staff. 2006. Keys to soil taxonomy. 10th edition. U.S. Department of Agriculture, Natural Resources Conservation Service.

## Rating Options

*Aggregation Method:* Percent Present

*Component Percent Cutoff: None Specified*

*Tie-break Rule:* Lower

# Appendix C
# Supporting Material for §257.62

## Table of Contents


- Appendix C-1: Excerpts from Feasibility Report (RMT 1997)
- Appendix C-2: USGS Quaternary Earthquake Fault Map (USGS 2015)

# Appendix C-1
# Excerpts from Feasibility Report (RMT 1997)

# FEASIBILITY REPORT

## DAIRYLAND POWER COOPERATIVE
## PHASE IV DISPOSAL AREA
## ALMA OFF-SITE ASH DISPOSAL FACILITY
## TOWN OF BELVIDERE
## BUFFALO COUNTY, WISCONSIN

**Prepared For**
**Dairyland Power Cooperative**

**Prepared By**
**RMT, Inc.**
**Madison, Wisconsin**

September 1997

WISCONSIN
PETER D. CREAMER
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Waunakee, WI
PROFESSIONAL ENGINEER

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Senior Project Engineer

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9/19/97

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# Section 8
# Hydrogeologic Investigation

## 8.1 Site Field Investigation

### 8.1.1 Soil Borings

The subsurface exploration program was designed to fulfill the requirements for submittal of a Feasibility Report as specified in NR 512. For the proposed 32.1-acre landfill, NR 512.09 (1) requires that 22 borings be sampled to a depth 25 feet below the proposed subbase grade. Prior to the Feasibility Report investigation, 23 soil borings had been completed at the site. Of these 23 soil borings, three borings (B15, B16, and B17) were located greater than the 300-foot distance requirement of NR 512.09, and five borings (B18, B19, B20, B21, and B22) did not meet the depth requirement. Station 6 (not one of the 23 borings noted above) was drilled as part of a separate evaluation during the October/November 1994 field activities to document groundwater conditions downgradient (south) of the existing Phase II disposal area. To supplement these data and provide data from across the proposed Phase IV disposal area, borings at 15 additional locations were drilled (B60, B61, B62, B63, B64, B65, B66, B67, B68, W100A, W101A, W104/104A, W105, W106, and W107). Test pits TP36, TP37, TP38, TP41, and TP42, excavated for previous investigations, were also used in the evaluation.

The borings used in the Feasibility Report, their installation dates, their distances from limits of fill, and the reasons for their installation are listed in Table 8-1. The locations of the soil borings are shown on Plan Sheet 2. Appendix A contains correspondence from the WDNR approving modification to the standard NR 512 geotechnical program.

The soil borings were extended using hollow-stemmed auger drilling or mud rotary drilling techniques. Rock drilling was conducted using air-rotary and coring techniques. Soil boring logs are included in Appendix E. Water used in drilling and decontamination of drilling equipment was obtained from the DPC on-site production well. A sample of this water was tested. Analytical results are included in Appendix F. An experienced geologist was on-site to observe and direct drilling, sampling, and related activities.

### 8.1.6 Inventory of Water Supply Wells

An inventory of public and private water supply wells within 1,200 feet of the proposed site was conducted. The only water supply well located within 1,200 feet of the proposed limits of fill is the DPC on-site supply well located approximately 1,000 feet downgradient of the proposed site (Plan Sheet 3). The well log, construction data, and pumping information for this well are contained in Appendix E.

## 8.2 Site Conditions

### 8.2.1 Topography and Hydrology

Plan Sheet 3 presents an existing conditions map that shows the topography of the area within a minimum of 1,500 feet of the proposed limits of fill. The map was prepared from portions of the Cream and Alma, Wisconsin, USGS topographic maps and an aerial survey flown by Aero-Metric Engineering, Inc., of Sheboygan, Wisconsin, on April 3, 1993. The aerial survey covered the proposed landfill area. The USGS topographic maps covered the surrounding areas.

A significant amount of topographic relief occurs across the site. The topographic map (Plan Sheet 3) reveals that the topography slopes steeply into a central valley. Surface water runoff from the uplands and slopes surrounding the site drains into ditches within the central valley that extend from the site area to the Mississippi River. Culverts along the path of the ditches within the central valley aid in controlling surface water runoff. The nearest wetlands are located approximately 1 mile south of the site along the Mississippi River.

The site is located within the Mississippi River drainage basin. There are no navigable streams located within approximately 1 mile of the site. The nearest navigable stream is the Mississippi River.

### 8.2.2 Soil and Geology

Evaluation of soil boring logs indicates that sand and silty sand are the predominant soil types on site. However, several borings contain a layer of finer grained soil, including silt and clay above the sandy soil, ranging from a few feet to as much as 40 feet thick at boring B20 and abandoned well W14. The sandy soil typically extends to bedrock, at depths ranging between 15 and 60 feet below the ground surface. There are also a few isolated areas where fill is present. The fill is associated with the existing landfill footprints at Phases I, II, and III, located south of the proposed disposal area, and with the soil stockpile (in the center of the proposed Phase IV disposal area footprint near

boring B19). Except at the existing landfill phases and the soil stockpile, the fill is generally less than 10 feet deep.

The sandy soil is primarily the result of fluvial deposition. However, some of the sand, near the bedrock surface, appears to have resulted from *in situ* weathering of the sandstone bedrock present beneath most of the site. This soil generally consists of fine- to coarse-grained silty sand, poorly graded sand with gravel, and/or poorly graded gravel with sand; is typically very dense, and is brownish-yellow (10 YR 6/6) in color. The silty and clayey soil overlying the sandy deposits appears to be the result of a combination of loess deposits and, to a lesser degree, isolated lacustrine deposition. This soil is generally described as soft to medium stiff, dark yellowish-brown (10 YR 4/6) to brown (7.5 YR 4/2) silt or silty clay. Rust-colored mottling is common within this unit.

The results of the laboratory testing of selected soil samples (from both the loess/lacustrine silt and clay and the fluvial sand and gravel) for grain-size distribution, Atterberg limits, and laboratory hydraulic conductivity are summarized in Table 8-2. The soil test data sheets are contained in Appendix G.

Bedrock in the site area is composed of the Prairie du Chien Group Dolomite, that acts as a cap rock overlying the Cambrian Sandstones. Prairie du Chien Group Dolomite was observed in W101 on the ridge top in the northern portion of the site (Plan Sheets 7 and 8). The contact between the dolomite and Cambrian Sandstones was observed in well W101 at approximately 844 feet M.S.L. The Prairie du Chien Group Dolomite at W101 was found to be highly fractured and weathered. In the proposed landfill footprint, the Prairie du Chien has been removed by erosion.

Cambrian Sandstones underlie the unconsolidated sediment in this area. The Cambrian Sandstones include the Jordan Sandstone; the St. Lawrence Formation; the Franconia, Galesville, Eau Claire, and Mount Simon Sandstones; and the Dresbach Formation. The Cambrian Sandstone beneath the site was found to be fine grained, fissle, friable, and glauconitic with interbedded lenses of dark-brown sandstone and calcareous shaley partings. Bedrock cores of this formation were obtained from W101A, W106, and W107.

Plan Sheet 12 is a map of the top of the competent bedrock surface in the site area. This surface is also depicted on Geologic Cross Sections A-A' through L-L' shown on Plan Sheets 4 through 10. The surface mimics the topography, only at higher relief. The top of bedrock is substantially deeper in the central part of the valley, beneath the proposed disposal area footprint, than the valley slope areas.

State of Wisconsin
Department of Natural Resources

Route To:
- ☒ Solid Waste
- ☐ Emergency Response
- ☐ Wastewater
- ☐ Haz. Waste
- ☐ Underground Tanks
- ☐ Water Resources
- ☐ Other

# Soil Boring Log Information

Form 4400-122 7-91



| Facility/Project Name | License/Permit/Monitoring Number | Boring Number |
|---|---|---|
| Dairyland Power 3081.23 | 2927 | W101A |

| Boring Drilled By (Firm name and name of crew chief) | Date Drilling Started | Date Drilling Completed | Drilling Method |
|---|---|---|---|
| Boart Longyear, Crew Chief: Eric Shoenberg | 10/23/95 | 10/30/95 | Air |

| DNR Facility Well No. | WI Unique Well No. | Common Well Name | Final Static Water Level | Surface Elevation | Borehole Diameter |
|---|---|---|---|---|---|
| | | | 813.0 Feet MSL | 923.1 Feet MSL | 6.0 Inches |

Boring Location
State Plane 172652.00 N, 1477729.00 E
NE 1/4 of NE 1/4 of Section 19 T 21 N,R 12W

Lat ° ' "
Long ° ' "

Local Grid Location (If applicable)
Feet ☐ N ☐ S Feet ☐ E ☐ W

| County | DNR County Code | Civil Town/City/ or Village |
|---|---|---|
| Buffalo County | 06 | Belvidere |

| Sample Number | Sample Length (In) Recovered | Blow Counts | Depth In Feet | Soil/Rock Description And Geologic Origin For Each Major Unit | USCS | Graphic Log | Well Diagram | PID/FID | Standard Penetration | Moisture Content | Liquid Limit | Plastic Limit | P 200 | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 30 | Blind drilled to 30.0 feet. See log of W101 for sample descriptions. | | | | | | | | | | |
| | | | 31 | | | | | | | | | | | |
| | | | 32 | **DOLOMITE/LIMESTONE**, hard, fractured, highly weathered, fractures filled with silt/sand. | | | | | | | | | | |
| | | | 33 | | | | | | | | | | | |
| | | | 34 | | | | | | | | | | | |
| | | | 35 | | | | | | | | | | | |
| | | | 36 | | | | | | | | | | | |
| | | | 37 | | | | | | | | | | | |
| | | | 38 | | | | | | | | | | | |
| | | | 39 | | | | | | | | | | | |
| | | | 40 | | | | | | | | | | | |
| | | | 41 | | | | | | | | | | | |
| | | | 42 | | | | | | | | | | | |
| | | | 43 | | | | | | | | | | | |
| | | | 44 | | | | | | | | | | | |
| | | | 45 | | | | | | | | | | | |
| | | | 46 | | | | | | | | | | | |
| | | | 47 | | | | | | | | | | | |
| | | | 48 | | | | | | | | | | | |
| | | | 49 | | | | | | | | | | | |
| | | | 50 | | | | | | | | | | | |
| | | | 51 | | | | | | | | | | | |
| | | | 52 | As above. | | | | | | | | | | |
| | | | 53 | | | | | | | | | | | |
| | | | 54 | | | | | | | | | | | |

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: Daniel D. Reid

Firm: RMT
744 Heartland Trail, Madison Wisconsin
Tel: 608-831-4444, Fax: 608-831-3334

This form is authorized by Chapters 144, 147 and 162, Wis. Stats. Completion of this report is mandatory. Penalties: Forfeit not less than $10 nor more than $5,000 for each violation. Fined not less than $10 or more than $100 or imprisoned not less than 30 days, or both for each violation. Each day of continued violation is a separate offense, pursuant to ss 144.99 and 162.06, Wis. Stats.

Boring Number **W101A** Use only as an attachment to Form 4400-122.



| Sample Number | Sample Length (In) Recovered | Blow Counts | Depth In Feet | Soil/Rock Description And Geologic Origin For Each Major Unit | USCS | Graphic Log | Well Diagram | PID/FID | Soil Properties: Standard Penetration | Moisture Content | Liquid Limit | Plastic Limit | P 200 | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 55 | | | | | | | | | | | |
| | | | 56 | | | | | | | | | | | |
| | | | 57 | | | | | | | | | | | |
| | | | 58 | | | | | | | | | | | |
| | | | 59 | | | | | | | | | | | |
| | | | 60 | | | | | | | | | | | |
| | | | 61 | | | | | | | | | | | |
| | | | 62 | | | | | | | | | | | |
| | | | 63 | | | | | | | | | | | |
| | | | 64 | | | | | | | | | | | |
| | | | 65 | | | | | | | | | | | |
| | | | 66 | | | | | | | | | | | |
| | | | 67 | | | | | | | | | | | |
| | | | 68 | | | | | | | | | | | |
| | | | 69 | | | | | | | | | | | |
| | | | 70 | | | | | | | | | | | |
| | | | 71 | | | | | | | | | | | |
| | | | 72 | | | | | | | | | | | |
| | | | 73 | | | | | | | | | | | |
| | | | 74 | **SANDSTONE**, olive green, glauconitic, soft, fissile, friable, fine to medium grained. | | | | | | | | | | |
| | | | 75 | | | | | | | | | | | |
| | | | 76 | | | | | | | | | | | |
| | | | 77 | | | | | | | | | | | |
| | | | 78 | **DOLOMITE/LIMESTONE**, hard, dense, highly weathered. | | | | | | | | | | |
| | | | 79 | | | | | | | | | | | |
| | | | 80 | **SANDSTONE**, olive green, glauconitic, interbedded with dark brown-black sandstone and white lenses, fine grained, fissile, medium friable, recovery=94%, RQD=50%, FF=3. | | | | | | | | | | |
| 1 | | | 81 | | | | | | | | | | | RC |
| | | | 82 | | | | | | | | | | | |
| | | | 83 | | | | | | | | | | | |
| | | | 84 | | | | | | | | | | | |
| | | | 85 | | | | | | | | | | | |
| | | | 86 | | | | | | | | | | | |
| | | | 87 | | | | | | | | | | | |
| | | | 88 | | | | | | | | | | | |
| | | | 89 | | | | | | | | | | | |
| | | | 90 | | | | | | | | | | | |
| 2 | | | 91 | Recovery=99%, RQD=55%, FF=6. | | | | | | | | | | RC |
| | | | 92 | | | | | | | | | | | |
| | | | 93 | As above, but also contains tan sandstone, very fine with lenses of shaley consistency, bottom 3.5 feet well cemented. | | | | | | | | | | |
| | | | 94 | | | | | | | | | | | |
| | | | 95 | | | | | | | | | | | |
| | | | 96 | | | | | | | | | | | |

Boring Number **W101A** Use only as an attachment to Form 4400-122.



| Sample Number | Sample Length (In) Recovered | Blow Counts | Depth In Feet | Soil/Rock Description And Geologic Origin For Each Major Unit | USCS | Graphic Log | Well Diagram | PID/FID | Soil Properties: Standard Penetration | Moisture Content | Liquid Limit | Plastic Limit | P 200 | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 97 | | | | | | | | | | | |
| | | | 98 | | | | | | | | | | | |
| | | | 99 | | | | | | | | | | | |
| | | | 100 | | | | | | | | | | | |
| 3 | | | 101 | | | | | | | | | | | RC |
| | | | 102 | | | | | | | | | | | |
| | | | 103 | Recovery=40%, RQD=0%. | | | | | | | | | | |
| | | | 104 | Core barrel locks up at 104.0 feet. | | | | | | | | | | |
| | | | 105 | | | | | | | | | | | |
| | | | 106 | | | | | | | | | | | |
| | | | 107 | | | | | | | | | | | |
| | | | 108 | | | | | | | | | | | |
| | | | 109 | | | | | | | | | | | |
| | | | 110 | | | | | | | | | | | |
| | | | 111 | | | | | | | | | | | |
| | | | 112 | | | | | | | | | | | |
| | | | 113 | | | | | | | | | | | |
| | | | 114 | | | | | | | | | | | |
| | | | 115 | | | | | | | | | | | |
| | | | 116 | | | | | | | | | | | |
| | | | 117 | | | | | | | | | | | |
| | | | 118 | | | | | | | | | | | |
| | | | 119 | | | | | | | | | | | |
| | | | 120 | | | | | | | | | | | |
| | | | 121 | | | | | | | | | | | |
| | | | 122 | | | | | | | | | | | |
| | | | 123 | | | | | | | | | | | |
| | | | 124 | | | | | | | | | | | |
| | | | 125 | As above, SANDSTONE, olive green, glauconitic, interbedded with dark brown to black sandstone and white calcareous shaley lenses, fine-grained, fissile, medium friable. | | | | | | | | | | |
| | | | 126 | | | | | | | | | | | |
| | | | 127 | | | | | | | | | | | |
| | | | 128 | | | | | | | | | | | |
| | | | 129 | | | | | | | | | | | |
| | | | 130 | | | | | | | | | | | |
| | | | 131 | | | | | | | | | | | |
| | | | 132 | | | | | | | | | | | |
| | | | 133 | | | | | | | | | | | |
| | | | 134 | | | | | | | | | | | |
| | | | 135 | | | | | | | | | | | |
| | | | 136 | | | | | | | | | | | |
| | | | 137 | | | | | | | | | | | |

Boring Number **W101A** Use only as an attachment to Form 4400-122.



| Sample Number | Sample Length (In) Recovered | Blow Counts | Depth In Feet | Soil/Rock Description And Geologic Origin For Each Major Unit | USCS | Graphic Log | Well Diagram | PID/FID | Soil Properties: Standard Penetration | Moisture Content | Liquid Limit | Plastic Limit | P 200 | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 138 | | | | | | | | | | | |
| | | | 139 | | | | | | | | | | | |
| | | | 140 | | | | | | | | | | | |
| | | | 141 | | | | | | | | | | | |
| | | | 142 | | | | | | | | | | | |
| | | | 143 | | | | | | | | | | | |
| | | | 144 | | | | | | | | | | | |
| | | | 145 | | | | | | | | | | | |
| | | | 146 | | | | | | | | | | | |
| | | | 147 | | | | | | | | | | | |
| | | | 148 | | | | | | | | | | | KH = 1X10-2 cm/sec |
| | | | 149 | | | | | | | | | | | |
| | | | 150 | | | | | | | | | | | |
| | | | 151 | | | | | | | | | | | |
| | | | 152 | End of boring at 152.0 feet. | | | | | | | | | | |

State of Wisconsin
Department of Natural Resources

Route To:
- [x] Solid Waste
- [ ] Emergency Response
- [ ] Wastewater
- [ ] Haz. Waste
- [ ] Underground Tanks
- [ ] Water Resources
- [ ] Other

# Soil Boring Log Information

Form 4400-122 7-91



| Facility/Project Name | License/Permit/Monitoring Number | Boring Number |
|---|---|---|
| Dairyland Power 3081.23 | 2927 | W106 |

| Boring Drilled By (Firm name and name of crew chief) | Date Drilling Started | Date Drilling Completed | Drilling Method |
|---|---|---|---|
| Boart Longyear, Crew Chief: Paul Dickinson | 11/2/95 | 11/7/95 | 8"MUD ROTARY |

| DNR Facility Well No. | WI Unique Well No. | Common Well Name | Final Static Water Level | Surface Elevation | Borehole Diameter |
|---|---|---|---|---|---|
| | | | 773.6 Feet MSL | 848.3 Feet MSL | 8.0 Inches |

Boring Location
State Plane 171530.00 N, 1476837.00 E
NE 1/4 of NE 1/4 of Section 19 T 21 N,R 12W
Lat ° ' "
Long ° ' "
Local Grid Location (If applicable)
Feet [ ] N [ ] S Feet [ ] E [ ] W

County: Buffalo County
DNR County Code: 06
Civil Town/City/ or Village: Belvidere

| Sample Number | Length (In) Recovered | Blow Counts | Depth In Feet | Soil/Rock Description And Geologic Origin For Each Major Unit | U S C S | Graphic Log | Well Diagram | PID/FID | Standard Penetration | Moisture Content | Liquid Limit | Plastic Limit | P 200 | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | **SILTY SAND WITH GRAVEL (SM)**, fine to coarse, 15-30% silt, 10YR 6/6 yellowish brown, medium dense, (Fill). | | | | | | M | | | | |
| 1 | 20 | 12 | 5 | | SM | | | | | | | | | SS |
| 2 | 18 | 19 | 10 | As above. | | | | | | | | | | SS |
| 3 | 14 | 38 | 15 | As above. | | | | | | | | | | SS |
| 4 | 14 | 20 | 20 | As above. | | | | | | | | | | SS |
| | | | 24 | | | | | | | | | | | |

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: Craig O. Bartlett

Firm: RMT
744 Heartland Trail, Madison Wisconsin
Tel: 608-831-4444, Fax: 608-831-3334

This form is authorized by Chapters 144, 147 and 162, Wis. Stats. Completion of this report is mandatory. Penalties: Forfeit not less than $10 nor more than $5,000 for each violation. Fined not less than $10 or more than $100 or imprisoned not less than 30 days, or both for each violation. Each day of continued violation is a separate offense, pursuant to ss 144.99 and 162.06, Wis. Stats.

Boring Number **W106** Use only as an attachment to Form 4400-122.



| Sample Number | Length (In) Recovered | Blow Counts | Depth In Feet | Soil/Rock Description And Geologic Origin For Each Major Unit | USCS | Graphic Log | Well Diagram | PID/FID | Standard Penetration | Moisture Content | Liquid Limit | Plastic Limit | P 200 | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 | 18 | 100/.5' | 26 | As above, but native soil. | | | | | | | | | | SS |
| | | | 27 | | | | | | | | | | | |
| | | | 28 | **SILTY SAND (SM)**, fine to medium, 10% clay, 5Y 4/4 olive, very dense, (glauconitic), (weathered sandstone). | | | | | | | | | | |
| | | | 29 | | | | | | | M | | | | |
| | | | 30 | | | | | | | | | | | |
| 6 | 20 | 46 | 31 | | SM | | | | | | | | | SS |
| | | | 32 | | | | | | | | | | | |
| | | | 33 | | | | | | | | | | | |
| | | | 34 | | | | | | | | | | | |
| 7 | 10 | 12 | 35 | | | | | | | | | | | SS |
| | | | 36 | | | | | | | | | | | |
| | | | 37 | | | | | | | | | | | |
| | | | 38 | | | | | | | | | | | |
| | | | 39 | | | | | | | | | | | |
| 8 | 12 | 100/14" | 40 | | | | | | | | | | | SS |
| | | | 41 | As above, but interbedded with silt and fines. | | | | | | | | | | |
| | | | 42 | | | | | | | | | | | |
| | | | 43 | | | | | | | | | | | |
| | | | 44 | | | | | | | | | | | |
| 9 | 8 | 100/10" | 45 | | | | | | | | | | | SS |
| | | | 46 | As above, but very dense. | | | | | | | | | | |
| | | | 47 | | | | | | | | | | | |
| | | | 48 | | | | | | | | | | | |
| | | | 49 | | | | | | | | | | | |
| 10 | 6 | 100/8" | 50 | | | | | | | | | | | SS |
| | | | 51 | As above. | | | | | | | | | | |
| | | | 52 | | | | | | | | | | | |
| | | | 53 | | | | | | | | | | | |
| | | | 54 | | | | | | | | | | | |
| 11 | 6 | 100/6" | 55 | | | | | | | | | | | SS |
| | | | 56 | As above. | | | | | | | | | | |
| | | | 57 | | | | | | | | | | | |
| | | | 58 | | | | | | | | | | | |
| | | | 59 | | | | | | | | | | | |
| 12 | 3 | 100/3" | 60 | | | | | | | | | | | SS |
| | | | 61 | As above. | | | | | | | | | | |
| | | | 62 | | | | | | | | | | | |
| | | | 63 | | | | | | | | | | | |
| | | | 64 | **SANDSTONE**, tan to greenish tan, weathered, some fracturing, only 2 pieces longer than 4". | | | | | | | | | | |
| | | | 65 | | | | | | | | | | | |
| | | | 66 | | | | | | | | | | | |

State of Wisconsin
Department of Natural Resources

Soil Boring Log Information Supplement
Form 4400-122A 7-91

Boring Number **W106** Use only as an attachment to Form 4400-122.



| Sample Number | Sample Length (In) Recovered | Blow Counts | Depth In Feet | Soil/Rock Description And Geologic Origin For Each Major Unit | USCS | Graphic Log | Well Diagram | PID/FID | Soil Properties: Standard Penetration | Moisture Content | Liquid Limit | Plastic Limit | P 200 | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13 | | NA | 67 | Recovery=32%, RQD=5%. | | | | | | | | | | RC |
| | | | 68 | | | | | | | | | | | |
| | | | 69 | | | | | | | | | | | |
| | | | 70 | | | | | | | | | | | |
| | | | 71 | | | | | | | | | | | |
| | | | 72 | | | | | | | | | | | |
| | | | 73 | | | | | | | | | | | |
| 14 | | NA | 74 | | | | | | | W | | | | RC |
| | | | 75 | | | | | | | | | | | |
| | | | 76 | | | | | | | | | | | |
| | | | 77 | Recovery=25%, RQD=4%. | | | | | | | | | | |
| | | | 78 | | | | | | | | | | | |
| | | | 79 | | | | | | | | | | | |
| | | | 80 | | | | | | | | | | | |
| | | | 81 | | | | | | | | | | | |
| | | | 82 | | | | | | | | | | | |
| | | | 83 | | | | | | | | | | | |
| | | | 84 | End of boring at 84.0 feet. | | | | | | | | | | |

State of Wisconsin
Department of Natural Resources

Route To:
☒ Solid Waste
☐ Emergency Response
☐ Wastewater
☐ Haz. Waste
☐ Underground Tanks
☐ Water Resources
☐ Other

# Soil Boring Log Information

Form 4400-122 7-91



| Facility/Project Name | License/Permit/Monitoring Number | Boring Number |
|---|---|---|
| Dairyland Power 3081.30 | 2927 | W107 |

| Boring Drilled By (Firm name and name of crew chief) | Date Drilling Started | Date Drilling Completed | Drilling Method |
|---|---|---|---|
| Boart Longyear, Crew Chief: T. Schmalfeldt | 4/29/97 | 5/1/97 | 6 1/4 HSA |

| DNR Facility Well No. | WI Unique Well No. | Common Well Name | Final Static Water Level | Surface Elevation | Borehole Diameter |
|---|---|---|---|---|---|
| | | | Feet MSL | 906.2 Feet MSL | 6.0 Inches |

Boring Location
State Plane 173527.44 N, 1477214.99 E
NE 1/4 of NE 1/4 of Section 19 T 21 N,R 12W
Lat ° ' "
Long ° ' "
Local Grid Location (If applicable)
Feet ☐ N ☐ S Feet ☐ E ☐ W

| County | DNR County Code | Civil Town/City/ or Village |
|---|---|---|
| Buffalo County | 06 | Belvidere |

| Sample Number | Length (In) Recovered | Blow Counts | Depth In Feet | Soil/Rock Description And Geologic Origin For Each Major Unit | U S C S | Graphic Log | Well Diagram | PID/FID | Standard Penetration | Moisture Content | Liquid Limit | Plastic Limit | P 200 | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1–3 | SILT (ML), 5% fine to coarse sand, 5% fine gravel, 10-15% clay, slightly plastic, stiff, 7.5YR 4/4 brown. | | | | | | M<br>M | | | | |
| 1 | 8 | 26 | 4–9 | POORLY GRADED SAND WITH GRAVEL (SP) to SILTY SAND WITH GRAVEL (SM), fine to coarse, 10-20% silt, 15-20% fine to coarse gravel, 5% cobbles, 10YR 6/6 brownish yellow, medium dense. | SP | | | | | | | | | SS |
| 2 | 24 | 56 | 10–14 | As above. | | | | | | | | | | SS |
| 3 | 15 | 36 | 15–17 | As above, but with boulder at ~12.0-13.5 feet. | | | | | | | | | | SS |
| 4 | 18 | 26 | 18–25 | POORLY GRADED SAND WITH SILT (SP/SM), 10% silt, 10% fine to medium gravel (angular fragments), 10YR 6/6 brownish yellow, medium dense. | SP/SM | | | | | M | | | | SS |

I hereby certify that the information on this form is true and correct to the best of my knowledge.

| Signature | Firm |
|---|---|
| David A. Reid | RMT<br>744 Heartland Trail, Madison Wisconsin<br>Tel: 608-831-4444, Fax: 608-831-3334 |

This form is authorized by Chapters 144, 147 and 162, Wis. Stats. Completion of this report is mandatory. Penalties: Forfeit not less than $10 nor more than $5,000 for each violation. Fined not less than $10 or more than $100 or imprisoned not less than 30 days, or both for each violation. Each day of continued violation is a separate offense, pursuant to ss 144.99 and 162.06, Wis. Stats.

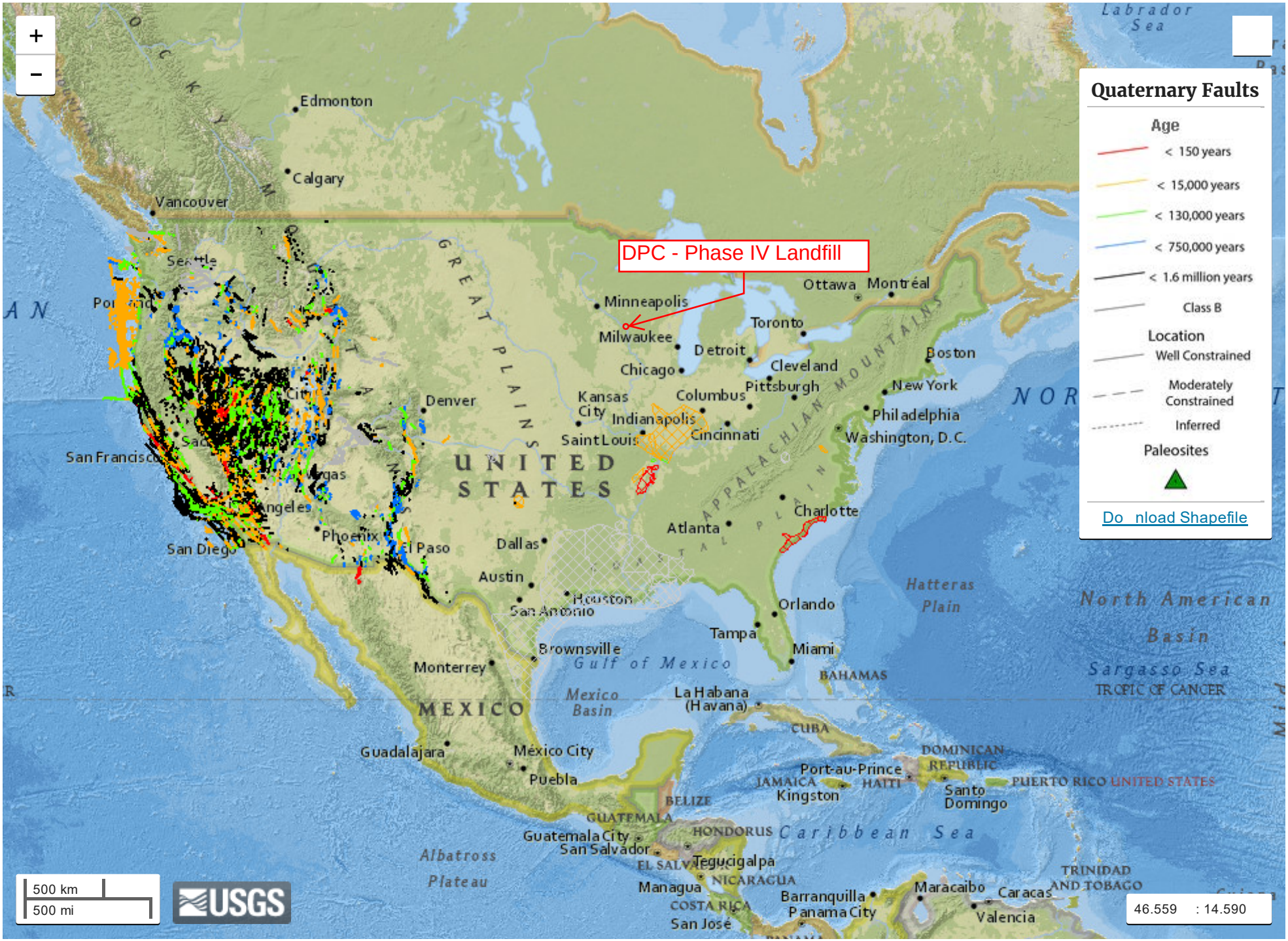
Boring Number **W107** Use only as an attachment to Form 4400-122. 

| Sample Number | Length (In) Recovered | Blow Counts | Depth In Feet | Soil/Rock Description And Geologic Origin For Each Major Unit | USCS | Graphic Log | Well Diagram | PID/FID | Standard Penetration | Moisture Content | Liquid Limit | Plastic Limit | P 200 | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 | 14 | 44 | 26 | As above, except ~20% silt. | | | | | | | | | | SS |
| | | | 27 | | | | | | | | | | | |
| | | | 28 | | | | | | | | | | | |
| | | | 29 | | | | | | | | | | | |
| | | | 30 | | | | | | | | | | | |
| 6 | 15 | 100/5 | 31 | **WEATHERED DOLOMITE BEDROCK**, becomes competent at ~31.0 feet. | | | | | | | | | | SS |
| RC1 | 24 | NA | 32 | | | | | | | | | | | RQD=0 |
| | | | 33 | | | | | | | | | | | |
| | | | 34 | | | | | | | | | | | FF=0 |
| | | | 35 | | | | | | | | | | | Rec=40% |
| | | | 36 | | | | | | | | | | | |
| 7 | | | 37 | | | | | | | | | | | GRAB |
| | | | 38 | | | | | | | | | | | |
| | | | 39 | | | | | | | | | | | |
| 8 | | | 40 | Alternating layers (1-2 feet thick) of light brown dolomite and olive brown to olive green silty sandstone. | | | | | | | | | | GRAB |
| | | | 41 | | | | | | | | | | | |
| | | | 42 | | | | | | | | | | | |
| | | | 43 | | | | | | | | | | | |
| | | | 44 | | | | | | | | | | | |
| 9 | | | 45 | | | | | | | | | | | GRAB |
| | | | 46 | | | | | | | | | | | |
| | | | 47 | | | | | | | | | | | |
| | | | 48 | | | | | | | | | | | |
| | | | 49 | Olive brown to olive green SILTY SANDSTONE, glauconitic, fine to medium grained. | | | | | | | | | | |
| 10 | | | 50 | | | | | | | | | | | GRAB |
| | | | 51 | | | | | | | | | | | |
| | | | 52 | | | | | | | | | | | |
| | | | 53 | | | | | | | | | | | |
| | | | 54 | Driller notes large fractures at ~53.0 feet, loose air circulation. | | | | | | | | | | |
| | | | 55 | **DOLOMITE**, light brown to gray, highly weathered with alternating layers of olive brown to olive green silty sandstone. | | | | | | | | | | |
| | | | 56 | | | | | | | | | | | |
| | | | 57 | | | | | | | | | | | |
| | | | 58 | | | | | | | | | | | |
| | | | 59 | | | | | | | | | | | |
| | | | 60 | | | | | | | | | | | |
| | | | 61 | Air circulation returns at ~60.0 feet. | | | | | | | | | | |
| | | | 62 | Olive brown to olive green Glauconitic SANDSTONE, fine-grained with many silty lenses. | | | | | | | | | | |
| | | | 63 | | | | | | | | | | | |
| | | | 64 | | | | | | | | | | | |
| | | | 65 | | | | | | | | | | | |
| | | | 66 | | | | | | | | | | | |

Boring Number **W107** Use only as an attachment to Form 4400-122. 

| Sample Number | Sample Length (In) Recovered | Blow Counts | Depth In Feet | Soil/Rock Description And Geologic Origin For Each Major Unit | USCS | Graphic Log | Well Diagram | PID/FID | Soil Properties: Standard Penetration | Moisture Content | Liquid Limit | Plastic Limit | P 200 | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 67 | | | | | | | | | | | |
| | | | 68 | | | | | | | | | | | |
| | | | 69 | | | | | | | | | | | |
| | | | 70 | Olive green glauconitic SANDSTONE, fine grained with many silty lenses. | | | | | | | | | | |
| | | | 71 | | | | | | | | | | | |
| | | | 72 | | | | | | | | | | | |
| | | | 73 | | | | | | | | | | | |
| | | | 74 | | | | | | | | | | | |
| | | | 75 | Water at 74.5 feet while drilling. | | | | | | | | | | |
| RC2 | 18 | NA | 76 | | | | | | | | | | | RQD=0 |
| | | | 77 | | | | | | | | | | | FF=0 |
| | | | 78 | | | | | | | | | | | Rec=38% |
| | | | 79 | | | | | | | | | | | |
| | | | 80 | | | | | | | | | | | |
| | | | 81 | | | | | | | | | | | |
| | | | 82 | | | | | | | | | | | |
| | | | 83 | | | | | | | | | | | |
| | | | 84 | | | | | | | | | | | |
| | | | 85 | | | | | | | | | | | |
| | | | 86 | End of boring at 86.0 feet. | | | | | | | | | | |

# Appendix C-2
# USGS Quaternary Earthquake Fault Map (USGS, 2015)




Leaflet ontent ma not reflect ational eographic s current map polic . Sources: ational eographic sri DeLorme U M US S S S M

# Appendix D
# Supporting Material for §257.63

U.S. Geological Survey - Earthquake Hazards Program

# Alma Offsite Facility, Phase IV Landfill

**Latitude = 44.290°N, Longitude = 91.876°W**

Location

Reference Document

2015 NEHRP Provisions

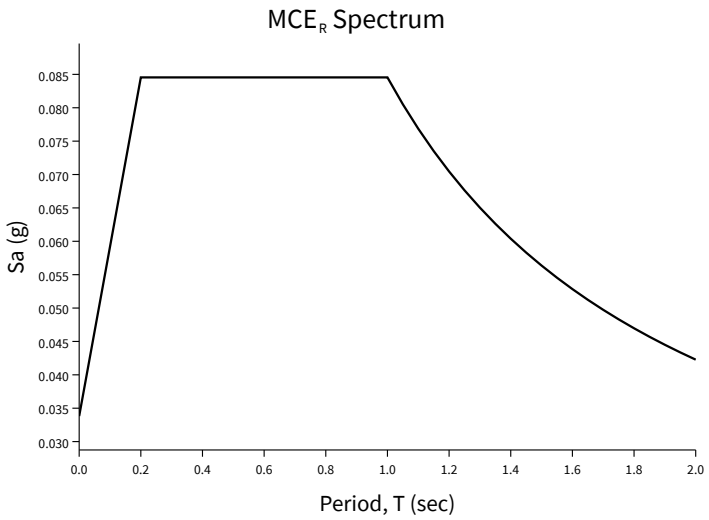
Site Class

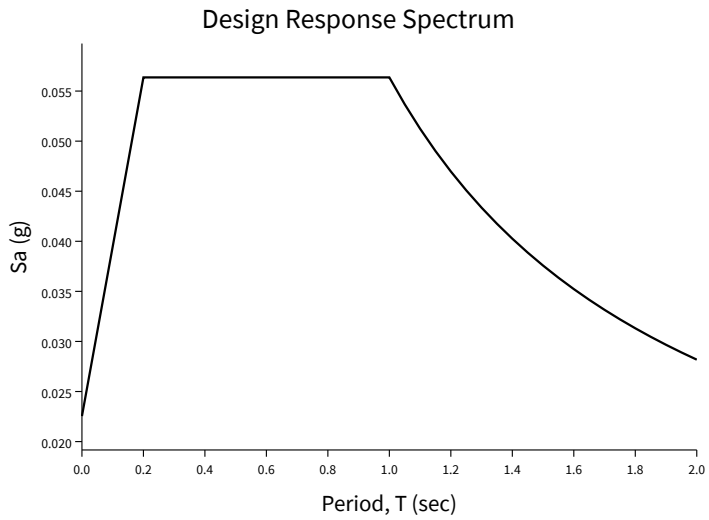
D (determined): Stiff Soil

Risk Category

IV e.g. (Essential Facilities)

| | | | | | |
|---|---|---|---|---|---|
| $S_S$ = | 0.047 g | $S_{MS}$ = | 0.075 g | $S_{DS}$ = | 0.050 g |
| $S_1$ = | 0.035 g | $S_{M1}$ = | 0.085 g | $S_{D1}$ = | 0.056 g |




Since $S_{MS} < S_{M1}$, for this response spectrum $S_{MS}$ has been set equal to $S_{M1}$ in accordance with Section 11.4.3.

Since $S_{MS} < S_{M1}$, for this response spectrum $S_{MS}$ has been set equal to $S_{M1}$ (and hence $S_{DS}$ has been set equal to $S_{D1}$), in accordance with Section 11.4.3.

## Mapped Acceleration Parameters, Long-Period Transition Periods, and Risk Coefficients

Note: The $S_S$ and $S_1$ ground motion maps provided below are for the direction of maximmum horizontal spectral response acceleration. They have been converted from corresponding geometric mean ground motions computed by the USGS by applying factors of 1.1 (to obtain $S_S$) 1.3 (to obtain $S_1$).

- FIGURE 22-1 $S_S$ Risk-Targeted Maximum Considered Earthquake ($MCE_R$) Ground Motion Parameter for the Conterminous United States for 0.2 s Spectral Response Acceleration (5% of Critical Damping), Site Class B
- FIGURE 22-2 $S_1$ Risk-Targeted Maximum Considered Earthquake ($MCE_R$) Ground Motion Parameter for the Conterminous United States for 1.0 s Spectral Response Acceleration (5% of Critical Damping), Site Class B
- FIGURE 22-9 Maximum Considered Earthquake Geometric Mean ($MCE_G$) PGA, %g, Site Class B for the Conterminous United States
- FIGURE 22-14 Mapped Long-Period Transition Period, $T_L$ (s), for the Conterminous United States
- FIGURE 22-18 Mapped Risk Coefficient at 0.2 s Spectral Response Period, $C_{RS}$
- FIGURE 22-19 Mapped Risk Coefficient at 1.0 s Spectral Response Period, $C_{R1}$

## Site Class

The authority having jurisdiction (not the USGS), site-specific geotechnical data, and/or the default has classified the site class as Site Class , based on the site soil properties in accordance with Chapter 20.

### Table 20.3-1 Site Classification

| Site Class | $\bar{v}_S$ | $\bar{N}$ or $\bar{N}_{ch}$ | $\bar{s}_u$ |
|---|---|---|---|
| A. Hard Rock | >5,000 ft/s | N/A | N/A |
| B. Rock | 2,500 to 5,000 ft/s | N/A | N/A |
| C. Very dense soil and soft rock | 1,200 to 2,500 ft/s | >50 | >2,000 psf |
| D. Stiff Soil | 600 to 1,200 ft/s | 15 to 50 | 1,000 to 2,000 psf |
| E. Soft clay soil | <600 ft/s | <15 | <1,000 psf |
| | Any profile with more than 10 ft of soil having the characteristics:<br>• Plasticity index PI > 20<br>• Moisture content w ≥ 40%, and<br>• Undrained shear strength $\bar{s}_u$ < 500 psf | | |
| F. Soils requiring site response analysis in accordance with Section 21.1 | See Section 20.3.1 | | |
| For SI: 1ft/s = 0.3048 m/s 1lb/ft$^2$ = 0.0479 kN/m$^2$ | | | |

## Site Coefficients and Risk-Targeted Maximum Considered Earthquake ($MCE_R$) Spectral Response Acceleration Parameters

Risk-targeted Ground Motion (0.2 s)

$C_{RS}S_{SUH} = 0.942 \times 0.050 = 0.047$ g

Deterministic Ground Motion (0.2 s)

$S_{SD} = 1.500$ g

$S_S \equiv$ "Lesser of $C_{RS}S_{SUH}$ and $S_{SD}$" = 0.047 g

Risk-targeted Ground Motion (1.0 s)

$C_{R1}S_{1UH} = 0.877 \times 0.040 = 0.035$ g

Deterministic Ground Motion (1.0 s)

$S_{1D} = 0.600$ g

$S_1 \equiv$ "Lesser of $C_{R1}S_{1UH}$ and $S_{1D}$" = 0.035 g

### Table 11.4-1: Site Coefficient $F_a$

| Site Class | Spectral Reponse Acceleration Parameter at Short Period | | | | | |
|---|---|---|---|---|---|---|
| | $S_S \leq 0.25$ | $S_S = 0.50$ | $S_S = 0.75$ | $S_S = 1.00$ | $S_S = 1.25$ | $S_S \geq 1.50$ |
| A | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |
| B (measured) | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 |
| B (unmeasured) | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| C | 1.3 | 1.3 | 1.2 | 1.2 | 1.2 | 1.2 |
| D (determined) | 1.6 | 1.4 | 1.2 | 1.1 | 1.0 | 1.0 |
| D (default) | 1.6 | 1.4 | 1.2 | 1.2 | 1.2 | 1.2 |
| E | 2.4 | 1.7 | 1.3 | 1.2 * | 1.2 * | 1.2 * |
| F | See Section 11.4.7 | | | | | |

* For Site Class E and $S_S \geq 1.0$ g, see the requirements for site-specific ground motions in Section 11.4.7 of the 2015 NEHRP Provisions. Here the exception to those requirements allowing $F_a$ to be taken as equal to that of Site Class C has been invoked.

Note: Use straight-line interpolation for intermediate values of $S_S$.

Note: Where Site Class B is selected, but site-specific velocity measurements are not made, the value of $F_a$ shall be taken as 1.0 per Section 11.4.2.

Note: Where Site Class D is selected as the default site class per Section 11.4.2, the value of $F_a$ shall not be less than 1.2 per Section 11.4.3.

## For Site Class = D (determined) and $S_S$ = 0.047 g, $F_a$ = 1.600

## Table 11.4-2: Site Coefficient $F_v$

| Site Class | Spectral Response Acceleration Parameter at 1-Second Period | | | | | |
|---|---|---|---|---|---|---|
| | $S_1 \leq 0.10$ | $S_1 = 0.20$ | $S_1 = 0.30$ | $S_1 = 0.40$ | $S_1 = 0.50$ | $S_1 \geq 0.60$ |
| A | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |
| B (measured) | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |
| B (unmeasured) | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| C | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.4 |
| D (determined) | 2.4 | 2.2 [1] | 2.0 [1] | 1.9 [1] | 1.8 [1] | 1.7 [1] |
| D (default) | 2.4 | 2.2 [1] | 2.0 [1] | 1.9 [1] | 1.8 [1] | 1.7 [1] |
| E | 4.2 | 3.3 [1] | 2.8 [1] | 2.4 [1] | 2.2 [1] | 2.0 [1] |
| F | See Section 11.4.7 | | | | | |

[1] For Site Class D or E and $S_1 \geq 0.2$ g, site-specific ground motions might be required. See Section 11.4.7 of the 2015 NEHRP Provisions.

Note: Use straight-line interpolation for intermediate values of $S_1$.

Note: Where Site Class B is selected, but site-specific velocity measurements are not made, the value of $F_v$ shall be taken as 1.0 per Section 11.4.2.

**For Site Class = D (determined) and $S_1$ = 0.035 g, $F_v$ = 2.400**

Site-adjusted $MCE_R$ (0.2 s)

$$S_{MS} = F_a S_S = 1.600 \times 0.047 = 0.075 \text{ g}$$

Site-adjusted $MCE_R$ (1.0 s)

$$S_{M1} = F_v S_1 = 2.400 \times 0.035 = 0.085 \text{ g}$$

## Design Spectral Acceleration Parameters

Design Ground Motion (0.2 s)

$S_{DS} = ⅔\ S_{MS} = ⅔ \times 0.075 = 0.050$ g

---

Design Ground Motion (1.0 s)

$S_{D1} = ⅔\ S_{M1} = ⅔ \times 0.085 = 0.056$ g

---

# Design Response Spectrum

Long-Period Transition Period = $T_L$ = 12 s

## Figure 11.4-1: Design Response Spectrum

Since $S_{MS} < S_{M1}$, for this response spectrum $S_{MS}$ has been set equal to $S_{M1}$ (and hence $S_{DS}$ has been set equal to $S_{D1}$), in accordance with Section 11.4.3.

Spectral Response Acceleration, Sa (g)

Period, T (sec)

## $MCE_R$ Response Spectrum

The $MCE_R$ response spectrum is determined by multiplying the design response spectrum above by 1.5.
Since $S_{MS} < S_{M1}$, for this response spectrum $S_{MS}$ has been set equal to $S_{M1}$ in accordance with Section 11.4.3.

# Additional Geotechnical Investigation Report Requirements for Seismic Design Categories D through F

## Table 11.8-1: Site Coefficient for $F_{PGA}$

| Site Class | Mapped MCE Geometric Mean ($MCE_G$) Peak Ground Acceleration | | | | | |
|---|---|---|---|---|---|---|
| | PGA ≤ 0.10 | PGA = 0.20 | PGA = 0.30 | PGA = 0.40 | PGA = 0.50 | PGA ≥ 0.60 |
| A | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |
| B (measured) | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 |
| B (unmeasured) | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| C | 1.3 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 |
| D (determined) | 1.6 | 1.4 | 1.3 | 1.2 | 1.1 | 1.1 |
| D (default) | 1.6 | 1.4 | 1.3 | 1.2 | 1.2 | 1.2 |
| E | 2.4 | 1.9 | 1.6 | 1.4 | 1.2 | 1.1 |
| F | See Section 11.4.7 | | | | | |

Note: Use straight-line interpolation for intermediate values of PGA

Note: Where Site Class D is selected as the default site class per Section 11.4.2, the value of $F_{pga}$ shall not be less than 1.2.

**For Site Class = D (determined) and PGA = 0.023 g, $F_{PGA}$ = 1.600**

Mapped $MCE_G$

$PGA = 0.023$ g

Site-adjusted $MCE_G$

$PGA_M = F_{PGA}PGA = 1.600 \times 0.023 = 0.036$ g

# Appendix E
# Supporting Material for §257.64

DAIRYLAND Power

COOPERATIVE – LACROSSE, WISCONSIN

# PLAN OF OPERATION

# PHASE IV DISPOSAL AREA
# ALMA OFF-SITE ASH DISPOSAL FACILITY
# TOWN OF BELVIDERE
# BUFFALO COUNTY, WISCONSIN

**PREPARED FOR**
**DAIRYLAND POWER COOPERATIVE**

**PREPARED BY**
**RMT, INC.**
**MADISON, WISCONSIN**

October 2000

# Purpose/Approach/Methodologies/Assumptions/ Results/References

RMT

COMPUTATION SHEET

SHEET 1 OF 5

744 Heartland Trail (53717-8923) P. O. Box 8923 (53708-8923) Madison, WI (608) 831-4444 FAX: (608) 831-3334 VOICE: (608) 831-1989

| PROJECT/PROPOSAL NAME | PREPARED By: | Date: | CHECKED By: | Date: | PROJECT/PROPOSAL NO. |
|---|---|---|---|---|---|
| Dairyland Power Cooperative | JDH<br>Rev. BJK | 9/97<br>9/00 | PDC | 9/97 | 3081.40 |

# GLOBAL SLOPE STABILITY

## Purpose

To evaluate the global slope stability of the liner and final slopes.

## Approach

The global stability analysis was performed by evaluating the following worst-case slope conditions:

### Liner Slope

The worst-case slope of the liner consists of an 83-foot-high 3H:1V slope with a 2-foot-thick low-permeability soil layer, a GCL, a geomembrane, and a 1-foot-thick granular drainage layer (approximately Coordinate N172500, E147700, west slope [see Figure J-1]).

### Final Cover Slope

The worst-case slope of the final cover consists of a 36-foot-high, 4H:1V slope (approximately Coordinate N172000, E1477000, west slope [see Figure J-2]). Conditions are modeled for ash waste.

## Methodologies

- The analyses have been performed using the computer program XSTABL, which was developed at Purdue University and subsequently modified by Interactive Software Designs, Inc., of Moscow, Idaho (1994). XSTABL is used to perform the iterative task of identifying the worst-case failure scenario for each case using the Modified Bishops Method. XSTABL uses a two-dimensional static equilibrium method to determine a factor of safety against failure.
- The failure mode considered for the stability analysis was the circular or rotational failure of the waste, subgrade, natural formations, and compacted embankments (*i.e.*, perimeter berm, liner, and cover).
- The circular trial failure surface generator performs a search for the critical failure surface based on failure initiation and termination points established by the user, and is often used when no well-defined weak zone exists in the profile being evaluated. This failure mode is used in evaluating the stability of the liner and final slopes.
- The worst-case (lowest factor of safety) is identified by varying the limits of the failure generation locations. In cases where both types of failure are used to analyze the stability, the failure mode resulting in the most critical (lowest) factor of safety is presented in the results.

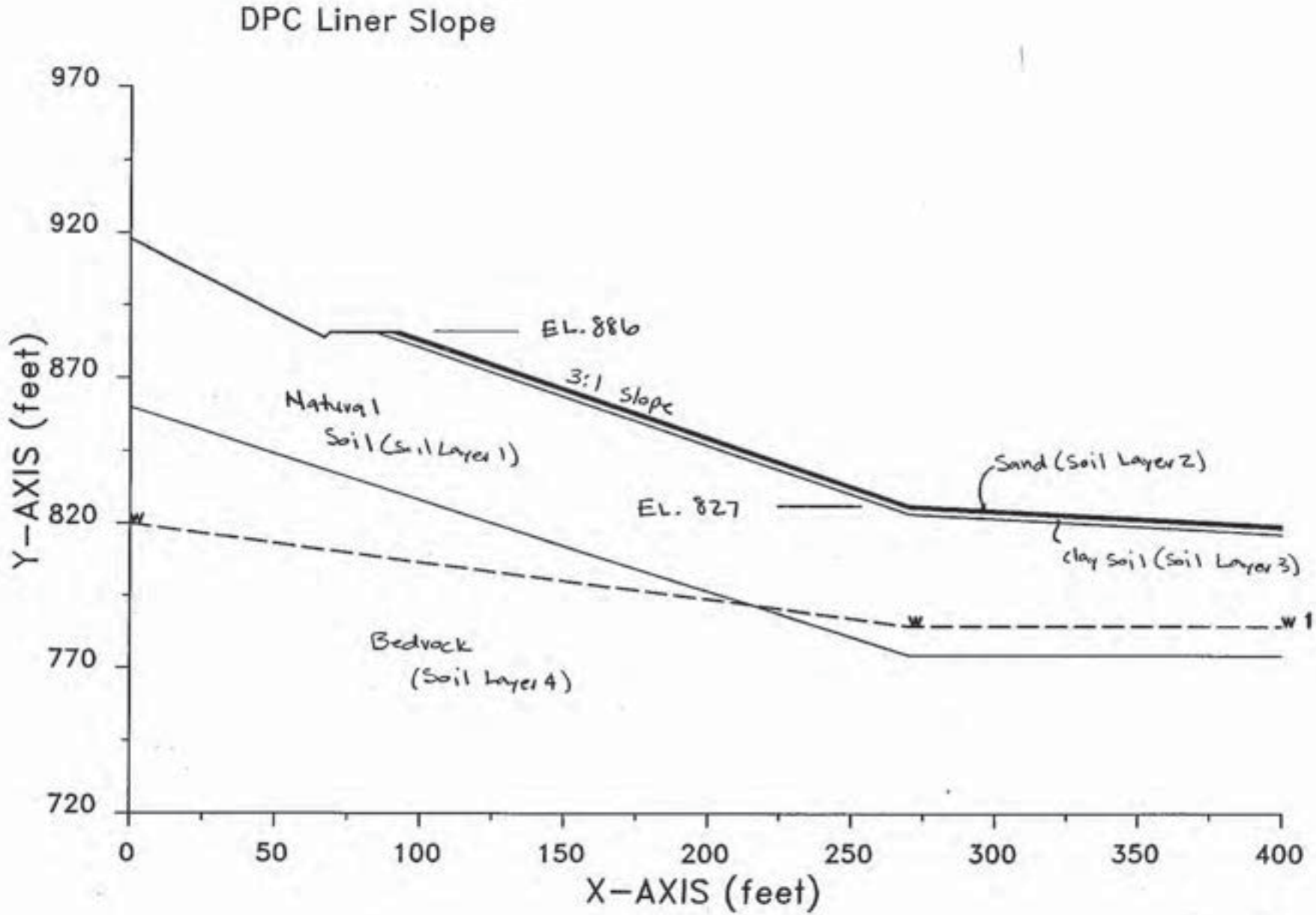



FIGURE J-1
DPC 3081.28

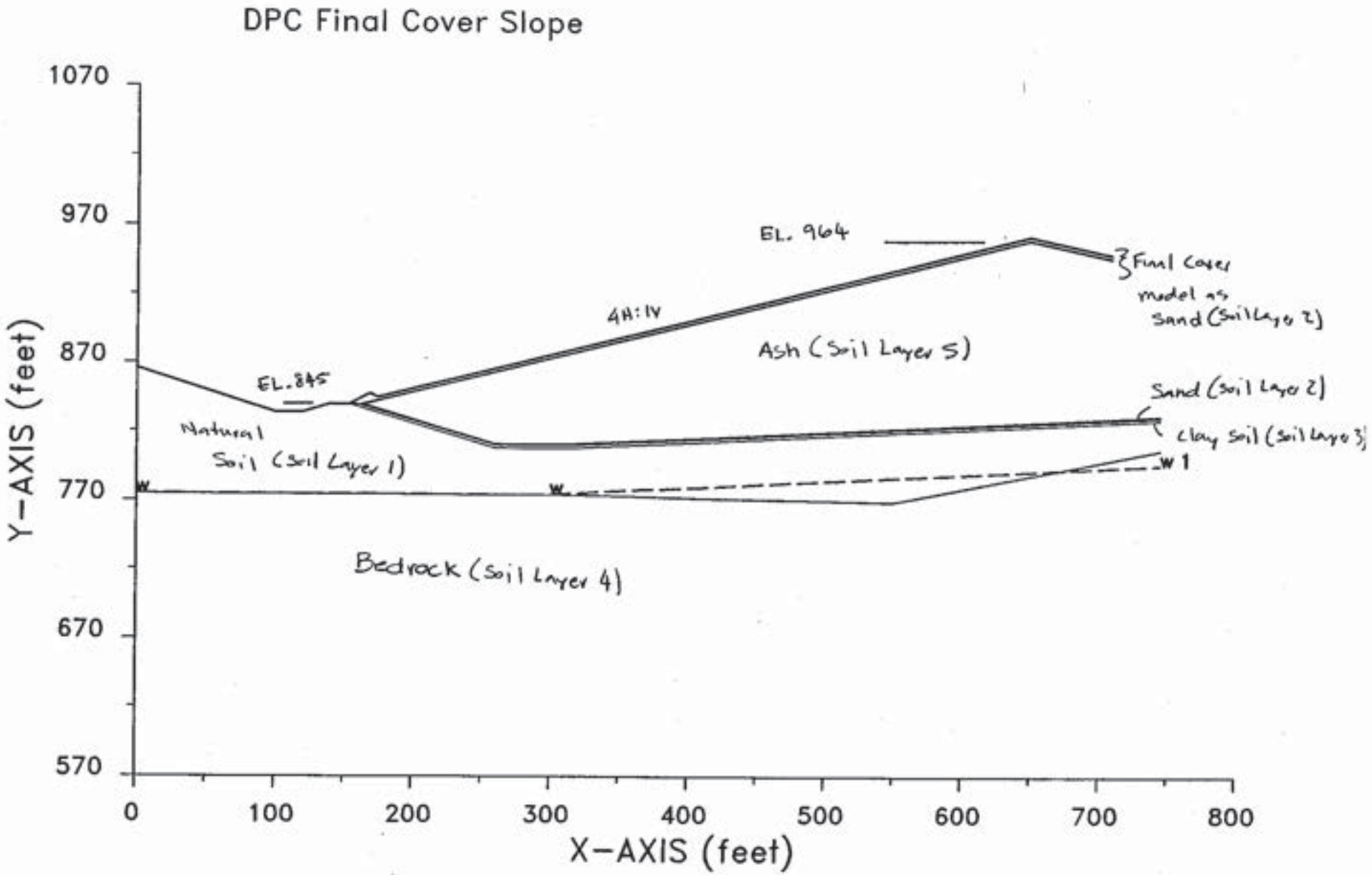



FIGURE J-2
DPC 3081.28

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| PROJECT/PROPOSAL NAME | PREPARED By: | PREPARED Date: | CHECKED By: | CHECKED Date: | PROJECT/PROPOSAL NO. |
|---|---|---|---|---|---|
| Dairyland Power Cooperative | JDH<br>Rev. BJK | 9/97<br>9/00 | PDC | 9/97 | 3081.40 |

## Assumptions

- Profile - The cross sections selected to be analyzed are representative of worst-case profiles with regard to slope stability. The longest and highest slopes were selected for modeling. The geologic setting and subgrade information was based on the information found on the geologic cross sections contained in this report.
- To simplify the analysis, the final cover is modeled as a single layer of soil, using sand soil characteristics. This assumption is minor due to the small thickness of the final cover relative to the thickness of waste.
- Groundwater - The water table is estimated to be at varying elevations of 775 to 799 feet through the cross section based on the groundwater elevation maps found in this report.
- A factor of safety of at least 1.3 is acceptable against global slope failures.
- The shear strength of the ash is based on published results of fly ash materials (Oweis, 1990). The results of these tests are as follows:

| MATERIAL | MC (%) | $\gamma_d$ (pcf) | c (psf) | $\phi$ (degrees) |
|---|---|---|---|---|
| DPC ash waste | 40 | 50 | 130 | 20 |

Notes:
MC = moisture content.
$\gamma_d$ = dry unit weight.
c = cohesion (psf).
$\phi$ = friction angle.

- Soil Parameters - Unit weight, friction angles, and cohesive strength parameters were estimated based on information gathered from boring logs contained in Appendix C of Addendum 3 for the Initial Site Report (RMT, 1995) and on geologic cross sections. Parameters were chosen based on their correlation with pocket penetration numbers and Plasticity Indices. Published values and engineering judgment were also considered to conservatively estimate the clay, soil, and waste characteristics, as presented in the following table:

| MATERIAL | $\gamma$ (pcf) | $\gamma$ Sat (pcf) | $\phi$ (degrees) | c (psf) |
|---|---|---|---|---|
| Natural soil | 120 | 120 | 20 | 200 |
| Sand | 110 | 110 | 30 | 0 |
| Clay soil | 125 | 125 | 25 | 400 |
| Bedrock | 145 | 145 | 45 | 10000 |
| Ash waste | 80 | 80 | 20 | 130 |

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| PROJECT/PROPOSAL NAME | PREPARED By: | Date: | CHECKED By: | Date: | PROJECT/PROPOSAL NO. |
|---|---|---|---|---|---|
| Dairyland Power Cooperative | JDH<br>Rev. BJK | 9/97<br>9/00 | PDC | 9/97 | 3081.40 |

## Results

- The results of the slope stability analysis are summarized below.

**Factors of Safety Against Circular Failure**

| | FACTOR OF SAFETY |
|---|---|
| Liner slope | 1.6 |
| Final cover slope | 1.8 |

- Based on the assumed soil strength parameters and slope conditions, the slopes of the liner and final cover will be stable under the specified modeled conditions.

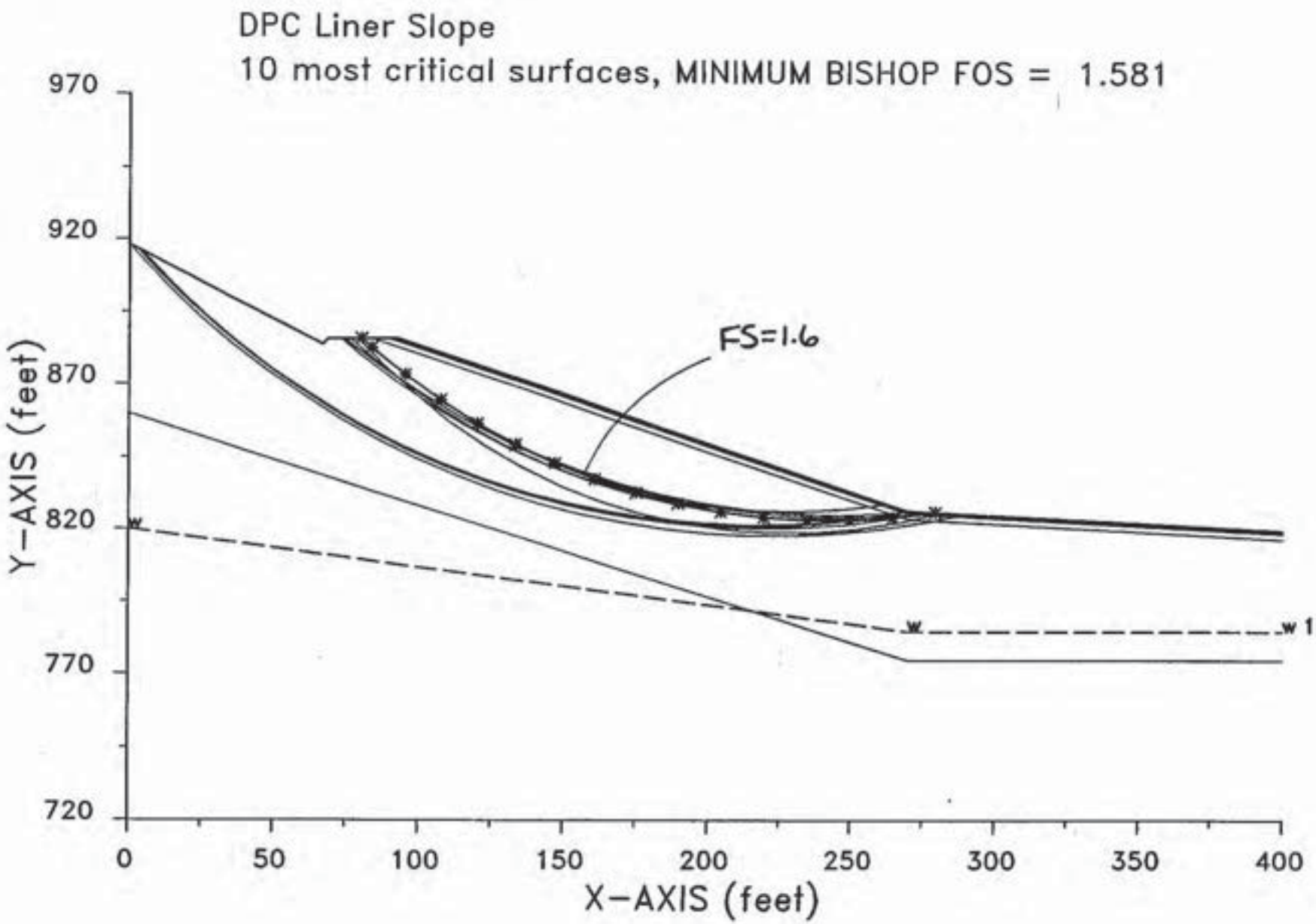
## References

Oweis, I. S. and R.P. Khera. 1990. Geotechnology of waste management. Butterworths, London.

RMT, Inc. 4/1995. Initial site report for Dairyland Power Cooperative.

Interactive Software Designs. 1994. XSTABL Slope Stability Computer Program. Moscow, Idaho.

# XSTABL Outputs


DPC Liner Slope
10 most critical surfaces, MINIMUM BISHOP FOS = 1.581
FS=1.6
Y-AXIS (feet)
X-AXIS (feet)
970
920
870
820
770
720
0
50
100
150
200
250
300
350
400
w
w
w 1

XSTABL File: LIN

```
*****************************************
*              X S T A B L              *
*                                       *
*        Slope Stability Analysis       *
*               using the               *
*            Method of Slices           *
*                                       *
*        Copyright (C) 1992 - 96        *
*   Interactive Software Designs, Inc.  *
*        Moscow, ID 83843, U.S.A.       *
*                                       *
*          All Rights Reserved          *
*                                       *
* Ver. 5.200                96 - 1460 *
*****************************************
```

Problem Description : DPC Liner Slope

✓ JDA 8/97

---

SEGMENT BOUNDARY COORDINATES

---

7 SURFACE boundary segments

| Segment No. | x-left (ft) | y-left (ft) | x-right (ft) | y-right (ft) | Soil Unit Below Segment |
|---|---|---|---|---|---|
| 1 | .0 | 918.0 | 67.0 | 884.0 | 1 |
| 2 | 67.0 | 884.0 | 69.0 | 886.0 | 1 |
| 3 | 69.0 | 886.0 | 84.0 | 886.0 | 1 |
| 4 | 84.0 | 886.0 | 90.0 | 886.0 | 3 |
| 5 | 90.0 | 886.0 | 93.0 | 886.0 | 2 |
| 6 | 93.0 | 886.0 | 270.0 | 827.0 | 2 |
| 7 | 270.0 | 827.0 | 400.0 | 820.0 | 2 |

6 SUBSURFACE boundary segments

| Segment No. | x-left (ft) | y-left (ft) | x-right (ft) | y-right (ft) | Soil Unit Below Segment |
|---|---|---|---|---|---|
| 1 | 90.0 | 886.0 | 270.0 | 826.0 | 3 |
| 2 | 270.0 | 826.0 | 400.0 | 819.0 | 3 |
| 3 | 84.0 | 886.0 | 270.0 | 824.0 | 1 |
| 4 | 270.0 | 824.0 | 400.0 | 817.0 | 1 |
| 5 | .0 | 860.0 | 270.0 | 775.0 | 4 |
| 6 | 270.0 | 775.0 | 400.0 | 775.0 | 4 |

---

ISOTROPIC Soil Parameters

---

4 Soil unit(s) specified

| Soil Unit No. | Unit Weight Moist (pcf) | Unit Weight Sat. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Pore Pressure Parameter Ru | Pore Pressure Constant (psf) | Water Surface No. |
|---|---|---|---|---|---|---|---|
| 1 | 120.0 | 120.0 | 200.0 | 20.00 | .000 | .0 | 1 - Natural Soil |
| 2 | 110.0 | 110.0 | .0 | 30.00 | .000 | .0 | 1 - Sand |
| 3 | 125.0 | 125.0 | 400.0 | 25.00 | .000 | .0 | 1 - Clay Soil |
| 4 | 145.0 | 145.0 | 10000.0 | 45.00 | .000 | .0 | 1 - Bedrock |

1 Water surface(s) have been specified

Unit weight of water = 62.40 (pcf)

Water Surface No. 1 specified by 3 coordinate points

**********
PHREATIC SURFACE,
**********

| Point No. | x-water (ft) | y-water (ft) |
|---|---|---|
| 1 | .00 | 820.00 |
| 2 | 270.00 | 785.00 |
| 3 | 400.00 | 785.00 |

A critical failure surface searching method, using a random technique for generating CIRCULAR surfaces has been specified.

400 trial surfaces will be generated and analyzed.

20 Surfaces initiate from each of 20 points equally spaced along the ground surface between x = 250.0 ft
and x = 290.0 ft

Each surface terminates between x = .0 ft
and x = 90.0 ft

Unless further limitations were imposed, the minimum elevation at which a surface extends is y = .0 ft

15.0 ft line segments define each trial failure surface.

---
ANGULAR RESTRICTIONS
---

The first segment of each failure surface will be inclined within the angular range defined by :

Lower angular limit := -45.0 degrees
Upper angular limit := (slope angle - 5.0) degrees

Factors of safety have been calculated by the :

* * * * * SIMPLIFIED BISHOP METHOD * * * * *

The most critical circular failure surface is specified by 16 coordinate points

| Point No. | x-surf (ft) | y-surf (ft) |
|---|---|---|
| 1 | 279.47 | 826.49 |
| 2 | 264.59 | 824.66 |
| 3 | 249.61 | 823.77 |
| 4 | 234.61 | 823.79 |
| 5 | 219.64 | 824.75 |
| 6 | 204.76 | 826.63 |
| 7 | 190.02 | 829.43 |
| 8 | 175.49 | 833.14 |
| 9 | 161.21 | 837.74 |
| 10 | 147.25 | 843.21 |
| 11 | 133.65 | 849.54 |
| 12 | 120.46 | 856.70 |
| 13 | 107.75 | 864.66 |
| 14 | 95.55 | 873.39 |
| 15 | 83.92 | 882.86 |
| 16 | 80.52 | 886.00 |

**** Simplified BISHOP FOS = 1.581 ****

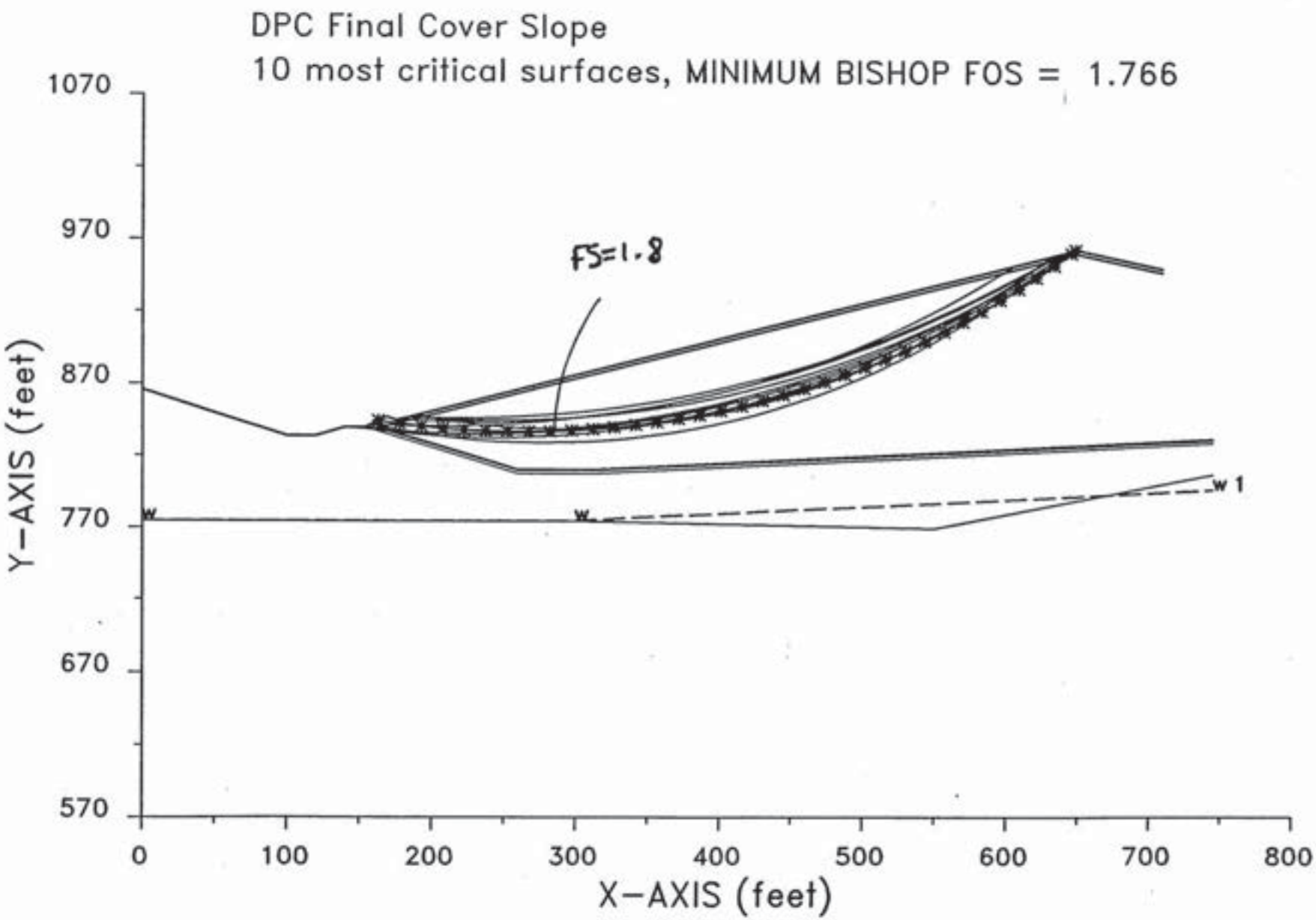
The following is a summary of the TEN most critical surfaces

Problem Description : DPC Liner Slope

| | FOS (BISHOP) | Circle Center x-coord (ft) | Circle Center y-coord (ft) | Radius (ft) | Initial x-coord (ft) | Terminal x-coord (ft) | Resisting Moment (ft-lb) |
|---|---|---|---|---|---|---|---|
| 1. | 1.581 | 242.58 | 1065.87 | 242.21 | 279.47 | 80.52 | 4.571E+07 |
| 2. | 1.583 | 240.37 | 1080.10 | 256.18 | 277.37 | 73.34 | 5.172E+07 |
| 3. | 1.588 | 217.22 | 1112.22 | 290.31 | 271.05 | 2.88 | 9.804E+07 |
| 4. | 1.588 | 222.43 | 1115.96 | 297.80 | 290.00 | .10 | 1.125E+08 |
| 5. | 1.589 | 245.92 | 1099.38 | 273.91 | 273.16 | 74.27 | 5.033E+07 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 6. | 1.590 | 228.19 | 1018.10 | 199.02 | 281.58 | 79.45 | 4.717E+07 |
| 7. | 1.590 | 246.76 | 1096.56 | 272.04 | 279.47 | 74.66 | 5.171E+07 |
| 8. | 1.590 | 219.48 | 1112.23 | 291.43 | 277.37 | 4.12 | 1.004E+08 |
| 9. | 1.592 | 215.31 | 1104.38 | 282.98 | 271.05 | 4.55 | 9.690E+07 |
| 10. | 1.592 | 227.51 | 1048.57 | 221.91 | 262.63 | 76.64 | 4.135E+07 |

* * * END OF FILE * * *


DPC Final Cover Slope
10 most critical surfaces, MINIMUM BISHOP FOS = 1.766
FS=1.8
w
w
w 1
1070
970
870
770
670
570
Y-AXIS (feet)
0
100
200
300
400
500
600
700
800
X-AXIS (feet)

XSTABL File: COVER 8-26-97 8:38

```
*****************************************
*              X S T A B L              *
*                                       *
*        Slope Stability Analysis       *
*               using the               *
*            Method of Slices           *
*                                       *
*        Copyright (C) 1992 - 96        *
*   Interactive Software Designs, Inc.  *
*        Moscow, ID 83843, U.S.A.       *
*                                       *
*          All Rights Reserved          *
*                                       *
* Ver. 5.200                96 - 1460 *
*****************************************
```

Problem Description : DPC Final Cover Slope

---

SEGMENT BOUNDARY COORDINATES

---

✓JOH 8/97

9 SURFACE boundary segments

| Segment No. | x-left (ft) | y-left (ft) | x-right (ft) | y-right (ft) | Soil Unit Below Segment |
|---|---|---|---|---|---|
| 1 | .0 | 866.0 | 100.0 | 834.0 | 1 |
| 2 | 100.0 | 834.0 | 120.0 | 834.0 | 1 |
| 3 | 120.0 | 834.0 | 140.0 | 840.0 | 1 |
| 4 | 140.0 | 840.0 | 154.0 | 840.0 | 1 |
| 5 | 154.0 | 840.0 | 168.0 | 847.0 | 2 |
| 6 | 168.0 | 847.0 | 170.0 | 847.0 | 2 |
| 7 | 170.0 | 847.0 | 175.0 | 845.0 | 2 |
| 8 | 175.0 | 845.0 | 650.0 | 964.0 | 2 |
| 9 | 650.0 | 964.0 | 710.0 | 951.0 | 2 |

17 SUBSURFACE boundary segments

| Segment No. | x-left (ft) | y-left (ft) | x-right (ft) | y-right (ft) | Soil Unit Below Segment |
|---|---|---|---|---|---|
| 1 | 162.0 | 839.4 | 650.0 | 961.5 | 2 |
| 2 | 650.0 | 961.5 | 710.0 | 948.5 | 2 |
| 3 | 164.5 | 839.6 | 650.0 | 961.0 | 5 |
| 4 | 650.0 | 961.0 | 710.0 | 948.0 | 5 |
| 5 | 164.5 | 839.6 | 260.0 | 811.0 | 2 |
| 6 | 260.0 | 811.0 | 315.0 | 811.0 | 2 |
| 7 | 315.0 | 811.0 | 745.0 | 833.0 | 2 |
| 8 | 154.0 | 840.0 | 160.0 | 840.0 | 3 |
| 9 | 160.0 | 840.0 | 260.0 | 810.0 | 3 |
| 10 | 260.0 | 810.0 | 315.0 | 810.0 | 3 |

| | | | | | |
|---|---|---|---|---|---|
| 11 | 315.0 | 810.0 | 745.0 | 832.0 | 3 |
| 12 | 154.0 | 840.0 | 260.0 | 808.0 | 1 |
| 13 | 260.0 | 808.0 | 315.0 | 808.0 | 1 |
| 14 | 315.0 | 808.0 | 745.0 | 830.0 | 1 |
| 15 | .0 | 775.0 | 300.0 | 775.0 | 4 |
| 16 | 300.0 | 775.0 | 550.0 | 770.0 | 4 |
| 17 | 550.0 | 770.0 | 745.0 | 808.0 | 4 |

---
ISOTROPIC Soil Parameters
---

5 Soil unit(s) specified

| Soil Unit No. | Unit Weight Moist (pcf) | Unit Weight Sat. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Pore Pressure Parameter Ru | Pore Pressure Constant (psf) | Water Surface No. | |
|---|---|---|---|---|---|---|---|---|
| 1 | 120.0 | 120.0 | 200.0 | 20.00 | .000 | .0 | 1 | Natural Soil |
| 2 | 110.0 | 110.0 | .0 | 30.00 | .000 | .0 | 1 | Sand |
| 3 | 125.0 | 125.0 | 400.0 | 25.00 | .000 | .0 | 1 | Clay Soil |
| 4 | 145.0 | 145.0 | 10000.0 | 45.00 | .000 | .0 | 1 | Bedrock |
| 5 | 80.0 | 80.0 | 130.0 | 20.00 | .000 | .0 | 1 | Ash |

1 Water surface(s) have been specified

Unit weight of water = 62.40 (pcf)

Water Surface No. 1 specified by 3 coordinate points

**********
PHREATIC SURFACE,
**********

| Point No. | x-water (ft) | y-water (ft) |
|---|---|---|
| 1 | .00 | 775.00 |
| 2 | 300.00 | 775.00 |
| 3 | 745.00 | 797.00 |

A critical failure surface searching method, using a random technique for generating CIRCULAR surfaces has been specified.

400 trial surfaces will be generated and analyzed.

20 Surfaces initiate from each of 20 points equally spaced along the ground surface between x = 100.0 ft
and x = 200.0 ft

Each surface terminates between x = 550.0 ft

and x = 650.0 ft

Unless further limitations were imposed, the minimum elevation
at which a surface extends is y = .0 ft

15.0 ft line segments define each trial failure surface.

---
ANGULAR RESTRICTIONS
---

The first segment of each failure surface will be inclined
within the angular range defined by :

Lower angular limit := -45.0 degrees
Upper angular limit := (slope angle - 5.0) degrees

Factors of safety have been calculated by the :

* * * * * SIMPLIFIED BISHOP METHOD * * * * *

The most critical circular failure surface
is specified by 36 coordinate points

| Point No. | x-surf (ft) | y-surf (ft) |
|---|---|---|
| 1 | 163.16 | 844.58 |
| 2 | 178.01 | 842.44 |
| 3 | 192.90 | 840.65 |
| 4 | 207.83 | 839.20 |
| 5 | 222.79 | 838.10 |
| 6 | 237.77 | 837.34 |
| 7 | 252.76 | 836.93 |
| 8 | 267.76 | 836.86 |
| 9 | 282.76 | 837.14 |
| 10 | 297.75 | 837.77 |
| 11 | 312.72 | 838.74 |
| 12 | 327.66 | 840.06 |
| 13 | 342.57 | 841.72 |
| 14 | 357.43 | 843.72 |
| 15 | 372.25 | 846.06 |
| 16 | 387.00 | 848.75 |
| 17 | 401.70 | 851.78 |
| 18 | 416.31 | 855.14 |
| 19 | 430.85 | 858.84 |
| 20 | 445.30 | 862.87 |
| 21 | 459.65 | 867.24 |
| 22 | 473.89 | 871.94 |
| 23 | 488.03 | 876.96 |

| | | |
|---|---|---|
| 24 | 502.04 | 882.31 |
| 25 | 515.93 | 887.98 |
| 26 | 529.68 | 893.97 |
| 27 | 543.29 | 900.27 |
| 28 | 556.75 | 906.89 |
| 29 | 570.06 | 913.81 |
| 30 | 583.20 | 921.04 |
| 31 | 596.17 | 928.57 |
| 32 | 608.97 | 936.40 |
| 33 | 621.58 | 944.52 |
| 34 | 634.00 | 952.93 |
| 35 | 646.23 | 961.63 |
| 36 | 649.10 | 963.77 |

**** Simplified BISHOP FOS = 1.766 ****

The following is a summary of the TEN most critical surfaces

Problem Description : DPC Final Cover Slope

| | FOS (BISHOP) | Circle Center x-coord (ft) | Circle Center y-coord (ft) | Radius (ft) | Initial x-coord (ft) | Terminal x-coord (ft) | Resisting Moment (ft-lb) |
|---|---|---|---|---|---|---|---|
| 1. | 1.766 | 263.14 | 1487.27 | 650.42 | 163.16 | 649.10 | 3.560E+08 |
| 2. | 1.772 | 245.10 | 1579.89 | 735.11 | 184.21 | 644.14 | 3.177E+08 |
| 3. | 1.781 | 291.69 | 1377.57 | 538.73 | 189.47 | 631.14 | 2.805E+08 |
| 4. | 1.782 | 277.11 | 1389.77 | 560.64 | 157.89 | 638.35 | 3.532E+08 |
| 5. | 1.786 | 228.21 | 1584.42 | 749.38 | 142.11 | 647.53 | 4.003E+08 |
| 6. | 1.786 | 201.38 | 1697.08 | 856.23 | 157.89 | 639.17 | 3.588E+08 |
| 7. | 1.790 | 222.48 | 1597.73 | 761.99 | 142.11 | 642.84 | 3.896E+08 |
| 8. | 1.790 | 219.39 | 1665.49 | 818.94 | 184.21 | 636.06 | 3.063E+08 |
| 9. | 1.791 | 244.31 | 1492.11 | 659.28 | 147.37 | 633.16 | 3.638E+08 |
| 10. | 1.791 | 233.61 | 1533.39 | 689.57 | 178.95 | 605.85 | 2.576E+08 |

* * * END OF FILE * * *

# Revised Location Demonstrations Studies

# ASCE 7 Hazards Report

**Address:**
No Address at This Location

**Standard:** ASCE/SEI 7-22
**Risk Category:** III
**Soil Class:** D - Stiff Soil

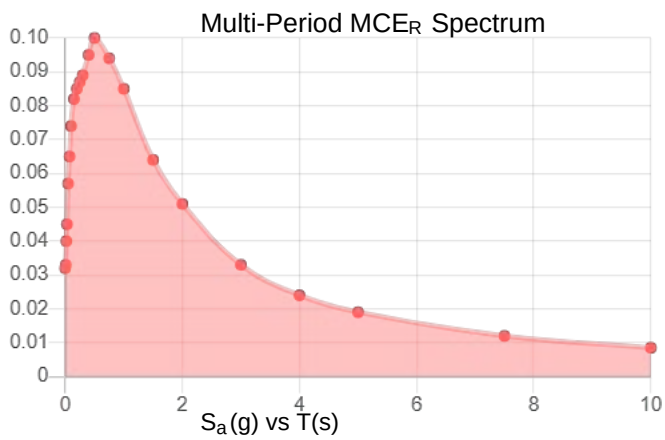
**Elevation:** 810.56 ft (NAVD 88)
**Latitude:** 44.29
**Longitude:** -91.876

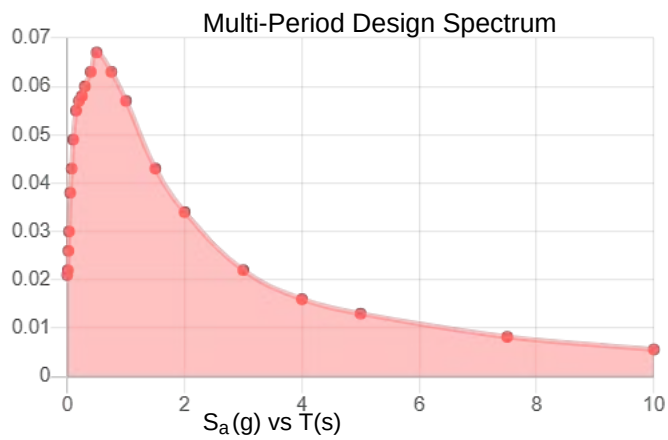
# Seismic

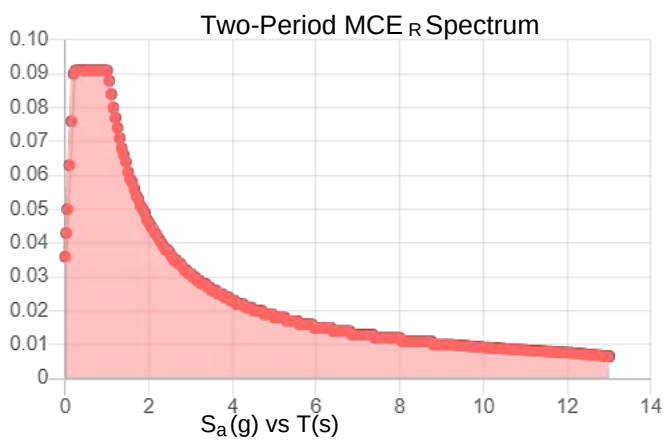
**Site Soil Class:**

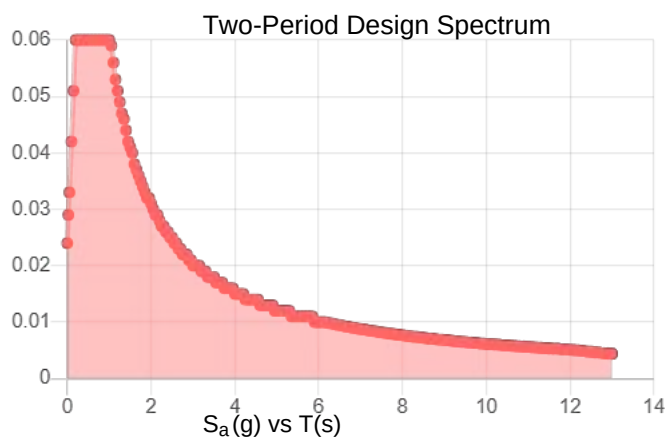
**Results:**

| | | | |
|---|---|---|---|
| $PGA_M$ : | 0.029 | $T_L$ : | 12 |
| $S_{MS}$ : | 0.091 | $S_S$ : | 0.056 |
| $S_{M1}$ : | 0.092 | $S_1$ : | 0.04 |
| $S_{DS}$ : | 0.06 | $S_{DC}$ : | |
| $S_{D1}$ : | 0.061 | $V_{S30}$ : | 260 |




MCE$_R$ Vertical Response Spectrum

Vertical ground motion data has not yet been made available by USGS.

Design Vertical Response Spectrum

Vertical ground motion data has not yet been made available by USGS.

**Data Accessed:** **Tue Oct 18 2022**

**Date Source:**

**USGS Seismic Design Maps based on ASCE/SEI 7-22 and ASCE/SEI 7-22 Table 1.5-2. Additional data for site-specific ground motion procedures in accordance with ASCE/SEI 7-22 Ch. 21 are available from USGS.**

**The ASCE 7 Hazard Tool is provided for your convenience, for informational purposes only, and is provided "as is" and without warranties of any kind. The location data included herein has been obtained from information developed, produced, and maintained by third party providers; or has been extrapolated from maps incorporated in the ASCE 7 standard. While ASCE has made every effort to use data obtained from reliable sources or methodologies, ASCE does not make any representations or warranties as to the accuracy, completeness, reliability, currency, or quality of any data provided herein. Any third-party links provided by this Tool should not be construed as an endorsement, affiliation, relationship, or sponsorship of such third-party content by or from ASCE.**

**ASCE does not intend, nor should anyone interpret, the results provided by this Tool to replace the sound judgment of a competent professional, having knowledge and experience in the appropriate field(s) of practice, nor to substitute for the standard of care required of such professionals in interpreting and applying the contents of this Tool or the ASCE 7 standard.**

**In using this Tool, you expressly assume all risks associated with your use. Under no circumstances shall ASCE or its officers, directors, employees, members, affiliates, or agents be liable to you or any other person for any direct, indirect, special, incidental, or consequential damages arising from or related to your use of, or reliance on, the Tool or any information obtained therein. To the fullest extent permitted by law, you agree to release and hold harmless ASCE from any and all liability of any nature arising out of or resulting from any use of data provided by the ASCE 7 Hazard Tool.**

# 2022 Earthquake Fault Map

10/18/2022, 10:29:42 AM

1:18,489,298

0 180 360 720 mi

0 280 560 1,120 km

Fault Areas

- Class B
- historic
- late Quaternary
- latest Quaternary
- middle and late Quaternary

National Database

- Historic (< 150 years), well constrained location
- Historic (< 150 years), moderately constrained location
- Historic (< 150 years), inferred location
- Latest Quaternary (<15,000 years), well constrained location
- Latest Quaternary (<15,000 years), moderately constrained location
- Latest Quaternary (<15,000 years), inferred location
- Late Quaternary (< 130,000 years), well constrained location
- Late Quaternary (< 130,000 years), moderately contrained location
- Late Quaternary (< 130,000 years), inferred location
- Middle and late Quaternary (< 750,000 years), well constrained location
- Middle and late Quaternary (< 750,000 years), moderately constrained location
- Middle and late Quaternary (< 750,000 years), inferred location
- Undifferentiated Quaternary (< 1.6 million years), well constrained location
- Undifferentiated Quaternary (< 1.6 million years), moderately constrained location
- Undifferentiated Quaternary (< 1.6 million years), inferred location

National Geographic, Esri, Garmin, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.

USGS

National Geographic, Esri, Garmin, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp. | USGS |

# Appendix E: Endangered Species/Critical Habitats Demonstration

# United States Department of the Interior

FISH AND WILDLIFE SERVICE
Minnesota-Wisconsin Ecological Services Field Office
3815 American Blvd East
Bloomington, MN 55425-1659
Phone: (952) 858-0793 Fax: (952) 646-2873


In Reply Refer To: December 07, 2022
Project Code: 2023-0022822
Project Name: Alma Off-Site Disposal Facility, Phase IV Landfill

Subject: List of threatened and endangered species that may occur in your proposed project location or may be affected by your proposed project

To Whom It May Concern:

This response has been generated by the Information, Planning, and Conservation (IPaC) system to provide information on natural resources that could be affected by your project. The U.S. Fish and Wildlife Service (Service) provides this response under the authority of the Endangered Species Act of 1973 (16 U.S.C. 1531-1543), the Bald and Golden Eagle Protection Act (16 U.S.C. 668-668d), the Migratory Bird Treaty Act (16 U.S.C. 703-712), and the Fish and Wildlife Coordination Act (16 U.S.C. 661 *et seq.*).

**Threatened and Endangered Species**
The enclosed species list identifies threatened, endangered, proposed and candidate species, as well as proposed and final designated critical habitat, that may occur within the boundary of your proposed project and may be affected by your proposed project. The species list fulfills the requirement for obtaining a Technical Assistance Letter from the U.S. Fish and Wildlife Service under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. Note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days. The Service recommends that verification be completed by visiting the ECOS IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through the ECOS IPaC system by completing the same process used to receive the enclosed list.

**Consultation Technical Assistance**
Please refer to refer to our Section 7 website for guidance and technical assistance, including step-by-step instructions for making effects determinations for each species that might be present and for specific guidance on the following types of projects: projects in developed areas, HUD, CDBG, EDA, pipelines, buried utilities, telecommunications, and requests for a Conditional Letter of Map Revision (CLOMR) from FEMA.

**Using the IPaC Official Species List to Make No Effect and May Affect Determinations for Listed Species**

1. If IPaC returns a result of "There are no listed species found within the vicinity of the project," then project proponents can conclude the proposed activities will have **no effect** on any federally listed species under Service jurisdiction. Concurrence from the Service is not required for **no effect** determinations. No further consultation or coordination is required. Attach this letter to the dated IPaC species list report for your records.
2. If IPaC returns one or more federally listed, proposed, or candidate species as potentially present in the action area of the proposed project – other than bats (see below) – then project proponents must determine if proposed activities will have **no effect** on or **may affect** those species. For assistance in determining if suitable habitat for listed, candidate, or proposed species occurs within your project area or if species may be affected by project activities, you can obtain Life History Information for Listed and Candidate Species on our office website. If no impacts will occur to a species on the IPaC species list (e.g., there is no habitat present in the project area), the appropriate determination is **no effect**. No further consultation or coordination is required. Attach this letter to the dated IPaC species list report for your records.
3. Should you determine that project activities **may affect** any federally listed, please contact our office for further coordination. Letters with requests for consultation or correspondence about your project should include the Consultation Tracking Number in the header. Electronic submission is preferred.

**Northern Long-Eared Bats**

Northern long-eared bats occur throughout Minnesota and Wisconsin and the information below may help in determining if your project may affect these species.

This species hibernates in caves or mines only during the winter. In Minnesota and Wisconsin, the hibernation season is considered to be November 1 to March 31. During the active season (April 1 to October 31) they roost in forest and woodland habitats. Suitable summer habitat for northern long-eared bats consists of a wide variety of forested/wooded habitats where they roost, forage, and travel and may also include some adjacent and interspersed non-forested habitats such as emergent wetlands and adjacent edges of agricultural fields, old fields and pastures. This includes forests and woodlots containing potential roosts (i.e., live trees and/or snags ≥3 inches dbh for northern long-eared bat that have exfoliating bark, cracks, crevices, and/or hollows), as well as linear features such as fencerows, riparian forests, and other wooded corridors. These wooded areas may be dense or loose aggregates of trees with variable amounts of canopy closure. Individual trees may be considered suitable habitat when they exhibit the characteristics of a potential roost tree and are located within 1,000 feet (305 meters) of forested/wooded habitat. Northern long-eared bats have also been observed roosting in human-made structures, such as buildings, barns, bridges, and bat houses; therefore, these structures should also be considered potential summer habitat and evaluated for use by bats. If your project will impact caves or mines or will involve clearing forest or woodland habitat containing suitable roosting habitat, northern long-eared bats could be affected.

Examples of unsuitable habitat include:

- Individual trees that are greater than 1,000 feet from forested or wooded areas,
- Trees found in highly developed urban areas (e.g., street trees, downtown areas),

- A pure stand of less than 3-inch dbh trees that are not mixed with larger trees, and
- A stand of eastern red cedar shrubby vegetation with no potential roost trees.

If IPaC returns a result that northern long-eared bats are potentially present in the action area of the proposed project, project proponents can conclude the proposed activities **may affect** this species **IF** one or more of the following activities are proposed:

- Clearing or disturbing suitable roosting habitat, as defined above, at any time of year,
- Any activity in or near the entrance to a cave or mine,
- Mining, deep excavation, or underground work within 0.25 miles of a cave or mine,
- Construction of one or more wind turbines, or
- Demolition or reconstruction of human-made structures that are known to be used by bats based on observations of roosting bats, bats emerging at dusk, or guano deposits or stains.

*If none of the above activities are proposed*, project proponents can conclude the proposed activities will have **no effect** on the northern long-eared bat. Concurrence from the Service is not required for **No Effect** determinations. No further consultation or coordination is required. Attach this letter to the dated IPaC species list report for your records.

*If any of the above activities are proposed*, please use the northern long-eared bat determination key in IPaC. This tool streamlines consultation under the 2016 rangewide programmatic biological opinion for the 4(d) rule. The key helps to determine if prohibited take might occur and, if not, will generate an automated verification letter. No further review by us is necessary.

*Please note that on March 23, 2022, the Service published a proposal to reclassify the northern long-eared bat as endangered under the Endangered Species Act. The U.S. District Court for the District of Columbia has ordered the Service to complete a new final listing determination for the bat by November 2022 (Case 1:15-cv-00477, March 1, 2021). The bat, currently listed as threatened, faces extinction due to the range-wide impacts of white-nose syndrome (WNS), a deadly fungal disease affecting cave-dwelling bats across the continent. The proposed reclassification, if finalized, would remove the current 4(d) rule for the NLEB, as these rules may be applied only to threatened species. Depending on the type of effects a project has on NLEB, the change in the species' status may trigger the need to re-initiate consultation for any actions that are not completed and for which the Federal action agency retains discretion once the new listing determination becomes effective (anticipated to occur by December 30, 2022). If your project may result in incidental take of northern long-eared bats after the new listing goes into effect this will first need to addressed in an updated consultation that includes an Incidental Take Statement. If your project may require re-initiation of consultation, please contact our office for additional guidance.*

**Whooping Crane**

Whooping crane is designated as a non-essential experimental population in Wisconsin and consultation under Section 7(a)(2) of the Endangered Species Act is only required if project activities will occur within a National Wildlife Refuge or National Park. If project activities are proposed on lands outside of a National Wildlife Refuge or National Park, then you are not required to consult. For additional information on this designation and consultation requirements, please review "Establishment of a Nonessential Experimental Population of

Whooping Cranes in the Eastern United States."

**Other Trust Resources and Activities**

*Bald and Golden Eagles* - Although the bald eagle has been removed from the endangered species list, this species and the golden eagle are protected by the Bald and Golden Eagle Act and the Migratory Bird Treaty Act. Should bald or golden eagles occur within or near the project area please contact our office for further coordination. For communication and wind energy projects, please refer to additional guidelines below.

*Migratory Birds* - The Migratory Bird Treaty Act (MBTA) prohibits the taking, killing, possession, transportation, and importation of migratory birds, their eggs, parts, and nests, except when specifically authorized by the Service. The Service has the responsibility under the MBTA to proactively prevent the mortality of migratory birds whenever possible and we encourage implementation of recommendations that minimize potential impacts to migratory birds. Such measures include clearing forested habitat outside the nesting season (generally March 1 to August 31) or conducting nest surveys prior to clearing to avoid injury to eggs or nestlings.

*Communication Towers* - Construction of new communications towers (including radio, television, cellular, and microwave) creates a potentially significant impact on migratory birds, especially some 350 species of night-migrating birds. However, the Service has developed voluntary guidelines for minimizing impacts.

*Transmission Lines* - Migratory birds, especially large species with long wingspans, heavy bodies, and poor maneuverability can also collide with power lines. In addition, mortality can occur when birds, particularly hawks, eagles, kites, falcons, and owls, attempt to perch on uninsulated or unguarded power poles. To minimize these risks, please refer to guidelines developed by the Avian Power Line Interaction Committee and the Service. Implementation of these measures is especially important along sections of lines adjacent to wetlands or other areas that support large numbers of raptors and migratory birds.

*Wind Energy* - To minimize impacts to migratory birds and bats, wind energy projects should follow the Service's Wind Energy Guidelines. In addition, please refer to the Service's Eagle Conservation Plan Guidance, which provides guidance for conserving bald and golden eagles in the course of siting, constructing, and operating wind energy facilities.

**State Department of Natural Resources Coordination**

While it is not required for your Federal section 7 consultation, please note that additional state endangered or threatened species may also have the potential to be impacted. Please contact the Minnesota or Wisconsin Department of Natural Resources for information on state listed species that may be present in your proposed project area.

*Minnesota*
Minnesota Department of Natural Resources - Endangered Resources Review Homepage
Email: Review.NHIS@state.mn.us

*Wisconsin*
Wisconsin Department of Natural Resources - Endangered Resources Review Homepage
Email: DNRERReview@wi.gov

We appreciate your concern for threatened and endangered species. Please feel free to contact our office with questions or for additional information.

Attachment(s):

- Official Species List
- USFWS National Wildlife Refuges and Fish Hatcheries
- Migratory Birds
- Wetlands

# Official Species List

This list is provided pursuant to Section 7 of the Endangered Species Act, and fulfills the requirement for Federal agencies to "request of the Secretary of the Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action".

This species list is provided by:

**Minnesota-Wisconsin Ecological Services Field Office**
3815 American Blvd East
Bloomington, MN 55425-1659
(952) 858-0793

# Project Summary

Project Code: 2023-0022822
Project Name: Alma Off-Site Disposal Facility, Phase IV Landfill
Project Type: Landfill - Solid Waste
Project Description: Data request for plan modification for initial permitting of coal combustion residual (CCR) landfills.
Project Location:

Approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/@44.289800850000006,-91.87516053879101,14z

Counties: Buffalo County, Wisconsin

# Endangered Species Act Species

There is a total of 4 threatened, endangered, or candidate species on this species list.

Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species.

IPaC does not display listed species or critical habitats under the sole jurisdiction of NOAA Fisheries[1], as USFWS does not have the authority to speak on behalf of NOAA and the Department of Commerce.

See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

---

1. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

## Mammals

| NAME | STATUS |
|---|---|
| Northern Long-eared Bat *Myotis septentrionalis*<br>No critical habitat has been designated for this species.<br>Species profile: https://ecos.fws.gov/ecp/species/9045 | Endangered |

## Clams

| NAME | STATUS |
|---|---|
| Higgins Eye (pearlymussel) *Lampsilis higginsii*<br>No critical habitat has been designated for this species.<br>Species profile: https://ecos.fws.gov/ecp/species/5428 | Endangered |
| Sheepnose Mussel *Plethobasus cyphyus*<br>No critical habitat has been designated for this species.<br>Species profile: https://ecos.fws.gov/ecp/species/6903 | Endangered |

## Insects

| NAME | STATUS |
|---|---|
| Monarch Butterfly *Danaus plexippus*<br>No critical habitat has been designated for this species.<br>Species profile: https://ecos.fws.gov/ecp/species/9743 | Candidate |

## Critical habitats

THERE ARE NO CRITICAL HABITATS WITHIN YOUR PROJECT AREA UNDER THIS OFFICE'S JURISDICTION.

# USFWS National Wildlife Refuge Lands And Fish Hatcheries

Any activity proposed on lands managed by the National Wildlife Refuge system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

THERE ARE NO REFUGE LANDS OR FISH HATCHERIES WITHIN YOUR PROJECT AREA.

# Migratory Birds

Certain birds are protected under the Migratory Bird Treaty Act[1] and the Bald and Golden Eagle Protection Act[2].

Any person or organization who plans or conducts activities that may result in impacts to migratory birds, eagles, and their habitats should follow appropriate regulations and consider implementing appropriate conservation measures, as described below.

---

1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.
3. 50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)

**The birds listed below are birds of particular concern either because they occur on the USFWS Birds of Conservation Concern (BCC) list or warrant special attention in your project location.** To learn more about the levels of concern for birds on your list and how this list is generated, see the FAQ below. This is not a list of every bird you may find in this location, nor a guarantee that every bird on this list will be found in your project area. To see exact locations of where birders and the general public have sighted birds in and around your project area, visit the E-bird data mapping tool (Tip: enter your location, desired date range and a species on your list). For projects that occur off the Atlantic Coast, additional maps and models detailing the relative occurrence and abundance of bird species on your list are available. Links to additional information about Atlantic Coast birds, and other important information about your migratory bird list, including how to properly interpret and use your migratory bird report, can be found below.

For guidance on when to schedule activities or implement avoidance and minimization measures to reduce impacts to migratory birds on your list, click on the PROBABILITY OF PRESENCE SUMMARY at the top of your list to see when these birds are most likely to be present and breeding in your project area.

| NAME | BREEDING SEASON |
|---|---|
| Bald Eagle *Haliaeetus leucocephalus*<br>This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. | Breeds Dec 1 to Aug 31 |
| Black Tern *Chlidonias niger*<br>This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.<br>https://ecos.fws.gov/ecp/species/3093 | Breeds May 15 to Aug 20 |

| NAME | BREEDING SEASON |
|---|---|
| Black-billed Cuckoo *Coccyzus erythropthalmus*<br>This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.<br>https://ecos.fws.gov/ecp/species/9399 | Breeds May 15 to Oct 10 |
| Bobolink *Dolichonyx oryzivorus*<br>This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. | Breeds May 20 to Jul 31 |
| Canada Warbler *Cardellina canadensis*<br>This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. | Breeds May 20 to Aug 10 |
| Chimney Swift *Chaetura pelagica*<br>This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. | Breeds Mar 15 to Aug 25 |
| Eastern Whip-poor-will *Antrostomus vociferus*<br>This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. | Breeds May 1 to Aug 20 |
| Golden Eagle *Aquila chrysaetos*<br>This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.<br>https://ecos.fws.gov/ecp/species/1680 | Breeds elsewhere |
| Henslow's Sparrow *Ammodramus henslowii*<br>This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.<br>https://ecos.fws.gov/ecp/species/3941 | Breeds May 1 to Aug 31 |
| Lesser Yellowlegs *Tringa flavipes*<br>This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.<br>https://ecos.fws.gov/ecp/species/9679 | Breeds elsewhere |
| Red-headed Woodpecker *Melanerpes erythrocephalus*<br>This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. | Breeds May 10 to Sep 10 |
| Ruddy Turnstone *Arenaria interpres morinella*<br>This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA | Breeds elsewhere |
| Rusty Blackbird *Euphagus carolinus*<br>This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA | Breeds elsewhere |

| NAME | BREEDING SEASON |
|---|---|
| Short-billed Dowitcher *Limnodromus griseus*<br>This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.<br>https://ecos.fws.gov/ecp/species/9480 | Breeds elsewhere |
| Wood Thrush *Hylocichla mustelina*<br>This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. | Breeds May 10 to Aug 31 |

## Probability Of Presence Summary

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds. Please make sure you read and understand the FAQ "Proper Interpretation and Use of Your Migratory Bird Report" before using or attempting to interpret this report.

**Probability of Presence (■)**

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. (A year is represented as 12 4-week months.) A taller bar indicates a higher probability of species presence. The survey effort (see below) can be used to establish a level of confidence in the presence score. One can have higher confidence in the presence score if the corresponding survey effort is also high.

How is the probability of presence score calculated? The calculation is done in three steps:

1. The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.
2. To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.
3. The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

**Breeding Season (■)**

Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

**Survey Effort** (|)
Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps. The number of surveys is expressed as a range, for example, 33 to 64 surveys.

**No Data** (–)
A week is marked as having no data if there were no survey events for that week.

**Survey Timeframe**
Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.

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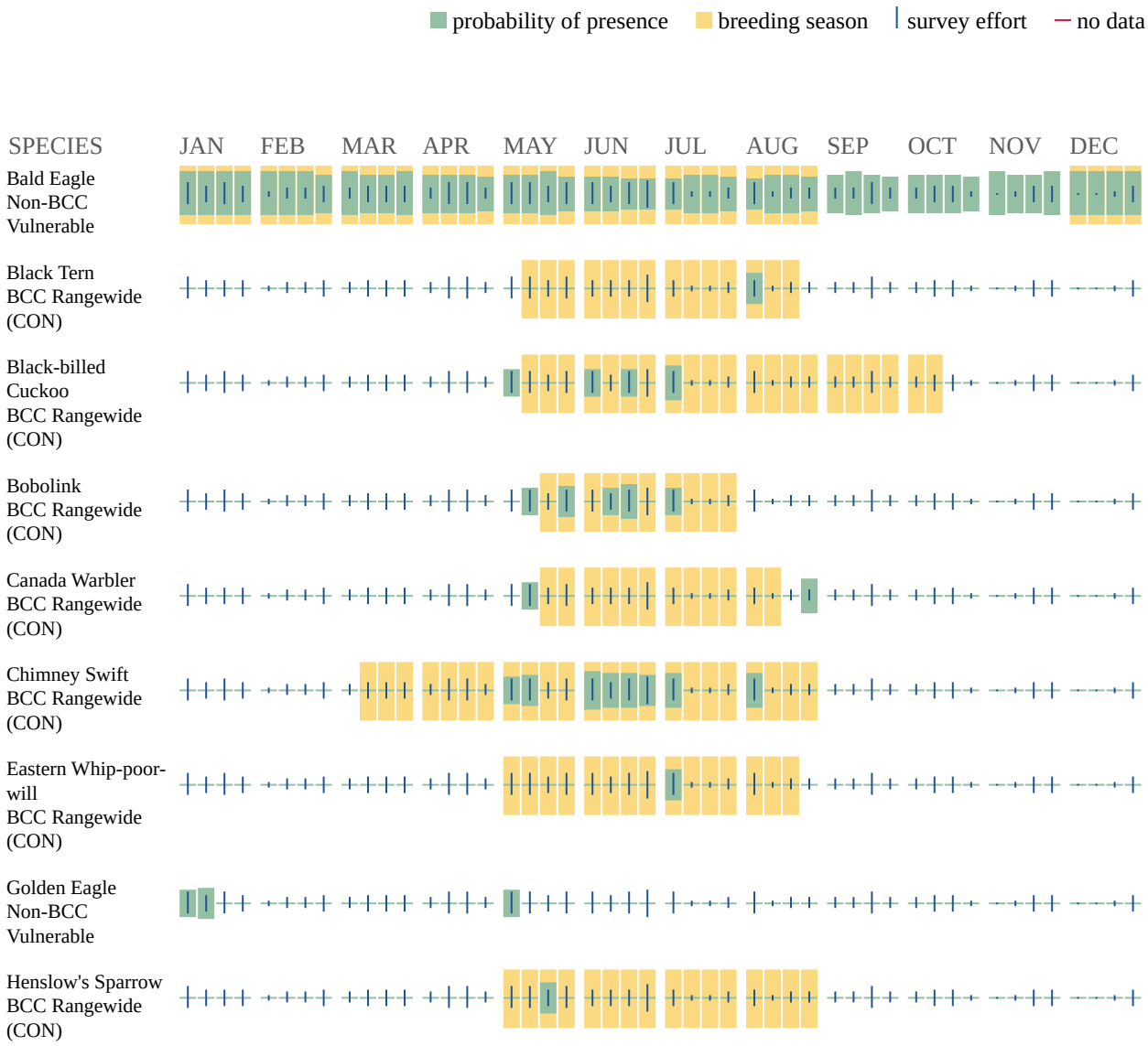

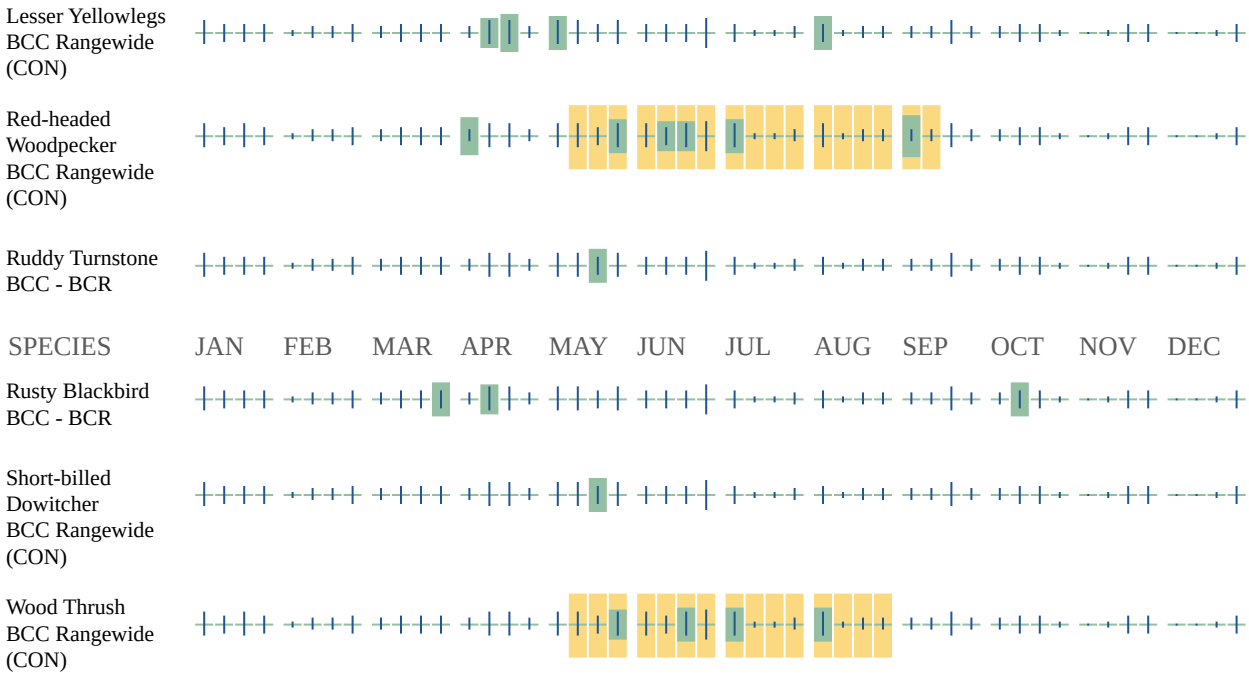


Additional information can be found using the following links:

- Birds of Conservation Concern https://www.fws.gov/program/migratory-birds/species
- Measures for avoiding and minimizing impacts to birds https://www.fws.gov/library/collections/avoiding-and-minimizing-incidental-take-migratory-birds
- Nationwide conservation measures for birds https://www.fws.gov/sites/default/files/documents/nationwide-standard-conservation-measures.pdf

## Migratory Birds FAQ

**Tell me more about conservation measures I can implement to avoid or minimize impacts to migratory birds.**

Nationwide Conservation Measures describes measures that can help avoid and minimize impacts to all birds at any location year round. Implementation of these measures is particularly important when birds are most likely to occur in the project area. When birds may be breeding in the area, identifying the locations of any active nests and avoiding their destruction is a very helpful impact minimization measure. To see when birds are most likely to occur and be breeding in your project area, view the Probability of Presence Summary. Additional measures or permits may be advisable depending on the type of activity you are conducting and the type of infrastructure or bird species present on your project site.

**What does IPaC use to generate the list of migratory birds that potentially occur in my specified location?**

The Migratory Bird Resource List is comprised of USFWS Birds of Conservation Concern (BCC) and other species that may warrant special attention in your project location.

The migratory bird list generated for your project is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are a BCC species in that area, an eagle (Eagle Act requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, please visit the Rapid Avian Information Locator (RAIL) Tool.

**What does IPaC use to generate the probability of presence graphs for the migratory birds potentially occurring in my specified location?**
The probability of presence graphs associated with your migratory bird list are based on data provided by the Avian Knowledge Network (AKN). This data is derived from a growing collection of survey, banding, and citizen science datasets.

Probability of presence data is continuously being updated as new and better information becomes available. To learn more about how the probability of presence graphs are produced and how to interpret them, go the Probability of Presence Summary and then click on the "Tell me about these graphs" link.

**How do I know if a bird is breeding, wintering or migrating in my area?**
To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating or year-round), you may query your location using the RAIL Tool and look at the range maps provided for birds in your area at the bottom of the profiles provided for each bird in your results. If a bird on your migratory bird species list has a breeding season associated with it, if that bird does occur in your project area, there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

**What are the levels of concern for migratory birds?**
Migratory birds delivered through IPaC fall into the following distinct categories of concern:

1. "BCC Rangewide" birds are Birds of Conservation Concern (BCC) that are of concern throughout their range anywhere within the USA (including Hawaii, the Pacific Islands, Puerto Rico, and the Virgin Islands);
2. "BCC - BCR" birds are BCCs that are of concern only in particular Bird Conservation Regions (BCRs) in the continental USA; and
3. "Non-BCC - Vulnerable" birds are not BCC species in your project area, but appear on your list either because of the Eagle Act requirements (for eagles) or (for non-eagles) potential susceptibilities in offshore areas from certain types of development or activities (e.g. offshore energy development or longline fishing).

Although it is important to try to avoid and minimize impacts to all birds, efforts should be made, in particular, to avoid and minimize impacts to the birds on this list, especially eagles and BCC species of rangewide concern. For more information on conservation measures you can implement to help avoid and minimize migratory bird impacts and requirements for eagles, please see the FAQs for these topics.

**Details about birds that are potentially affected by offshore projects**
For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the Northeast Ocean Data Portal. The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review. Alternately, you may download the bird model results files underlying the portal maps through the NOAA NCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf project webpage.

Bird tracking data can also provide additional details about occurrence and habitat use throughout the year, including migration. Models relying on survey data may not include this information. For additional information on marine bird tracking data, see the Diving Bird Study and the nanotag studies or contact Caleb Spiegel or Pam Loring.

**What if I have eagles on my list?**
If your project has the potential to disturb or kill eagles, you may need to obtain a permit to avoid violating the Eagle Act should such impacts occur.

**Proper Interpretation and Use of Your Migratory Bird Report**
The migratory bird list generated is not a list of all birds in your project area, only a subset of birds of priority concern. To learn more about how your list is generated, and see options for identifying what other birds may be in your project area, please see the FAQ "What does IPaC use to generate the migratory birds potentially occurring in my specified location". Please be aware this report provides the "probability of presence" of birds within the 10 km grid cell(s) that overlap your project; not your exact project footprint. On the graphs provided, please also look carefully at the survey effort (indicated by the black vertical bar) and for the existence of the "no data" indicator (a red horizontal bar). A high survey effort is the key component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In contrast, a low survey effort bar or no data bar means a lack of data and, therefore, a lack of certainty about presence of the species. This list is not perfect; it is simply a starting point for identifying what birds of concern have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list helps you know what to look for to confirm presence, and helps guide you in knowing when to implement conservation measures to avoid or minimize potential impacts from your project activities, should presence be confirmed. To learn more about conservation measures, visit the FAQ "Tell me about conservation measures I can implement to avoid or minimize impacts to migratory birds" at the bottom of your migratory bird trust resources page.

# Wetlands

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

Please note that the NWI data being shown may be out of date. We are currently working to update our NWI data set. We recommend you verify these results with a site visit to determine the actual extent of wetlands on site.

RIVERINE

- R4SBC
- R4SBA

FRESHWATER EMERGENT WETLAND

- PEM1C

# IPaC User Contact Information


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# Appendix F: Plan of Operation Excerpts

- F.1: Plan of Operation Report Section 3.0 and 4.0 Excerpts
- F.2: Plan of Operation Plan Set
- F.3: Appendix E Excerpt – Geomembrane Compatibility
- F.4: Appendix H Excerpt – Piping and Permeability
- F.5: Appendix F Excerpt – Saturated Head Over Liner Calculation
- F.6: Appendix G Excerpt – Pipe Strength Calculations
- F.7: Appendix J Excerpt – Global Stability

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# PLAN OF OPERATION

# PHASE IV DISPOSAL AREA
# ALMA OFF-SITE ASH DISPOSAL FACILITY
# TOWN OF BELVIDERE
# BUFFALO COUNTY, WISCONSIN

**PREPARED FOR**
**DAIRYLAND POWER COOPERATIVE**

**PREPARED BY**
**RMT, INC.**
**MADISON, WISCONSIN**

October 2000

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10/13/00

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CRAIG O. BARTHOLOMEW 7-25 MADISON WI PROFESSIONAL GEOLOGIST

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Craig O. Bartholomew, P.G.
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# Certification Statement

I, _____, hereby certify that I am a registered
Bernard J. Kraatz
professional engineer in the State of Wisconsin, registered in accordance with the requirements of ch. A-E 4, Wis. Adm. Code; that this document has been prepared in accordance with the Rules of Professional Conduct in ch. A-E 8, Wis. Adm. Code; and that, to the best of my knowledge, all information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR 500 to 536, Wis. Adm. Code.

I, _____, hereby certify that I am a registered
Craig O. Bartholomew
professional geologist in the State of Wisconsin, registered in accordance with the requirements of ch. A-E 10, Wis. Adm. Code; that this document has been prepared in accordance with the Rules of Professional Conduct in ch. A-E 8, Wis. Adm. Code; and that, to the best of my knowledge, all information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR 500 to 536, Wis. Adm. Code.

# F.1
# Plan of Operation Report Section 3.0 and 4.0 Excerpts

# Section 3
# Engineering Design Concepts

## 3.1 General

The proposed landfill design has been developed to provide efficient, environmentally sound, and cost-effective ash disposal. The proposed design has been prepared to meet the following requirements: Wisconsin Administrative NR 500 series codes, WDNR Feasibility Determination Conditions, and local and site-specific conditions.

The supporting calculations for the design are referenced throughout the text and are included in the appendices. Details and drawings illustrating design layout and specifications are referenced as applicable and presented on the plan sheets and figures.

## 3.2 Waste Types, Volumes, and Site Life

The proposed Phase IV disposal area has an estimated design capacity of approximately 3,011,000 cubic yards based upon the proposed GCL liner and final cover design alternative. This design capacity represents the total waste (i.e., ash) volume since no daily or intermediate soil cover is required for the ash. This volume was obtained by comparing the base grades and final grades, as shown on Plan Sheets 5 and 12. Design capacity is defined as "the volume contained between the top of the 1-foot-thick granular drainage layer on the base grades and the bottom of the 3-foot-thick final cover."

The proposed landfill will accept bottom ash and fly ash from DPC's Genoa No. 3, Alma Units 1-5, and John P. Madgett (JPM) power generating facilities. Other than small quantities of wastewater treatment plant sludge and asbestos (less than 1 percent of the total waste stream), no other solid or hazardous waste as defined by the WDNR will be disposed of in the proposed Phase IV disposal area. Disposal of these waste types is consistent with DPC's current landfill operating practices.

The types of coal used by DPC can vary throughout time. Different types of coal will generate different amounts of ash, with different properties. The type of ash generated can therefore affect the rate of beneficial use (i.e., nonlandfill applications), as will market conditions. The projected annual ash volumes to be placed in the landfill have been estimated by DPC and RMT to average approximately 156,600 dry tons or 217,000 in-place cubic yards of ash per year. The anticipated site life is 13.9 years with an anticipated final closure date of September 2015.

Depending on the type of coal used and the market conditions for beneficial reuse, these ash disposal volumes may vary from year to year.

In the FR, it was estimated that ash filling would begin in Phase IV during the year 2004. On the basis of current ash generation projections, and updated estimates of remaining existing landfill capacity, DPC will now need to begin ash filling in Phase IV in the fall of 2001. Because of the fluctuations in ash generation and the rate of beneficial use, 217,000 in-place cubic yards per year is still considered a representative estimate of average ash disposal.

## 3.3 Site Development

The proposed Phase IV disposal area consists of approximately 32.1 acres of disposal area. The layout of the landfill is shown on Plan Sheets 4 and 5 (subbase and base grades). The landfill will be developed and operated as an area fill and will be developed generally from east to west over four cells (i.e., Cell 1, Cell 2 – Modules A and B, Cell 3, and Cell 4 – Modules A and B). Phasing sheets for site development are shown on Plan Sheets 6 to 11. Table 1 in Appendix C summarizes the estimated design capacity by cell.

The phased development of the landfill has the following advantages:

- The landfill will be constructed, operated, and closed in segments.
- Construction costs will be distributed throughout the facility's life.
- Areas to be maintained for ash filling will be smaller.
- As cells (or modules) reach closure grades, they may be capped with temporary intermediate cover if needed to minimize leachate generation and to divert clean surface water to the surface water management system. The final cover system will be completed in the subsequent construction season.

The proposed horizontal limits of ash filling are shown on Plan Sheet 5 (base grades). The horizontal limits of filling have been established based on topographic constraints and operational constraints. The proposed subbase (bottom of compacted 2-foot-thick select low-permeability subbase soil layer [low-permeability layer]) grades have been developed to provide a minimum separation distance of 10 feet from the seasonal high groundwater table or the top of the bedrock surface, whichever is highest.

Initial site development will include constructing storm water management structures, site access roads and Cell 1. Surface water controls consisting of ditches, diversion berms, and erosion control measures (e.g., silt fence, hay bale check dams, and seeding of disturbed areas) will be developed prior to Cell 1 construction to collect and divert surface water runoff from the construction areas and control erosion from the site.

The topsoil in Cell 1 will be stripped and stockpiled for future use. Cell 1 will then be excavated to subbase grades. Subbase grades are shown on Plan Sheet 4. Select loess soil obtained from the excavation will be used to construct the low-permeability layer. General fill obtained from the excavation will be used to construct the perimeter berms, access roads, and storm water management structures. Once subbase grades are established, the liner system, leachate collection system, and leachate transfer system will be constructed. Construction activities will be documented in accordance with applicable NR 500 requirements and the Construction Quality Assurance Plan (CQA Plan), which has been developed as part of this POO (Appendix D).

Surface water drainage from areas within the watershed will be routed around the landfill in diversion ditches. The construction of these ditches will be phased with the landfill construction as shown on Plan Sheets 6 through 11 and as described in Subsection 4.9. These ditches have been designed for the 100-year, 24-hour storm event.

## 3.4 Materials Balance

The materials balance for the proposed Phase IV disposal area is presented in Appendix C. This appendix provides information on the materials needed and on which materials are available on-site for construction. The following assumptions were used to develop the materials quantities:

1. No soil for daily or immediate cover is required.
2. All volumes are in-place cubic yards, neglecting shrink/swell factors and handling losses.
3. Design capacity is defined as the volume available for ash.

The materials balance for the site indicates that the on-site excavations will provide enough material to complete construction of the low-permeability layer component of the liner for each of the cells. On-site excavations and existing stockpiles will provide enough general fill material to complete construction of the final cover grading layer and the general fill cover layer components of the final covers for each of the cells, and for construction of perimeter berms, drainage ditches/diversion berms, sedimentation basins, and other appurtenances.

As indicated in Tables 2 and 3 in Appendix C, excavation in some cells will not provide an adequate volume of material for the low-permeability layer and general fill construction. For these cells, supplemental material needed will be excavated from future cell areas.

In cells where there is an excess of soil excavated during development of the landfill, the soil will be stockpiled on-site, as shown on Plan Sheets 6 through 11. Stockpiles will be surrounded by erosion control features, such as berms, sediment fences, and hay bales, as shown on the

phasing plans and on Plan Sheet 23. Stockpiles that will remain dormant for more than one construction season will be seeded to establish vegetation to minimize erosion.

Select granular fill (drainage layers of liners and covers), select aggregate fill (pipe bedding), select graded fill (if needed), base course, and riprap will be obtained from locally available commercial sources.

The design capacity of the proposed landfill is approximately 3,011,000 cubic yards. Table 1 in Appendix C summarizes the design capacity by cell. In accordance with NR 506.05(2) and NR 506.06, high-volume industrial waste landfills, including the proposed DPC Phase IV disposal area, are not subject to daily and intermediate cover requirements, respectively. Since the waste consists almost entirely of coal ash (approximately 99 percent), the use of daily and intermediate cover soil to control odors will not be required. If temporary intermediate cover is used, it will be subsequently used as the 0.5-foot grading layer soil component of the final cover or for structures within the waste limits.

## 3.5 Subbase Grades

The subbase grades (i.e., bottom of the low-permeability layer) have been designed to provide a minimum separation distance of 10 feet from the seasonal high groundwater table or the top of the bedrock surface, whichever is highest (Plan Sheet 4). Elevations of the subbase excavation range from approximately 780 feet mean sea level (M.S.L.) in the southern portion of the site to about 862 feet M.S.L. in the northern portion of the site, with a maximum cut below existing grade of approximately 60 feet. The maximum excavation area is in the location of an existing stockpile in Cell 1 and Cell 2, Module B.

During subbase preparation, excavated soil will be used in the construction of the site (i.e., low-permeability layer, perimeter berms, surface water management features, final cover, or other exterior features) or stockpiled for later use as described in Subsection 3.4.

## 3.6 Base Grades

The base grades over the landfill site range from elevations of approximately 782 to 864 feet M.S.L. Base grades representing the top of the composite liner, along with the leachate collection system, are shown on Plan Sheet 5. As shown, base grades will have a 2 percent minimum slope with a majority of the base at 6 percent and a horizontal distance of approximately 130 feet from the ridges to the leachate collection pipes. NR 504.06(5)(a) allows for flow distances to exceed 130 feet across the base of the liner for well designed composite-lined landfills. The proposed base grade slopes meet or exceed the minimum of 2 percent to collection lines, which will provide better flow of leachate to collection pipes. Subsection 3.8 provides additional details regarding the design of the leachate collection system.

## 3.7 Composite Liner System

Under the provisions of NR 504.10, an alternative liner system design is proposed. The proposed system will consist of a composite liner system placed along the base and interior slopes of the landfill. The composite liner will consist of a geosynthetic clay liner (GCL) overlain by a 60-mil high-density polyethylene (HDPE) geomembrane. The composite liner will be installed over a low-permeability soil layer (see Detail 1 on Plan Sheet 17). The low-permeability layer will be obtained from on-site material excavated within the Phase IV footprint having a maximum hydraulic conductivity of $1 \times 10^{-5}$ cm/s. The composite liner system will function as the primary containment system.

### 3.7.1 Low-permeability Layer

The low-permeability layer will be placed directly below the GCL layer. This layer will be placed in accordance with the CQA Plan (refer to Appendix D). During the placement of the low-permeability layer, clump and stone sizes within the soil will be limited to 2 inches or less as described in the CQA Plan. The final lift of the low-permeability layer, including the vee trenches constructed for the leachate collection system piping, will be smooth drum–rolled, and coarse gravel or cobbles larger than 1 inch in diameter and ruts greater than 1 inch in depth will be removed from the surface prior to placement of the GCL in accordance with WDNR Guidance for the Use of GCLs and manufacturers' recommendations. Refer to Subsection 4.6.1 for further discussion on the construction of the low-permeability layer. Details of the liner are shown on Plan Sheet 17.

### 3.7.2 Geosynthetic Clay Liner

A GCL placed above the low-permeability layer and in conjunction with the geomembrane, discussed in Subsection 3.7.3, will constitute the composite liner system. As allowed in NR 504.10, the GCL and the low-permeability layer discussed above will be installed in lieu of the clay layer described in NR 504.06. The GCL will be installed in accordance with Subsection 4.6.3 of this report and the CQA Plan (refer to Appendix D), which was prepared in accordance with the Bureau of Waste Management's "Guidance for the Use of Geosynthetic Clay Liners (GCLs) at Solid Waste Facilities" and manufacturers' recommendations. Material specifications from some of the acceptable manufacturers are contained in Appendix E.

The GCL will consist of a layer of pure sodium bentonite encapsulated between two geotextiles, which will meet the minimum physical characteristics found in the CQA Plan. In addition, the GCL will be the same or equivalent to that used in the chemical compatibility testing found in the FR Addendum dated December 15, 1997 (RMT,

1997c). The results of that test indicated that the leachate from DPC would not adversely affect the performance of the GCL.

As a result of a recent change in the coal source utilized by DPC, additional synthetic leachate generation and leachate quality testing using representative ash samples is currently underway. This testing is being performed to verify that leachate characteristics have not significantly changed due to the change in coal source. The results of this testing will be submitted to the WDNR when available. If necessary, additional GCL compatibility testing will be performed to verify GCL compatibility with the new leachate.

### 3.7.3 60-mil HDPE Geomembrane

A 60-mil HDPE geomembrane liner will be placed directly above the GCL. The base geomembrane liner will consist of smooth geomembrane, while the geomembrane on the sidewalls will be textured for added stability. The geomembrane will be protected from abrasion and ultraviolet degradation by a 1-foot-thick select granular fill drainage layer overlying the geomembrane. Details of the geomembrane liner are shown on Plan Sheet 17.

Design calculations for the stability of the textured geomembrane/low-permeability layer and textured geomembrane/select granular fill (granular drainage layer) interfaces are included in Appendix J. Material specifications from some of the acceptable manufacturers are contained in Appendix E. The geomembrane liner will meet the minimum physical, mechanical, endurance, and degradation properties presented in the CQA Plan (Appendix D).

HDPE geomembrane has been included in the design and construction of numerous nonhazardous waste facilities. Testing of the compatibility of the HDPE geomembrane with the leachate generated from this type of facility has been performed by geomembrane manufacturers, suppliers, and industry users. Test results indicate that the leachate from a typical nonhazardous waste disposal facility will not adversely affect the performance of the HDPE geomembrane liner. Geomembrane chemical resistance data are presented in Appendix E.

The geomembrane liner will be deployed above the GCL. In general, geomembrane panels will be placed in an orientation that runs directly down the sideslopes. A preconstruction report with a proposed panel layout diagram will be prepared and submitted to the WDNR prior to installation of the geomembrane.

As placement proceeds, the geomembrane will be anchored as shown on Detail 3 of Plan Sheet 17. Additional testing and installation requirements are detailed in Subsection 4.6.4 and in the CQA Plan in Appendix D. Following geomembrane installation, the select granular fill drainage layer will be installed to protect the geomembrane.

## 3.8 Leachate Collection and Handling System

### 3.8.1 General

The primary design criteria for the leachate collection system is to maintain the average leachate head on the liner system to less than 12 inches (s. NR 504.06[5][a]). To achieve this, the leachate collection system for the proposed landfill has been designed to provide effective drainage, collection, and removal of leachate from the landfill. The primary components of the leachate collection system consist of a drainage layer, leachate collection and transfer piping, cleanouts, manholes, a storage tank, a load-out facility, and leachate head wells.

The leachate collection system layout is shown on Plan Sheet 5, and the associated details are shown on Plan Sheets 17 and 18. Additional information concerning the leachate collection system is presented in the following subsections. A discussion of the construction of the leachate collection system is presented in Subsection 4.7.

### 3.8.2 Leachate Generation

Leachate generation has been estimated in accordance with NR 512.12(3), where 6 inches per year of impingement into the leachate collection system were assumed for all unclosed areas, while 1 inch per year was assumed to impinge the collection system under closed areas (i.e., for composite liner and final cover designs) (Appendix F). A generation rate of 3 inches per year was assumed on intermediate slopes due to the relatively steep (3:1) slopes and the characteristics (i.e., low hydraulic conductivity) of the ash. On the basis of these assumptions, the rate of leachate generation during active landfill operations at the DPC Phase IV disposal area is estimated to be as high as approximately 9,120 gallons per day (gpd) during Cell 4, Module B operations. Because of the relatively high moisture-holding capacity of the ash, the actual leachate generation rate during site operations is expected to be less than that estimated above. Other factors that will affect the actual leachate generation rate will include the ash filling rate, the total annual precipitation, and the evaporation rate.

The leachate generation rate after final closure is estimated to be approximately 2,388 gpd based on the 1 inch-per year impingement rate. Based on case studies at closed landfills, this post-closure flow rate is extremely conservative, and actual flow rates during closure are expected to be less.

### 3.8.3 Leachate Collection System

The leachate collection system consists of a select granular fill drainage layer, a network of leachate collection piping, and cleanout access piping. The select granular fill drainage layer will be placed over the geomembrane on the base and sidewalls. The granular drainage layer will be sloped at a minimum slope of 2 percent to the leachate collection trenches and pipes as shown on Plan Sheet 5. The drainage layer promotes the efficient transmission of leachate to the leachate collection trenches and pipes. The select granular fill drainage layer will be a minimum of 12 inches thick and will have a minimum hydraulic conductivity of $1.0 \times 10^{-2}$ cm/s. The select granular fill drainage layer material will meet the specifications presented in the CQA Plan (Appendix D). To protect this layer, DPC will place a minimum 2-foot layer of bottom ash, fly ash from the JPM Station, or a mixture of JPM and Alma fly ash over the select granular fill.

The leachate collection piping will be placed in vee-trenches in accordance with s. NR 504.06(5)(d) (refer to Detail 1 on Plan Sheet 17). The trenches will be 18 inches deep with maximum 3:1 sideslopes. A 12-ounce nonwoven polypropylene geotextile will be placed directly on the geomembrane liner along the entire length of the trench to provide protection for the geomembrane. The composite liner will be continuous beneath the vee-trench by undercutting the subbase along the length of the trench to maintain the 2-foot-thick low-permeability layer.

The leachate collection piping will consist of 6-inch-diameter perforated SDR 17 HDPE pipe. Pipe capacity and strength calculations are contained in Appendices F and G, respectively. The perforated collection pipe will have 3/8-inch-diameter holes on the bottom of the pipe, set 45° from center, and spaced 6 inches on center as shown on Plan Sheet 17. A minimum of 4 inches of bedding material will be placed below the perforated collection pipe in the trenches. Pipe bedding material will be placed around the perforated pipe and mounded a minimum of 1 foot above the pipe as shown on Plan Sheet 17. A 6-inch-thick layer of select graded fill will be placed over the pipe bedding material, if needed for filtering the select aggregate fill material. The select aggregate fill, or the select graded fill, if used, will then be covered by the select granular fill drainage layer. The piping and pipe bedding material, and select graded fill will meet the specifications presented in the CQA Plan (Appendix D).

Piping and permeability calculations were performed for the select granular fill, select aggregate fill (pipe bedding material), and leachate collection piping perforations. These calculations are included in Appendix H. Based on these calculations, the select granular fill/pipe bedding material design will provide adequate hydraulic conductivity for leachate collection without excessive migration of fines to clog the pipe bedding material or the leachate collection pipes. Grain-size distribution tests will be performed on the select granular fill, select graded fill, and pipe bedding materials used in construction to confirm this. Calculations were also performed to verify that the average leachate head on the liner is limited to 1 foot or less. These calculations are included in Appendix H.

The proposed layout of the leachate collection piping is shown on Plan Sheet 5. Leachate lines in each cell will be placed parallel to each other in valleys over the herringbone design across the base. In general, the leachate piping layout has been designed such that the leachate flows no more than 130 feet across the base of the liner before encountering a leachate collection pipe. In a few locations, the flow distance exceeds 130 feet. However, these are limited and are considered acceptable for this well designed composite landfill. The leachate collection lines are sloped at a minimum of 4.0 percent toward the low point in Cell 4, and at a minimum of 6.0 percent in Cells 1, 2, and 3. Each cell contains leachate collection lines that run in a north-northeast to south-southwest orientation. These lines all drain at a 4.0 to 6.0 percent slope and penetrate the composite liner at the southern end of each cell. At the penetration points, each penetration will be constructed with a geomembrane apron and sleeve (i.e., pipe boot) with extrusion welds, a neoprene seal, and geomembrane rub sheets (Detail 2 on Plan Sheet 17 and Detail 6 on Plan Sheet 19).

Perimeter cleanouts for all leachate collection pipes will be installed at each end of the pipe allowing each collection line to be cleaned out in both directions. In addition, midline cleanouts will be provided to the longest collection lines in Cell 3 and Cell 4. The maximum collection pipe cleanout length is approximately 1,200 feet from the entrance of the cleanout to the toe-of-slope on the opposite side of the landfill.

The cleanout risers and midline cleanouts consist of 6-inch-diameter nonperforated 6-inch SDR 17 HDPE pipe. The cleanout risers and midline cleanouts will be installed in trenches on the base and on the sideslopes as shown on Detail 6 on Plan Sheet 17. Cleanout locations are shown on Plan Sheet 5.

Temporary cell delineation berms will be used along the cell boundaries illustrated on Plan Sheets 6 through 11 to control surface water runon and minimize leachate generation, and to protect the composite liner splice area for successive cell construction.

Refer to Detail 5 on Plan Sheet 17 for further details on the temporary cell delineation berm design.

### 3.8.4 Leachate Removal and Transfer System

The leachate removal and transfer system consists of nonperforated leachate transfer piping, manholes, and cleanout access piping. The perforated leachate collection piping will transition to 6-inch-diameter nonperforated SDR 17 HDPE leachate transfer piping within the landfill just prior to where the transfer piping penetrates the liner system at the southern toe-of-slope of each cell. The horizontal pipe penetration has been designed to prevent leachate from leaving the landfill liner system through the liner penetration by implementing the following design features:

- An HDPE pipe boot will be installed at the location where the transfer piping exits the liner (see Detail 6 on Plan Sheet 19).
- Outside of the subbase grades (i.e., the bottom of the 2-foot-thick low-permeability layer), the transfer piping will be wrapped in a GCL for a distance of 23 feet beyond the subbase grades (see Details 2 and 4 on Plan Sheet 17).
- Approximately 8 feet from the bottom of the low-permeability layer, a ½-inch-thick HDPE panel (i.e., anti-seep collar) will be fused perpendicular to the orientation of the transfer piping. The GCL will wrap around the pipe from the pipe boot to the anti-seep collar where the transfer pipe will transition from a single-wall pipe to a double-wall pipe (see Details 2 and 4 on Plan Sheet 17).
- Approximately 1 foot beyond the HDPE anti-seep collar and GCL wrap, an 8-inch-diameter casing pipe will be installed around the 6-inch-diameter transfer piping. The remainder of the transfer piping (i.e., outside of the landfill liner) will be double encased (see Details 2 and 4 on Plan Sheet 17).
- The GCL-wrapped transfer piping, the HDPE anti-seep collar, and the transition to the double-encased piping system will all be encased in a horizontal extension of the low-permeability layer for a distance of 24 feet beyond the subbase grades (see Details 2 and 4 on Plan Sheet 17).

Outside of the limits of ash on the opposite side of the landfill perimeter berm, a 4-foot-diameter concrete manhole will be installed to provide a location for major changes in direction of the transfer piping, to provide a location for transfer piping to manifold into a single perimeter transfer pipe around the southern end of the landfill, and to provide a location for cleanout access piping. These manholes will also provide access to monitor the interstice between the transfer casing pipe and the transfer carrier pipe. Seven manholes are illustrated on Detail 2 on Plan Sheet 18, and manhole locations are shown on Plan Sheet 5.

The transfer piping from all of the cells meet at Manhole MH 3 located south of Cell 2. The combined transfer piping then extends to the leachate storage tank located near the ash processing facility. Transfer piping will be installed in a trench as shallow as practical, but will be located below frost depth. Leachate flows by gravity to the leachate storage tank. The leachate transfer piping, manholes, and storage tank will be constructed above the seasonal high water table. Plan Sheet 5 illustrates the location of the transfer piping, manholes, and the storage tank.

Within Manhole MH 5, located just upstream of the leachate storage tank, two actuated valves will be installed on the leachate transfer pipe. One valve will close if the high-level alarm is triggered in the storage tank, and the second valve will close if the high-high-level alarm is triggered in the tank. Both valves will fail closed if the power goes out at the tank (see Subsection 3.8.5). These valves will shut off the gravity flow of leachate to the storage tank, preventing overflow of the tank, if the tank becomes full or if power goes out at the tank. The second valve provides redundancy for the same function. Both valves will be compatible with the landfill leachate and will be accessible from the ground surface.

### 3.8.5 Leachate Storage, Loadout, Use, and Disposal

As discussed in Subsection 3.8.4, the site is designed to gravity-drain leachate to a proposed underground leachate storage tank located near the existing ash processing facility (see Plan Sheet 5). Leachate generation calculations (refer to Appendix F) indicate that a 30,000-gallon tank will be needed to provide a minimum 4-day storage capacity based on the peak leachate generation rate estimated for the site (when Cell 4B is operational, portions of Cell 4A has intermediate cover, and Cells 1 through 4A are closed). The leachate storage provided will allow for the temporary storage of leachate during nights, weekends, and holidays.

The leachate storage tank will consist of a double-walled tank (see Detail 1 on Plan Sheet 18). The interior of the tank will be coated with epoxy or another liner material compatible with the leachate. The dual-wall construction of the corrosion-resistant tank will allow for leak detection monitoring of the interstitial space between the inner and outer walls. The tank will provide access to allow for sampling of the leachate. The storage tank will be bedded in select granular fill (e.g., clean sand, pea gravel, No. 8 crushed stone, or equivalent) and will be held in-place by tie-down straps and concrete deadmen. The tank will be designed to withstand the soil and liquid loads encountered during installation and use. Tank installation methods will follow the manufacturer's recommended procedures. Representative manufacturers' information is included in Appendix E.

A submersible pump will be located inside the tank and will pump leachate through 3-inch-diameter SDR 17 HDPE discharge piping encased in 6-inch-diameter SDR 17 HDPE piping to existing piping located near the processing facility. Currently, ash processing water is pumped from the existing runoff sedimentation pond to either the processing facility or to the existing overhead loadout structure (used to top-load tanker trucks). The discharge piping from the proposed leachate storage tank will tap into the existing piping so that DPC can direct the Phase IV leachate to either the processing facility or the loadout structure. Valves will be installed to direct the leachate to the appropriate location for its intended use. See Detail 5 on Plan Sheet 21 for a piping schematic.

As shown on Detail 1 on Plan Sheet 18, the leachate storage tank will contain three liquid level sensors, which will function as follows (from highest to lowest):

- High-high alarm – will close one of the actuated valves contained in Manhole MH 5 to be installed on the leachate transfer piping entering the storage tank and will trigger a red alarm light
- High alarm – will close the second actuated valve contained in Manhole MH 5, also to be installed on the leachate transfer piping entering the storage tank. This sensor will also trigger a red alarm light
- Pump-off – will turn the pump off to ensure that the pump remains submerged

The pump will be turned on manually by DPC operations personnel.

The Phase IV leachate will be utilized and managed by DPC the same as runoff sedimentation pond water is currently managed. It will be utilized for conditioning ash prior to landfilling and/or it will be used for dust control in the active fill areas. If more leachate is produced than can be utilized on-site, it will be hauled via tanker truck to the DPC wastewater treatment plant (WWTP) located in Alma, Wisconsin, for treatment and disposal. If for some reason the DPC Alma WWTP is not available to accept the leachate, a secondary off-site disposal site will be the LaCrosse WasteWater Utility WWTP, located in LaCrosse, Wisconsin. A conditional approval letter from the LaCrosse WasteWater Utility is contained in Appendix I. The volume of leachate used on-site and hauled off-site to either WWTP for treatment will be recorded and submitted to the WDNR. All pumps, valves, and meters will be controlled and operated from the ground surface.

### 3.8.6 Leachate Head Wells

Leachate head monitoring wells will be installed to monitor the hydraulic head of the leachate generated in the landfill. Two leachate head monitoring wells will be installed

in each cell of development, for a total of eight head wells. The proposed locations of the head wells are shown on Plan Sheet 5.

The head wells will consist of a 3-inch-diameter Schedule 120 nonperforated PVC pipe with a 5-foot slotted pipe section for the screen. The 3-inch-diameter sidewall riser pipe will provide a conduit for standard monitoring equipment access (see Detail 6 on Plan Sheet 17).

The well piping will be bedded at the base of the select granular fill drainage layer of the leachate collection system. The nonperforated connecting pipe will be constructed at a level grade toward the toe of the perimeter berm sidewall. Each casing will be sealed with a threaded cap to control access to the leachate head well. The surface access points of the head wells will be protected by guard posts installed outside the limits of the geomembrane/GCL liner.

### 3.8.7 Leachate Pipe Strength

Pipe strength calculations were performed to determine the minimum standard dimension ratio (SDR) of the HDPE leachate pipe required to withstand the expected loads and deflection. Based on the calculations, the leachate pipes have been specified as SDR 17 pipe. The pipe strength calculations are included in Appendix G.

## 3.9 Daily and Intermediate Cover

In accordance with NR 506.05(2) NR 506.06, high-volume industrial waste landfills, including the proposed DPC Phase IV disposal area, are not subject to daily and intermediate cover requirements, respectively. Since the waste consists almost entirely of coal ash (approximately 99 percent), the use of daily and intermediate cover soil to control odors will not be required.

Although not required, temporary intermediate cover may be used on intermediate slopes to minimize leachate generation by diverting clean surface water to the surface water management system. If temporary intermediate cover is used, it will be subsequently used as the 0.5-foot grading layer component of the final cover or for structures within the ash limits.

## 3.10 Final Grades

Final grades have been designed to be compatible with the surrounding topography and the anticipated final use as open green space. The final grades will consist of 4H:1V sideslopes. The final grades, in conjunction with the final cover system and surface water management system, will effectively reduce infiltration of precipitation and thus reduce the quantity of leachate generated within the landfill. The proposed final grades are shown on Plan Sheet 12.

## 3.11 Composite Cover System

A final cover will be constructed to bring the site to final grades, as shown on Plan Sheet 12. The final cover system has been designed to meet the requirements of NR 504. The final cover system will consist of the following layers, from the bottom to top (also refer to Detail 1 on Plan Sheet 19):

- 6-inch-thick soil grading layer
- Geosynthetic clay liner (GCL)
- 40-mil-thick very flexible polyethylene (VFPE) geomembrane liner
- 12-inch-thick granular drainage layer
- 12-inch-thick general fill rooting layer
- 6-inch-thick topsoil layer

Each of these layers is described in further detail below.

### 3.11.1 Grading Layer

The 6-inch-thick soil grading layer will consist of on-site general fill soil and will be placed in accordance with the CQA Plan (refer to Appendix D). During placement, clump and stone sizes within the soil will be limited to 2 inches or less. The final lift will be smooth drum-rolled, and coarse gravel or cobbles larger than 1 inch in diameter and ruts greater than 1 inch in depth will be removed from the surface prior to placement of the GCL. Refer to Subsection 4.6.2 and the CQA Plan for further discussion on the construction of the soil grading layer. Details of the cover are shown on Plan Sheet 19.

During operation of Phase IV, DPC will evaluate the ease of grading the ash and the texture of the surface that can be graded. If the ash can be graded such that an adequate surface can be prepared for GCL deployment, DPC may, in the future, request that the 6-inch-thick soil grading layer be eliminated.

### 3.11.2 Geosynthetic Clay Liner (GCL)

A GCL placed above the soil grading layer and in conjunction with the geomembrane, discussed in Subsection 3.11.3, will constitute the composite cover system. As allowed in NR 504.10, the GCL will be installed in lieu of the clay layer described in NR 504.07. The GCL will be installed in accordance with Subsection 4.6.3 of this report and the CQA Plan (refer to Appendix D), which was prepared in accordance with the Bureau of Waste Management's "Guidance for the Use of Geosynthetic Clay Liners (GCLs) at Solid Waste Facilities" and manufacturers' recommendations. Material specifications from some of the acceptable manufacturers are contained in Appendix E.

The GCL will consist of a layer of pure sodium bentonite clay encapsulated between two geotextiles, which will meet the minimum physical characteristics found in the CQA Plan.

### 3.11.3 40-mil VFPE Geomembrane Liner

A 40-mil textured VFPE geomembrane liner will be placed directly above the GCL. The geomembrane liner material and placement activities will meet the requirements of s. NR 504.07(5) and the CQA Plan (refer to Appendix D).

Textured 40-mil VFPE geomembrane will be used throughout all areas of the final cover. Design calculations for the stability of the textured 40-mil geomembrane are included in Appendix J. Based on the geotechnical calculations, textured 40-mil VFPE geomembrane will provide the physical properties necessary for a stable design.

The 40-mil VFPE geomembrane will have the minimum physical, mechanical, hydraulic, endurance, and degradation properties presented in Subsection 4.6.4 and in the CQA Plan (Appendix D). Additional testing and installation requirements are also described in Subsection 4.6.4 and in the CQA Plan.

Geomembrane panels will be placed such that seaming occurs directly down the slopes. Plan Sheet 19 shows the design of the final cover.

### 3.11.4 Granular Drainage Layer

A 12-inch-thick select granular fill drainage layer will be placed above the geomembrane. The select granular fill will have a minimum hydraulic conductivity of $1 \times 10^{-3}$ cm/s at the anticipated placement density, in accordance with s. NR 504.07(6)(a). This material will meet the specifications presented in the CQA Plan (Appendix D) and will be obtained from a local quarry.

Surface water that enters the drainage layer will flow toward the perimeter of the landfill and will be collected in 4-inch-diameter perforated, corrugated polyethylene collection pipes located below diversion berms on the final cover as shown on Detail 2 on Plan Sheet 19 and in the perimeter berm as shown on Details 4 and 5 on Plan Sheet 19. Pipes will slope at a minimum of 1 percent with a majority at 2 percent to an outlet pipe. Pipes located below the diversion berms on the final cover will drain to the downslope flume locations and will discharge into the next lowest inlet pipe as shown on Detail 1 on Plan Sheet 20. Pipes located in trenches in the perimeter berm will follow the same slope as the top of the berm and will discharge through pipes located at 500-foot intervals around the landfill. Pipes located in areas where the top of berm is flat

will be sloped at 2 percent and will discharge through pipes spaced at 200-foot intervals as shown on Detail 4 on Plan Sheet 19. Surface water collected in the final cover collection pipes will discharge through the 4-inch-diameter nonperforated outlet pipes to the downslope flumes and to perimeter drainage ditches around the perimeter of the landfill (see Plan Sheet 12).

The final cover collection pipes will be bedded within an envelope of select aggregate fill pipe bedding material as shown on Details 2 and 4 on Plan Sheet 19. The bedding material will meet the same gradation requirements as the leachate collection line bedding material. The bedding material will be separated from fine-grained soil with a geotextile filter.

### 3.11.5 General Fill Rooting Layer

A 12-inch-thick uncompacted general fill rooting layer will be placed above the drainage layer. The general fill rooting layer will provide a rooting zone for vegetation, will protect the cap from damage due to freeze-thaw and desiccation, and will provide additional protection for the geomembrane. The general fill rooting layer will consist of on-site soil and will meet the requirements of the CQA Plan (Appendix D).

### 3.11.6 Topsoil and Vegetation

The top layer of the final cover system will be a 6-inch-thick layer of topsoil. Topsoil stripped from the landfill and perimeter areas during site preparation will be stockpiled and reused in the final cover. Samples will be obtained from each topsoil stockpile for soil fertility testing prior to placement of the final cover. Testing will consist of pH, nitrogen, phosphorus, and potassium assessment. After topsoil is placed, the area will be seeded, mulched, and fertilized, as required, based on the topsoil test results. Prior to seeding, the topsoil layer will be prepared for seeding by disking and pulverizing soil within 2 inches of the surface. Fertilizer and lime will be applied at rates specified by the nutrient analysis.

Seed will be applied at a rate of approximately 150 lb/acre. The seed mixture to be utilized is based on design recommendations included in Appendix K and consists of the following:

| VARIETY | DITCHES | SLOPES |
|---|---|---|
| White Clover | 10% | -- |
| Tall Fescue | -- | 40% |
| Hard Fescue | -- | 24% |
| Creeping Red Fescue | 25% | -- |
| Kentucky Bluegrass | 40% | 6% |
| Redtop | 5% | -- |

Alternatively, DPC may wish to utilize a prairie-type seed mix. If another seed mixture is used for final cover restoration, it will be preapproved by the WDNR. Mulch will consist of straw, hay, wood excelsior fiber, wood chips, or similar suitable material. Mulch will be placed to a loose depth of ½ inch to 1 ½ inches, or approximately 1.5 to 3 tons/acre. The CQA Plan in Appendix D details the material and placement requirements.

## 3.12 Geotechnical Analysis

The design of the proposed Phase IV disposal area takes into account the site-specific geology, hydrology, topography, and surface water drainage patterns. Specific attention and analysis have been given to global geotechnical stability and liner system interface stability. The analyses included in Appendix J were based upon site-specific information gathered for this facility. On the basis of the results of the geotechnical evaluation, the proposed Phase IV disposal area design will be stable.

### 3.12.1 Global Stability

A global stability analysis of the final cover and perimeter berm sideslopes is included in Appendix J. The analysis evaluated the worst-case liner sideslope in Cell 4, Module A, and the worst-case final cover slope along the southeast side of the final cover. The analyses indicate a minimum factor of safety of 1.6 has been achieved for each of these conditions. Based on these analyses, and on the performance of DPC's existing landfills, global slope stability is not a concern at this site.

### 3.12.2 Liner System Interface Slope Stability

Interface stability calculations were performed for the select granular fill/textured geomembrane, textured geomembrane/GCL, internal GCL, and GCL/subgrade interfaces of the liner system and final cover system. Friction angle and adhesion values used in the analyses were based on project-specific interface test results. Based on these

calculations, the critical interface for the liner system occurs between the textured geomembrane/GCL (hydrated). These calculations indicate that minimum factors of safety of 1.9 and 2.0 will be obtained for the critical liner and cover interfaces, respectively. These factors of safety are greater than the design factor of safety of 1.2 (using residual interface friction angles), indicating that the interfaces will be stable. Interface slope stability calculations are included in Appendix J.

## 3.13 Surface Water Management

### 3.13.1 Introduction

The surface water controls for the proposed Phase IV disposal area will consist of diversion berms, downslope flumes, ditching, sedimentation basins, and culverts, all designed to control surface water during both the operational and post-closure care periods of the landfill. The design of the surface water controls has been performed for the existing site conditions, for the operational periods when the combination of surface conditions and contributing acreage would result in the greatest runoff volume, and for the post-closure period. Given the location of the site, a greater factor of safety has been incorporated into the surface water management system design by utilizing a 100-year, 24-hour storm event rather than the 25-year storm required by NR 500. Calculations for the surface water control design are included in Appendix K.

Peak runoff quantities were computed using the Quick TR-55 program, which uses the TR-55 methods developed by the Soil Conservation Service for computing hydrographs. Diversion berm, ditch, and spillway sizing was performed using Manning's equation for the peak flows and proposed ditch configurations, and using erosion control design software. Sedimentation basins were designed using the Pond-2 basin routing program developed by Haestad Methods. The program routes the in-flow hydrograph from the design storm through the basin to determine the peak discharge and water stage.

The surface water design has been performed to meet the following requirements:

- Runoff curve numbers (RCNs) used in the analysis provide a conservative analysis of the potential land uses of the upland areas. Upland areas within the watershed primarily include wooded areas and agricultural lands. The wooded areas are located on the steeper-sloped areas of the valley and are unlikely to be affected by future land uses. High RCNs for the agricultural lands were selected to represent a conservative fallow condition with exposed bare soil. The RCNs selected for these areas were 86.
- Temporary and permanent storm water control structures have been designed using a 100-year, 24-hour storm event and a TR-55 Type II storm distribution to

determine peak flow rates. Rainfall distributions for the Type II storm event include "nested" higher intensity storm events within those needed for longer durations at the same probability. The resulting peak flows using this design method exceed the peak flows obtained using a 100-year time-of-concentration storm event.

- Sedimentation basins have been designed with a minimum surface area that exceeds the required surface area to settle 0.015 mm particles for all storm events up to, and including, the 100-year, 24-hour storm. Sedimentation basins have been designed to handle a 100-year, 24-hour storm event. Emergency spillways have been included to handle storms greater than the 100-year, 24-hour storm event. Both sedimentation basins have been designed to dewater in no less than 3 days following a 25-year, 24-hour storm event.
- Surface water controls have been designed to divert off-site surface water away from active fill and borrow areas. All on-site surface water will be routed to sedimentation basins, except surface water in contact with active fill areas, which will be treated as leachate. Impacts to adjacent properties will therefore be minimized.
- Information related to the recommended vegetation types for newly graded areas is included in Appendix K. Vegetation types for the design were selected based on their ability to withstand erosion in addition to their suitability for the site location and function.

### 3.13.2 Control of Surrounding Surface Water Run-on

Surface water from areas west, north, and east of the proposed landfill currently drain to existing drainage channels that have formed in the valleys at the site. These drainage channels converge at the location of the proposed landfill and continue to the south in a single drainage ditch. The main drainage ditch then routes the water to the south for approximately 1.5 miles before discharging into the Mississippi River (see Plan Sheet 5). For the post-development conditions, all surface water runoff will continue to be routed to the main drainage ditch. These drainage patterns are shown on Figure K-1 in Appendix K.

Diversion ditches have been designed to route off-site surface water around the landfill in a controlled manner. These ditches will be constructed in phases as the landfill is developed.

During Cell 1 development, the perimeter drainage ditch on the eastern side of the landfill will be constructed from the main channel south of the landfill to a location near Benchmark BM101 (see Plan Sheet 6). This ditch will route surface water from areas east and northeast of the landfill around the landfill. In addition, a temporary drainage ditch/diversion berm will be constructed on the western side of Cell 1 to route surface

water from areas north and west of the landfill around the landfill. During Cell 2, Module B development, the perimeter ditch on the eastern side of the landfill will be extended to the northern limit of the landfill to pick up surface water coming from the north. Also, the temporary drainage ditch/diversion berm on the western side of Cell 1 will be relocated further to the west to allow construction of Cell 2, Module B. During Cell 3 development, the perimeter drainage ditch on the western side of the landfill will be constructed from the main channel south of the landfill to a location near 171,800N (see Plan Sheet 9). This ditch will route surface water from areas west of the landfill around the landfill. In addition, a temporary drainage ditch/diversion berm will be constructed on the northwestern side of the landfill to route surface water from areas northwest of the landfill around the landfill. During Cell 4, Module B development, all surface water controls will be completed. Throughout the landfill's construction and operational sequencing, existing vegetation will be preserved whenever feasible to minimize erosion.

All temporary and permanent ditching and diversion berms have been designed to handle the peak flows associated with the 100-year, 24-hour storm event. These ditches in many cases will actually be wider than the existing drainage channels. In addition, they will be designed to handle the design flow velocity and will be lined as appropriate (e.g., grass, erosion matting, or riprap) to minimize the potential for erosion. These improvements are expected to improve the water quality of the runoff leaving the site.

### 3.13.3 Diversion Berms

Diversion berms are designed along the final cover system to collect and transfer surface water to the receiving downslope flume or sedimentation basin (see Detail 2 on Plan Sheet 19). These diversion berms concentrate and control flow, and discharge the surface water from the landfill more quickly. The swales created by the diversion berms have been designed at 2 percent typical slopes along the flow lines. The proposed locations of the surface water diversion berms are shown on Plan Sheet 12.

Drainage areas for the landfill are defined by the proposed surface water diversion berms at the site. Runoff computations were performed for the site with the proposed diversion berms in-place and are contained in Appendix K. Figure K-2 in Appendix K shows the post-closure drainage areas for the proposed DPC Phase IV disposal area.

### 3.13.4 Downslope Flumes

Downslope flumes have been included in the design to collect and transfer surface water from the diversion berms on the final cover of the landfill to the sedimentation basin.

Plan Sheet 12 shows the location of the downslope flumes. The downslope flumes have been designed as enclosed pipe flumes to limit erosion and to control the flow as it crosses roads. Downslope flume calculations are included in the culvert design subsection of Appendix K. Details of the downslope flumes are included on Plan Sheet 21. The downslope flumes terminate in an energy dissipator in Sedimentation Basin 1. Detail 3 on Plan Sheet 21 depicts the energy dissipator.

### 3.13.5 Ditching

Surface water ditching has been designed to minimize velocities and depths of flow. Velocities for the grass-lined ditching have been limited to 4 feet per second (fps). In areas where velocities exceed 4 fps, permanent erosion matting, or grouted riprap are proposed to limit erosion and reduce velocities. Ditch sizing calculations are contained in Appendix K. Proposed ditch locations are shown on Figure K-3 in Appendix K.

### 3.13.6 Sedimentation Basins

Two permanent and one temporary sedimentation basins are proposed to handle runoff from the proposed DPC Phase IV disposal area. The locations of the proposed sedimentation basins are shown on Plan Sheets 7 to 12. The basins have been designed with a minimum surface area that exceeds the surface area required to settle 0.015 mm particles for all storm events up to, and including, the 100-year, 24-hour storm. The sedimentation basins have also been designed to dewater in no less than 3 days following a 25-year, 24-hour storm. The sedimentation basins have been designed to handle the surface water runoff from a 100-year, 24-hour storm event. The emergency spillways have also been included to handle the surface runoff from a storm greater than the 100-year, 24-hour storm event. Calculations of the performance of the sedimentation basins are contained in Appendix K.

### 3.13.7 Culverts

Several culverts are proposed to handle runoff from the Phase IV disposal area and surrounding areas. The locations of the culverts are shown on Plan Sheets 6 to 12. The culverts have been designed to allow the peak runoff associated with a 100-year, 24-hour storm to pass through it without creating surface water breaching (i.e., berm overflow) or excessive backwater levels. Culvert sizing was performed using design charts developed by the U.S. Department of Transportation Federal Highway Administration. Culvert sizing calculations are included in Appendix K.

### 3.13.8 Temporary Surface Water Controls

In addition to the permanent surface water management features discussed above, temporary surface water controls will also be implemented during operation of the landfill to control surface water runoff from entering the active disposal area (where it would then be treated as leachate) and to limit erosion of the final cover. These temporary control features include diversion berms, downslope discharge structure, and culverts. Temporary diversion berms will be constructed as needed along the transition from an active area to an area that has reached final grade, or that has intermediate cover, in order to control surface water runoff from entering the active area. A temporary downslope discharge structure may also be used to route surface water runoff from diversion berms (either temporary or permanent) to the perimeter ditches.

### 3.13.9 Predevelopment Versus Post-Development Surface Water Flows

The proposed site development will not significantly alter the surface water discharge and runoff to the main drainage channel, and will exceed the requirements of NR 504.09. A comparison of total runoff and peak flow rates to the main drainage ditch from a 100-year, 24-hour storm for predevelopment and post-development conditions is presented below:

- Predevelopment
  - Total runoff (includes on-site and off-site areas – Figure K-1 in Appendix K) = 232 acre-feet
  - Peak flow rate = 1,895 cfs
- Post-development
  - Total runoff (includes on-site and off-site areas – Figures K-2 and K-3 in Appendix K) = 225 acre-foot
  - Peak flow rate = 1,622 cfs

From pre- to post-development, there was a slight decrease in the total runoff volume, and the peak flow rate to the main drainage ditch decreased by approximately 15 percent (273 cfs). This change is due primarily to the dampening effect of the sedimentation basins.

## 3.14 Gas Management System

NR 504.08 requires that facilities which accept waste with the potential to generate gas be designed to prevent the migration of explosive gases generated by the waste fill. The ash disposed at this site is biologically inert; thus, a gas management and monitoring system has not been included in the design in accordance with the Feasibility Determination.

## 3.15 Air Emission Permitting

On September 19, 2000, DPC submitted a request for exemption from construction permit and air monitoring requirements for the Phase IV disposal area (see Appendix A). On September 19, 2000, the WDNR West Central Region Air Management Program responded with a letter indicating that the proposed Phase IV disposal area has been determined to be exempt from construction permit requirements in accordance with NR 406.04(4)(h) (see Appendix A). In addition, air monitoring has been determined to not be necessary at this time.

## 3.16 Site Phasing

The site will be developed and operated in cells. The layout of cells is shown on Plan Sheet 4 (Subbase Grades). Cell 1 is located in the northeastern end of the site, with each cell thereafter proceeding to the west and south.

Filling will begin in Cell 1, progress to Cell 2 (Modules A and B), and continue sequentially through Cell 4, Module B. This cell-by-cell design will allow for the seasonal construction required for landfills.

As illustrated on Plan Sheets 6 through 11, liners, leachate collection systems, perimeter berms, and surface water drainage features will be constructed prior to the development of each successive cell to minimize erosion. As also shown on those phasing drawings, as major portions of final cover slopes reach final grades, the final cover system for those areas will be constructed and vegetated. Depending on when final grades are reached, final cover construction may not occur until the following construction season.

After waste placement in Cell 4, Module B is completed, the remainder of the final cover system will be constructed, and remaining portions of the access road and the drainage structures will be completed. See Plan Sheet 12 for the entire landfill final cover grades. Tables contained in Appendix C summarize the material quantities for each cell.

# Section 4
# Site Construction

## 4.1 General

This section addresses various considerations regarding landfill site construction beyond those already discussed in Section 3. Included is information on the major design considerations during construction, the limitations to construction due to weather conditions, the horizontal and vertical control that will be maintained during construction, the phasing and timing of construction, and the documentation that will be performed during construction and subsequently submitted to the WDNR for review and approval prior to ash placement. Personnel responsible for the construction should also be familiar with the contents of Section 3, which presents information on the logic used in preparing the design elements and the major objectives to be accomplished during construction.

## 4.2 Construction Procedures

Construction of the Phase IV ash disposal facility will occur in four cells. Construction of Cell 1 is planned to start in April 2001 and be completed in September 2001. Construction of Cells 2, Modules A and B, 3, and 4, Modules A and B is expected to occur sequentially, subject to actual ash disposal rates.

The construction procedures addressed in this section are presented to guide construction personnel in the development and closure of the site, although the actual site construction means and methods will be the responsibility of the construction contractor. The main work elements for site construction include site preparation, subbase excavation, abandonment and replacement of several monitoring wells, groundwater monitoring and installation of a new water supply well, composite liner system construction, leachate collection system installation, leachate head well installation, surface water drainage control, access and maintenance road construction, and final cover construction. Construction documentation and testing procedures and frequencies for earthen and synthetic materials will meet the requirements of NR 516 and the CQA Plan (Appendix D).

Erosion control features to minimize sediment runoff will be implemented prior to earthwork as discussed in Subsection 4.9.

## 4.3 Well Abandonment and Construction

Monitoring wells W42, P42A, W42B, W102, and W102A will be replaced with wells W42R, W42AR, W102R, and W102AR prior to ash disposal in Phase IV. In addition, wells Station 1, Station 2, and W43 will be abandoned during Cell 1 construction (refer to Plan Sheet 13). The existing high capacity well (PW1) will be abandoned, and a new high-capacity well will be installed at (or near) 168470N, 1476700E (Plan Sheet 3). This location is over 1,200 feet from all past, current, and proposed ash disposal units at the site. Bumper posts, or equivalent, will be utilized (as needed) to protect monitoring wells during landfill construction activities. A separate submittal will be forwarded to the WDNR Drinking Water Section to obtain approval for the new high-capacity well.

## 4.4 Subbase Grade Establishment

Subbase grades will be established as shown on Plan Sheet 4. Material excavated will be used for the construction of surface water control features, perimeter berms, access roads, subbase grades, liner construction, or other site development features. Excess material will be stockpiled for use in liner construction, final cover construction, berm and road construction, other on-site construction projects, and site operations. Stockpile locations are shown on Plan Sheets 6 through 11. Separate stockpiles will be created for the topsoil, general fill, and low-permeability layer material. These stockpiles will include surface water and erosion control features as described in Subsection 4.5. Material quantity estimates for the subbase excavation are included in Tables 2 and 3 in Appendix C, and are based on the grades shown on Plan Sheets 6 through 11.

Subbase grade preparation will consist of clearing and grubbing, stripping and stockpiling of low-permeability layer (loess) material, general fill, and topsoil; excavating and using or stockpiling material to achieve subbase grades; testing soil as required; undercutting leachate collection system lines; finish-grading; and documenting grades. Excavation will be controlled during construction through the use of grade staking and verification surveys. Subbase grades will be surveyed on a maximum 50-foot grid, and leachate collection trench undercut grades will be surveyed every 25 linear feet, or every 50 linear feet if a total station or laser equipment is used to set elevations, in accordance with Chapter NR 516.05(1)(a).

During subbase excavation, surface water drainage will be controlled through the use of temporary ditching, diversion berms, sedimentation basins, and erosion control measures. Surface water controls will be established in both the cell being constructed and in the area of material stockpiling. Additional information on surface water management during construction is presented in Subsection 4.9.

## 4.5 Stockpiles

Stockpiles will be created during the construction of each of the four cells. The proposed stockpile locations are shown on Plan Sheets 6 through 11. During excavation activities, care will be taken to identify the different types of material encountered, and to separate these materials during stockpiling. Separate areas of the stockpiles will be created for the topsoil, low-permeability layer material, and general fill. The material that is excavated and/or stockpiled will be used for liner, berm, final cover, and other miscellaneous construction. Upon completion of soil stockpiling activities, stockpile surfaces will be vegetated.

Erosion control measures for the stockpile areas will be implemented. The erosion control measures will include berms, ditching, hay bales, and the seeding of the stockpiles and of the area surrounding the stockpiles that will remain undisturbed for an extended period. Refer to Detail 2 on Plan Sheet 23 for a detail illustrating erosion control measures at the stockpiles.

## 4.6 Composite Liner and Cover System

### 4.6.1 Low-permeability Layer

The low-permeability layer to be used for the liner construction will be obtained from the on-site excavations for subbase preparation. Appendix C includes material balance calculations for the loess material to be used for the low-permeability layer. Low-permeability layer material (base and sidewalls) will meet the specifications provided in the CQA Plan (Appendix D), and will be placed and compacted to a density that is at least 90 percent of the maximum dry density as determined by the Modified Proctor test method. The CQA Plan also includes a discussion of procedures to segregate acceptable materials for use as the low-permeability layer. This material will be placed and compacted to achieve a hydraulic conductivity of $1 \times 10^{-5}$ cm/s or less. The soil will have a minimum thickness of 2 feet measured vertically from the liner surface. The thickness will be documented by surveys performed on the same 50-foot grid used to document subbase grades. Compaction will be achieved by use of a sheepsfoot compactor, with a minimum static weight of 30,000 pounds, or an equivalent piece of equipment.

During placement of the low-permeability layer, the maximum allowable clump size and stone size will be 2 inches in diameter. The final lift of the layer will be smooth drum-rolled, and coarse gravel or cobbles larger than 1 inch in diameter will be removed. In addition, areas with ruts greater than 1 inch in depth will be reworked to remove the ruts.

The soil will be tested both in the field (to document compaction) and in the laboratory (to document hydraulic conductivity and material properties) in accordance with s. NR 504.06. Samples of the soil will be obtained both prior to, and after, placement. Additional information on the field and laboratory testing requirements is presented in the CQA Plan in Appendix D.

The low-permeability layer material obtained may require moisture-conditioning prior to compaction. Soil that contains excessive moisture will be spread and disked, if necessary, and allowed to dry prior to compaction. Soil that is dry of the specified moisture content range will be moisture-conditioned with water prior to compaction. Areas of the liner that have dried out prior to placement of the subsequent lift of soil will be scarified and moisture-conditioned prior to the placement of the next lift.

During phased construction of the liner, the low-permeability layer will be extended beyond the cell line. This portion of the liner will be used for splicing together the liner systems of adjacent cells (see Detail 5 on Plan Sheet 17).

### 4.6.2 Grading Layer

The 6-inch–thick grading layer to be used for final cover construction will consist of general fill soil and will be obtained from the on-site excavations for subbase preparation. The grading layer material will meet the specifications provided in the CQA Plan (Appendix D). This soil will have a minimum thickness of 6 inches measured vertically from the cover surface. The thickness will be documented by surveys performed on the same 100-foot grid that will be used to document the subsequent final cover components (50-foot grid for areas less than 4 acres), in accordance with Chapter NR 516.06(1)(a).

During placement of the grading layer, the maximum allowable clump size and stone size will be 2 inches in diameter. The surface of the grading layer will be smooth drum-rolled and coarse gravel or cobbles larger than 1 inch in diameter will be removed. In addition, areas with ruts greater than 1 inch in depth will be reworked to remove the ruts. Refer to Details 1 and 3 on Plan Sheet 19 for illustrations of the final cover layers and a final cover splice, respectively.

During operation of Phase IV, DPC will evaluate the ease of grading the ash and the texture of the surface that can be graded. If the ash can be graded such that an adequate surface can be prepared for GCL deployment, DPC may, in the future, request that the 6-inch–thick soil grading layer be eliminated.

### 4.6.3 Geosynthetic Clay Liner

The installation of the GCL will begin following the approval of the low-permeability layer. Detailed specifications for the materials, installation, testing, and documentation of the GCL are contained in the CQA Plan (Appendix D); however, this subsection provides a brief overview of those items. As described in Subsection 4.12, a preconstruction report will be submitted to the WDNR a minimum of 15 days prior to a preconstruction meeting for the installation of the geosynthetic portions of the liner or cover for each cell.

The GCL will consist of a layer of pure sodium bentonite encapsulated between two geotextiles that will provide a low-permeability barrier layer. The GCL will be placed such that the side recommended by the manufacturer is facing up. The GCL will be orientated parallel (i.e., running up and down the slope) to the slopes that are in excess of 10 percent. Due to the manufactured roll length (150 feet), end seams will be necessary; however, the number of end seams on slopes greater than 10H:1V will be minimized and will not be deployed within 25 feet up- or down-slope of another end seam on an adjacent panel.

The GCL will be deployed such that there is a 6-inch minimum overlap on longitudinal seams and a 24-inch overlap on end seams or as recommended by the manufacturer, whichever is greater. The panels will be placed with the overlap on both longitudinal and end seams shingled down-slope. If the GCL requires granular bentonite to be placed along the seam, the overlapping panel edge will be pulled back and granular sodium bentonite will be poured continuously along all seams, at an application rate of ¼ pound per linear foot.

Anchor trenches will be constructed at the top of the slope of the liner to secure the GCL during installation (Detail 3 on Plan Sheet 17). In addition, sandbags will be deployed as needed, along the edge of the GCL to prevent the GCL from shifting due to high winds or for other construction-related reasons.

The GCL will be tested during manufacturing, and prior to installation. The results of manufacturer's testing will be submitted for review and approval prior to the acceptance of GCL rolls delivered to the site. Samples from selected rolls delivered to the site will also be collected for conformance testing to be completed by a third-party laboratory prior to acceptance and installation. No field testing of the GCL will be performed. The testing requirements, acceptable values, and responsibilities are further explained in the CQA Plan (Appendix D).

The installation of the GCL will be performed in accordance with s. NR 516, the "Guidance for the Use of Geosynthetic Clay Liners (GCLs) at Solid Waste Facilities, and the CQA Plan (Appendix D).

### 4.6.4 HDPE and VFPE Geomembrane

The HDPE and the VFPE geomembrane will be deployed at a rate equivalent to that of the GCL deployment rate such that the GCL panels will be covered daily to prevent against physical damage and/or hydration of the GCL. Detailed specifications for the materials, installation, testing, and documentation of the geomembrane are contained in the CQA Plan (Appendix D); however, this subsection provides a brief overview of those items. As described in Subsection 4.12, a preconstruction report will be submitted to the WDNR a minimum of 15 days prior to a preconstruction meeting for the installation of the geosynthetic portions of the liner or cover for each cell.

The geomembrane will be fabricated from a polyethylene resin, which will have a density range of 0.940 g/cc or higher for HDPE and 0.939 g/cc or less for VFPE. The nominal geomembrane thickness will be 60 mils for HDPE and 40 mils for VFPE, with no thickness measurements falling below the minimum industry-accepted manufacturing tolerance. In addition, the geomembrane will have a melt index value, per ASTM D1238, of less than 1.0 g/10 minutes for HDPE and 0.6 g/minutes for VFPE. The resin will be virgin material with no more than 10 percent rework, and if rework is used, it must be of the same formulation as the parent material. No post-consumer resin (PCR) of any type will be added to the formulation.

The geomembrane will be installed with the panels orientated perpendicular to the contours (i.e., running up and down the slope) on slopes in excess of 10H:1V. No horizontal seams will be allowed on slopes greater than 5H:1V. In corners and at other odd-shaped geometric intersections, the number of horizontal seams will be minimized.

The geomembrane will be deployed over the GCL using different techniques, dictated based on if the geomembrane is smooth or textured. On the shallower slopes, where smooth geomembrane is to be deployed, the geomembrane may be installed by pulling the geomembrane out to the desired length using laborers or small four-wheel-drive all-terrain vehicles (ATVs), either directly over the GCL or an adjacent panel. If pulled out over an adjacent panel, laborers will then pull the geomembrane sideways across the GCL into place. Alternative deployment methods may be proposed during the preconstruction meeting.

On steeper slopes, where textured geomembrane is to be deployed, a "rub sheet" made of thin plastic will be used to protect the GCL from damage when the geomembrane is pulled across the GCL. The method used to deploy the textured geomembrane may be similar to the two methods discussed for smooth geomembrane once the "rub sheet" is in place, or the installer may propose an alternative method during the preconstruction meeting.

Production seaming (linear seams) will be performed using the dual hot wedge (fusion type) seam method. Non-production seams (detail work and repairs) will be performed using the extrusion fillet weld process. Corners, butt seams, and long repairs will be fusion-welded where possible. The geomembrane component of the adjacent cell will be welded together for a continuous membrane surface.

Anchor trenches will be constructed at the top of the slope of the liner to secure the geomembrane during installation (Detail 3 on Plan Sheet 17). In addition, sandbags will be deployed as needed, along the edge of the geomembrane to prevent the geomembrane from shifting due to high winds or for other construction-related reasons. The geomembrane will be seamed completely to the end of the panels to minimize the potential for tears to start along the seams placed in the anchor trench.

The geomembrane will be tested during manufacturing, and prior to and during installation. The results of the manufacturer's testing will be submitted for review and approval prior to the acceptance of geomembrane rolls delivered to the site. Samples from selected rolls delivered to the site will also be collected for conformance testing by a third-party laboratory prior to acceptance and installation. Finally, during placement, both nondestructive and destructive testing of the geomembrane seams will be performed. Nondestructive testing will be performed by the installation contractor and observed by a third party. Destructive testing will consist of both field and third-party laboratory testing of the samples collected. The testing requirements, acceptable values, and responsibilities are further explained in the CQA Plan.

The geomembrane installation will be documented in accordance with s. NR 516 and the CQA Plan (Appendix D). In addition, following the installation of the select granular fill drainage layer material over the geomembrane liner, electrical resistivity testing will be conducted over the entire lined area. Detected defects will be uncovered and repaired in accordance with industry standards and manufacturer's recommendations.

### 4.6.5 Granular Drainage Layer

After placement and testing of the geomembrane, or portions thereof, a 12-inch-thick select granular fill drainage layer will be placed as soon as practicable to protect the geomembrane and to provide a confining pressure for the underlying GCL. DPC will make every effort to have the entire membrane covered with the drainage layer as soon as possible. At a minimum, the select granular fill will be placed within 30 days of completing the membrane installation and quality assurance testing. The select granular fill drainage layer is part of the leachate collection system and drainage layer for the final cover, which is further described in Subsections 3.8.3 and 3.11.4.

To minimize the potential for large wrinkles in the geomembrane, the drainage layer will be placed during cooler temperatures when possible. Wrinkles in the geomembrane that are higher than they are wide, will be smoothed or cut out and repaired prior to placing the drainage layer.

The initial lift of select granular fill will be 2 to 3 feet thick, depending on the type of equipment being used, to provide an access ramp into the cell. A minimum of 2 feet of material will be placed prior to operating tracked vehicles and flotation tire-equipped vehicles, while a minimum of 3 feet of material will be placed prior to operating trucks and other wheeled hauling equipment. The initial lifts of select granular fill will eventually be graded to the designed 1-foot-thick layer with a low ground pressure (< 5 psi) tracked vehicle. The procedure for deployment of the granular drainage blanket will be established at the preconstruction meeting.

### 4.6.6 Geotextile

A minimum 12 ounce/square yard geotextile cushion will be installed above the geomembrane in the leachate collection trenches to protect the geomembrane from damage from the leachate collection pipe bedding material, as well as to protect the geomembrane from ultraviolet (UV) degradation (refer to Detail 1 on Plan Sheet 17). A minimum 12 ounce/square yard geotextile cushion will be included over the entire liner area if the select granular fill material exceeds ¼ inch in size, in accordance with NR 504.06(5)(t).

### 4.6.7 General Fill Rooting Layer

A 12-inch-thick uncompacted general fill rooting layer will be placed above the drainage layer in a single lift. The general fill rooting layer will provide a rooting zone for vegetation, and will protect the cap from damage due to freeze-thaw and desiccation.

The general fill rooting layer will consist of on-site soil and will meet the requirements of the CQA Plan (Appendix D).

### 4.6.8 Topsoil and Vegetation

The top layer of the final cover system will be a 6-inch-thick layer of topsoil in accordance with NR 504.07(7). Topsoil stripped from the landfill and perimeter areas during site preparation will be stockpiled and reused in the final cover. Samples will be obtained from each topsoil stockpile for soil fertility testing prior to placement of final cover. Testing will consist of pH, nitrogen, phosphorus, and potassium assessment. After topsoil is placed, the area will be seeded, mulched, and fertilized, as required, based on the topsoil test results in accordance with NR 504.07(8). Prior to seeding, the topsoil layer will be prepared for seeding by disking and pulverizing soil within 2 inches of the surface. Fertilizer and lime will be applied at rates specified by the nutrient analysis.

The seed mixture and related information is described in Subsection 3.11.6. Seed will be applied at a rate of approximately 150 lb/acre.

## 4.7 Leachate Collection System

The leachate collection system will consist of perforated collection piping, cleanout risers, nonperforated double-walled transfer piping, leachate transfer manholes, a leachate collection tank, and leachate head wells. In addition, a 12-inch-thick layer of select granular fill will be placed on the entire base and the sidewalls of the landfill to convey leachate to the collection pipes (Subsection 4.6.5).

### 4.7.1 Leachate Collection Pipes

The leachate collection pipes will consist of perforated 6-inch-diameter SDR 17 HDPE pipes placed in vee-trenches as shown on Detail 1 on Plan Sheet 17. Collection trench elevations will be documented with surveys performed every 25 linear feet, or every 50 linear feet if a total station or laser equipment is used to set elevations, as specified in Chapter NR 516.05(1)(a). A minimum of 4 and 12 inches of select aggregate fill (pipe bedding material) will be placed below and above the pipes, respectively. The pipe bedding material will conform to the requirements of NR 504.06(5)(e) and the CQA Plan (see Appendix D). A 6-inch-thick layer of select graded fill will be placed over the pipe bedding material, if needed for filtering the select aggregate fill. Pipe joints will be butt-fusion-welded in accordance with the manufacturer's recommendations. The leachate collection piping will be flushed after construction, and the appropriate documentation will be submitted to the WDNR.

### 4.7.2 Cleanout Risers

Leachate collection piping will be connected to cleanout risers to allow access to the collection pipes. The cleanout risers will consist of nonperforated 6-inch-diameter SDR 17 HDPE pipe. Cleanout risers will be constructed inside manholes as shown on Detail 2 on Plan Sheet 18 and up the sidewalls as shown on Detail 6 of Plan Sheet 17. Twenty-four inches of granular drainage blanket material will be mounded over the cleanouts on the sideslopes. The cleanout risers will include a locking cap at the termination in the manholes and at the top of the sideslope.

### 4.7.3 Leachate Transfer Piping

Leachate will be transferred via gravity from the interior leachate collection piping system to the leachate storage tank through a double-walled HDPE transfer piping system. The transfer piping will penetrate the landfill liner as described in Subsection 3.8.4, and as shown on Details 2 and 4 on Plan Sheet 17. The transfer piping will be routed through a series of leachate transfer manholes (see Subsection 4.7.4, Plan Sheet 5, and Detail 2 on Plan Sheet 18).

The double-walled leachate transfer piping will consist of nonperforated 6-inch-diameter SDR 17 HDPE pipe encased in nonperforated 8-inch-diameter SDR 17 HDPE pipe and will be constructed in a trench as shown on Detail 3 on Plan Sheet 23. The transfer piping will be installed a minimum of 4 feet below final grade for frost protection. The HDPE forcemain piping will be joined using the butt-fusion-welding process in accordance with the pipe manufacturer's recommendations. The entire length of the transfer line and the containment pipe will be pressure-tested in accordance with the CQA Plan (Appendix D) to document the pipe welds. Additional information on the piping is included in Appendix E.

### 4.7.4 Leachate Transfer Manholes

Leachate transfer manholes will be placed just south of each cell and at a junction point between the landfill and the leachate storage tank. The leachate transfer manholes will be 4-foot-diameter precast concrete manholes with epoxy coating on the interior to provide the secondary containment for the pipes in the manhole. Transfer manhole locations and details are shown on Plan Sheets 5 and 18, respectively.

### 4.7.5 Leachate Storage Tank

Leachate will flow by gravity to the underground storage tank through double-walled SDR 17 HDPE transfer piping. The storage tank will consist of a 30,000-gallon double-walled STI-P3 cathodically protected steel-reinforced tank, as shown on Detail 1 on Plan

Sheet 18. The interior of the tank will be coated with epoxy or another liner material compatible with the leachate. The tank will be installed per the manufacturer's recommendations (refer to Appendix E for representative tank information). The tank will be anchored with concrete deadmen and tie-down straps and backfilled with select granular fill.

## 4.8 Leachate Head Well Installation

Once the geomembrane component of the composite liner system has been installed, the 3-inch-diameter Schedule 120 PVC leachate head wells will be installed (see Detail 6 on Plan Sheet 17). Two leachate head wells will be installed for each cell (see Plan Sheets 5 and 13 for locations). The head wells will be placed over the geomembrane/GCL liner, within the select granular fill drainage layer. General fill will be mounded around the head well piping at the termination at the top of the berm for support. During final cover construction, the mounded general fill will be replaced with final cover material.

## 4.9 Surface Water Control Features

Surface water controls will be constructed during each stage of landfill development to control rainfall runoff and limit the amount of sediment discharge off-site. Subsections 3.13.2 and 3.13.8 discuss the sequencing of storm water control features and temporary storm water controls.

During site construction, ditching will be used to divert surface water away from the construction areas to the maximum extent possible. Silt fencing will also be utilized to control erosion. In areas where soil is stockpiled, diversion berms/ditches and hay bale outlet structures will be installed to intercept the sediment in the surface water runoff. Refer to Plan Sheets 6 through 11 and Detail 2 on Plan Sheet 23 for stockpile erosion control features.

Additional erosion control measures will be taken as needed to control surface water drainage and erosion. Ditch checks consisting of silt fence or hay bales will be installed in drainage ditches to control erosion until vegetation is established. Exposed soil areas outside of the limits of landfill operations and stockpiles that will remain undisturbed for more than 6 months will be vegetated to minimize erosion. Refer to Detail 1 on Plan Sheet 23 for a sediment control fence detail.

The surface water control system will be inspected after each rainfall event during construction. When problems are identified, repairs will be made as soon as possible to restore the system to proper operating condition. Further details of the site-specific Storm Water Pollution Prevention Plan are included in Appendix L.

## 4.10 Access Roads and Maintenance Roads

The main access road into the facility is an existing bituminous access road that extends from U.S. Highway 35 to the ash processing area. Refer to Plan Sheets 3 and 5 for layout of the existing and proposed access roads.

The main access road to the Phase IV area is an 18-foot-wide all-weather access road that connects to the existing bituminous access road near the processing facility. During each cell development, new access roads will be constructed (see Plan Sheets 6 through 11). The all-weather access roads will be constructed as shown on Detail 6 on Plan Sheet 23. The turning radii of the various vehicles anticipated to use the main access road have been incorporated into the design. Access roads used by highway vehicles will be constructed to grades not to exceed 10 percent slope.

Maintenance roads will provide access to the perimeter berms for maintenance work and pipe cleaning. Refer to Plan Sheets 6 through 10 and Detail 5 on Plan Sheet 23.

## 4.11 Sequential Site Construction

### 4.11.1 General

The Phase IV disposal facility is divided into four cells. The phasing design presented in this Plan of Operation took into consideration ash disposal rates, leachate management, design capacity, access roads, and surface water management.

### 4.11.2 Individual Cells

Sequential site preparation, construction, and closure activities are listed on the phasing drawings (Plan Sheets 6 through 11). The phasing drawings also indicate where connections and cell-specific features are to be constructed throughout the phased development of the landfill.

A detailed discussion of sedimentation control measures to be implemented during construction activities is included in Subsection 4.9. The respective phasing drawings illustrate the erosion control features to be implemented, at a minimum. Silt fencing will be maintained or replaced, as needed, until it is no longer needed. After construction activities are completed and vegetation is established, silt fencing will be removed.

### 4.11.3 Site Closure

Site closure will consist of placing the final cover system components, and establishing vegetation. The site will be closed in increments as substantial areas reach final grades.

Placement of the final cover system components will include construction of surface water drainage structures. The phased closure of the landfill will reduce leachate generation rates. See Plan Sheets 6 through 12 for a listing of closure activities for each of the cells.

Although not required (see Subsection 3.9), intermediate cover consisting of on-site soil may be placed over areas that have received ash and that will remain inactive. Temporary intermediate cover may be used on intermediate slopes to minimize leachate generation by diverting clean surface water to surface water management system. If temporary intermediate cover is used, it will be subsequently used as the 6-inch grading layer component of the final cover system or for structures within the ash limits. Areas that received temporary intermediate cover and that will remain inactive for a period of 6 months or longer over a growing season will be vegetated.

### 4.11.4 Quantities and Timing

The quantities associated with each cell of construction are tabulated on each of the phasing drawings (Plan Sheets 6 through 12) and are summarized in Appendix C. Quantities are included for excavation, topsoil, low-permeability layer, geomembrane/GCL, geotextile, select granular fill material, general fill, and final cover. Also indicated are the design capacity and approximate time span over which ash disposal is projected for each cell.

The approximate life indicated for each cell is based on estimated average ash filling rates. The actual site life of each cell may vary depending on market conditions for power generation and beneficial use.

Adverse weather conditions could restrict construction progress during any construction season. Construction of areas for future ash disposal will therefore occur sufficiently in advance of the time when additional airspace will be needed to allow ample time to complete construction and receive approval.

### 4.11.5 Phased Sequencing of Soil Volumes

Throughout the development of the proposed landfill, there will be a need to handle large quantities of soil. Site preparation for each cell will include both excavation and soil placement for berm and liner construction. Upon completion of ash filling in an area, placement of the proposed final cover will require handling of soil materials. Soil quantities for each cell of development are summarized in Appendix C.

## 4.12 Preconstruction Report

In accordance with s. NR 516.04(5), a preconstruction report will be submitted to the WDNR, a minimum of 15 days prior to the preconstruction meeting for the installation of the geosynthetic portions of the liner or cover for each cell. The submittal will address the requirements of s. NR 516.04(5), including but not limited to, the following:

- The name of the manufacturer and contractor selected to supply and install the geosynthetics components and their respective experience
- The name of the third-party testing laboratory
- A copy of the technical specification for the geosynthetic components and their installation
- The results of the shear testing performed on the geosynthetics and the material with which they are in contact
- The most recent version of the Construction Quality Assurance (CQA) and Construction Quality Control (CQC) Plans
- Panel layouts for the geosynthetics to be used
- Information regarding the manufacturer's quality control, including certification from the GCL manufacture that the GCL is free of needles if the material is needle punched
- The identification and justification for proposed changes to the information presented in the POO

## 4.13 Construction Observation and Documentation

The construction and closure of the landfill will be documented under the direct supervision of a professional engineer registered in the State of Wisconsin, in accordance with s. NR 516.04. In addition, a registered professional engineer or a qualified technician under the direct supervision of a registered professional engineer will be present at all times during critical construction periods, such as liner and final cover placement, leachate collection system construction, leachate transfer and storage system construction, and granular drainage layer placement.

Reports documenting new cells and closure of cells (construction observation reports) will be prepared in accordance with NR 516.05 and NR 516.06, respectively. Additional site-specific details regarding construction observation and documentation are provided in the CQA Plan (see Appendix D).

Three copies of each construction observation report will be submitted to the WDNR Bureau of Solid and Hazardous Waste Management (in Madison, Wisconsin), and two copies will be submitted to the District Office (in LaCrosse, Wisconsin).

# F.2
# Plan of Operation Plan Set

# DAIRYLAND POWER COOPERATIVE

DAIRYLAND Power
COOPERATIVE – LACROSSE, WISCONSIN

## PLAN OF OPERATION
## PHASE IV DISPOSAL AREA
## ALMA OFF-SITE ASH DISPOSAL FACILITY

**PREPARED FOR:** DAIRYLAND POWER COOPERATIVE
LACROSSE, WISCONSIN

**PREPARED BY:** RMT, INC.
MADISON, WISCONSIN

**DATE:** OCTOBER 2000

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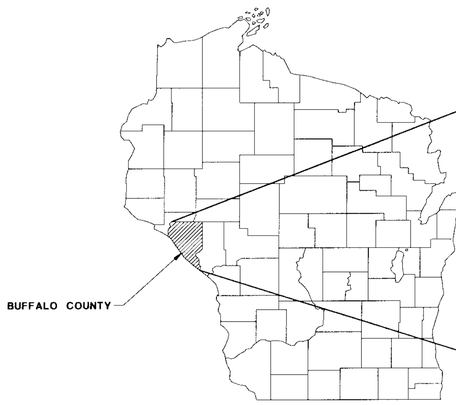
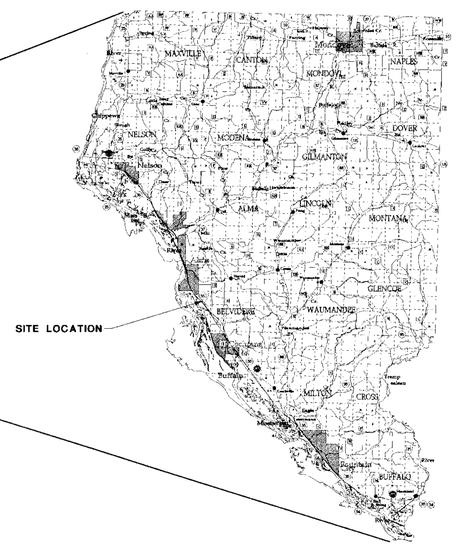
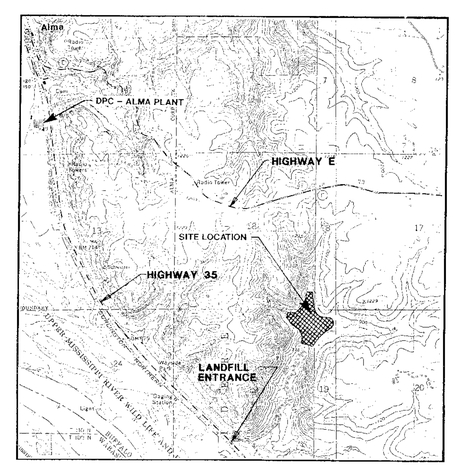



WISCONSIN




BUFFALO COUNTY




SCALE: 1"=2000'

MAP SOURCE: U.S.G.S. CREAM AND ALMA 7.5' QUADRANGLES, DATE 1974.

SITE LOCATION

NOTE: THESE PLANS ARE ACCOMPANIED BY A REPORT OF THE SAME TITLE. THESE DOCUMENTS ARE INTERRELATED AND ARE INTENDED TO BE USED AND REVIEWED TOGETHER. (NOT FOR CONSTRUCTION)


RMT
744 Heartland Trail
Madison, WI 53717-1934
P.O. Box 8923
Madison, WI 53708-8923
Phone: 608-831-4444



Plot Date
Design File : J:\0208-40\TITLE.dgn
Date : 10/13/2000
Plot File : J:\0208\40\TITLE.plt
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RMT COMPUTER AIDED DESIGN & DRAFTING

# STANDARD LEGEND

| EXISTING | DESIGNED | |
|---|---|---|
| | | **ROADWAYS** |
| | | GRAVEL |
| | | PAVED |
| | | RAILROAD |
| | | CENTERLINE |
| | | WALKS/DRIVES |
| | | **WALLS/FENCES** |
| | | EARTH WALL |
| | | FENCE LINE |
| | | **CONTOURS** |
| | 1054 | INDEX CONTOUR AND TEXT |
| | | INTERMEDIATE CONTOUR |
| | | DEPRESSION |
| | X 1055 | SPOT ELEVATION |
| | | **TREES** |
| | | DECIDIOUS |
| | | CONIFER |
| | | BUSH |
| | | TREELINE |
| | | **WATER** |
| | | BODIES OF WATER |
| | | RIVER/STREAMS |
| | | DITCH |
| | | DITCH WITH FLOW AND DIRECTION |
| | | WETLAND |
| | | BRIDGE |
| | | CULVERT |
| | | GROUNDWATER FLOW DIRECTION |
| | | **BUILDING** |
| | | BUILDING |
| | | **FEATURES** |
| | 001 | SEDIMENTATION BASIN OUTFALL LOCATION AND NUMBER |
| | MW1 | WATER TABLE WELL |
| | B1 | SOIL BORING LOCATION AND NUMBER |
| | RW1 | RECOVERY WELL |
| | TP3 | TEST PIT |
| | W100A; A1 | PIEZOMETER |
| | SG1 | STAFF GAUGE |
| | WS1 | WATER SAMPLE LOCATION |
| | GP1 | GAS MONITORING PROBE |
| | GV1 | GAS VENT |
| | GEW1 | GAS EXTRACTION WELL |
| | GHW1 | GAS EXTRACTION HEAD WELL |
| | LH1 | LEACHATE HEAD MONITORING WELL |
| | LGW1 | LEACHATE/GAS EXTRACTION WELL |
| | W43; STATION 1 | MONITORING WELL LOCATION AND NUMBER |
| | AMS1 | TSP AIR MONITORING STATION |
| | | **UTILITIES** |
| | SS | STORM SEWER LINE |
| | SAN | SANITARY SEWER LINE |
| | Eo | ELECTRIC |
| | GAS | GAS |
| | T | TELEPHONE |
| | C | CABLE |
| | UGT | UNDERGROUND TELEPHONE |
| | Ø | LIGHT POLE BASE |
| | W | WATER |
| | | **MISCELLANEOUS** |
| | | LIMITS OF CONSTRUCTION LINE |
| | | PROPOSED LIMITS OF ASH |
| | | APPROXIMATE LIMITS OF EXISTING ASH |
| | | DESIGN MANAGEMENT ZONE |
| | | PHASE/MODULE DELINEATION BERM LOCATION |
| | | **SURVEY DATA** |
| | | DPC PROPERTY LINE |
| | ROW | RIGHTOFWAY LINE |
| | BM5 | SURVEY BENCH MARK (VERTICAL AND HORIZONTAL CONTROL) |
| | | SURVEY CONTROL MONUMENT |

| EXISTING | DESIGNED | |
|---|---|---|
| | | **PIPE** |
| | FM | FORCEMAIN LINE |
| | | PIPE CLEANOUT |
| | MH1 | LEACHATE LIFT STATION/ MANHOLE |
| | | GAS COLLECTION/TRANSFER LINE |
| | DL1 | GAS EXTRACTION DRIPLEG |
| | SS1 | STORM SEWER MANHOLE |
| | | STORM SEWER INLET |
| | SAN1 | SANITARY SEWER MANHOLE |
| | | LEACHATE LYSIMETER RISER |
| | | GAS SERVICE VALVE |
| | | LEACHATE COLLECTION PIPE |
| | | SOLID WALL LEACHATE PIPE |
| | | COLLECTION SUMP/INCLINE LIFT STATION |
| | | **SURFACE** |
| | | FINAL COVER DIVERSION BERM |
| | | RIPRAP APRON |
| | | SURFACE WATER DOWNSLOPE FLUME |
| | | PERIMETER DRAINAGE DITCH WITH DIVERSION BERM |
| | | **PLAN SHEET** |
| | 10+00N | GRID TICK AND STATION |
| | OR | COORDINATE LOCATION |
| | 1/10 | DETAIL REFERENCE |
| | 5% | SLOPE PERCENT AND DIRECTION |
| | | ENGINEERING CROSSSECTION LOCATION |

# STANDARD NOTES

## NOTES

1. BASE MAP TOPOGRAPHY WAS OBTAINED BY DIGITIZING AND ENLARGING THE CREAM AND ALMA, WISCONSIN U.S.G.S. 7.5 MINUTE QUADRANGLE MAPS DATED 1974, AND FROM AERIAL PHOTOGRAPHY SUPPLIED BY AEROMETRIC ENGINEERING, INC., SHEBOYGAN, WISCONSIN. DATE OF PHOTOGRAPHY IS APRIL 3, 1993.
2. GRID SYSTEM UTILIZED IS BASED ON WISCONSIN STATE PLANE COORDINATES.
3. TOPOGRAPHIC CONTOUR INTERVAL IS 20 FEET.
4. VERTICAL DATUM (ELEVATION) IS REFERENCED TO USGS MEAN SEA LEVEL, 1929 ADJUSTMENT.
5. GROUNDWATER MONITORING WELLS STATIONS, W42, W100, W100A, W101, W101A, W102, W102A, W104, W104A, W105, W106, AND SOIL BORINGS B60, B61, B62, B63, B64, B65, B66, B67, B68, AND B103 WERE INSTALLED BY RMT, INC. BETWEEN OCTOBER 1994 AND NOVEMBER 1995. THE REMAINING MONITORING WELLS, SOIL BORINGS, AND TEST PITS WERE INSTALLED BY WARZYN, INC. BETWEEN 1979 AND 1982.
6. STATION 1, STATION 2, STATION 6, W42,W100,W100A, W101, W101A, W102, W102A, W104 W104A, W105, W106, B60, B61, B62, B63, B64, B65, B66, B67, B68, AND B103 WERE SURVEYED BY PARAGON ASSOCIATES FOR DPC ON 12/11/95. THE REMAINING BORINGS, MONITORING WELLS, AND TEST PIT LOCATIONS WERE TAKEN FROM WARZYN'S ENGINEERING REPORT DATED 2/25/80 TITLED "SUPPLEMENTARY SUBSURFACE INVESTIGATION OF THE NAMMACHER AND COX PROPERTIES PROPOSED SITE BI FLY ASH DISPOSAL FACILITY, DAIRYLAND POWER COOPERATIVE."
7. WELL W102 WAS INSTALLED ON MAY 1, 1997 AND SURVEYED SHORTLY THEREAFTER.

| BENCHMARK I.D. | NORTHING | EASTING | ELEVATION |
|---|---|---|---|
| BM101 | 172,659.32 | 1,477,719.53 | 923.85 |
| BM104 | 171,535.64 | 1,477,701.51 | 843.25 |
| BM106 | 171,529.11 | 1,476,833.90 | 848.44 |
| NE CORNER SEC. 19 | 172,589.61 | 1,478,280.50 | 895.48 |
| | | | |

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(NOT FOR CONSTRUCTION)

| NO. | BY | DATE | REVISION | APP'D. |
|---|---|---|---|---|
| 3. | | | | |
| 2. | | | | |
| 1. | | | | |

PROJECT: **DAIRYLAND POWER COOPERATIVE PLAN OF OPERATION BUFFALO COUNTY, WISCONSIN**

SHEET TITLE: **STANDARD LEGEND AND NOTES**

| | | |
|---|---|---|
| DRAWN BY: STORMERL | SCALE: | PROJ. NO. 3081.40 |
| CHECKED BY: DM | | FILE NO. LEGEND.PLT |
| APPROVED BY: BJK | DATE PRINTED: OCT 13 2000 | SHEET 2 OF 23 |
| DATE: OCTOBER 2000 | | |

RMT
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P.O. Box 8923
Madison, WI 53708-8923
Phone: 608-831-4444

Plot Date
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RMT COMPUTER AIDED DESIGN & DRAFTING

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E 1476000 | E 1476500 | E 1477000 | E 1477500 | E 1478000 | E 1478500 | E 1479000 | E 1479500

PHASE I LIMITS

PHASE III LIMITS

EXISTING PHASE III LANDFILL

EXISTING PHASE I LANDFILL

STATION 5

STATION 4

STATION 3

C3 C2 C1

B3 B2 B1

A3 A2 A1

PW2
PROPOSED WATER SUPPLY WELL 50' SOUTH AT 168470N,1476700E

APPROXIMATE EXISTING LIMITS OF ASH

DESIGN MANAGEMENT ZONE

STATION 6

EXISTING PHASE II LANDFILL

TP15 (ABANDONED)

W14

B13

TP16

PW1
DPC EXISTING WATER SUPPLY WELL

W100 W100A

W41

TP17 (ABANDONED)

W105

TP34

TP54

BM104 W104A W104

TP46

B22

B21

STATION 2

TP6

TP5

W102 W102A

B60

W102AR W102R

19 18
20 17

TP14

B15

TP59

TP40

W42R P42AR

TP60

TP11 TP10

B16

TP39

TP38

BM106 W106

W42 P42B P42A

TP7

TP51

APPROXIMATE PROPOSED LIMITS OF ASH

B66

TP36

TP52

B63

TP37

B17

B65

W107

B62 B18

B103

STATION 1

TP50

PROPOSED PHASE IV DISPOSAL AREA

B68

B64

TP41

B67

TP49

B19 B20

TP42

W101A

BM101 W101

W43

B61

APPROXIMATE DPC PROPERTY LINE

1500'

1200'

0 200 400 600 800

SCALE: 1" = 200'

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| NO. | BY | DATE | REVISION | APP'D. |
|---|---|---|---|---|
| 3. | | | | |
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| 1. | | | | |

PROJECT: DAIRYLAND POWER COOPERATIVE
PLAN OF OPERATION
BUFFALO COUNTY, WISCONSIN

SHEET TITLE:
**EXISTING CONDITIONS MAP**

| | | |
|---|---|---|
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| CHECKED BY: DM | | FILE NO. EXIST.PLT |
| APPROVED BY: BJK | DATE PRINTED: OCT 13 2000 | SHEET 3 OF 23 |
| DATE: OCTOBER 2000 | | |

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Madison, WI 53708-8923
Phone: 608-831-4444

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Plot Time : 16:12:08
Plot Date : 09/26/2000

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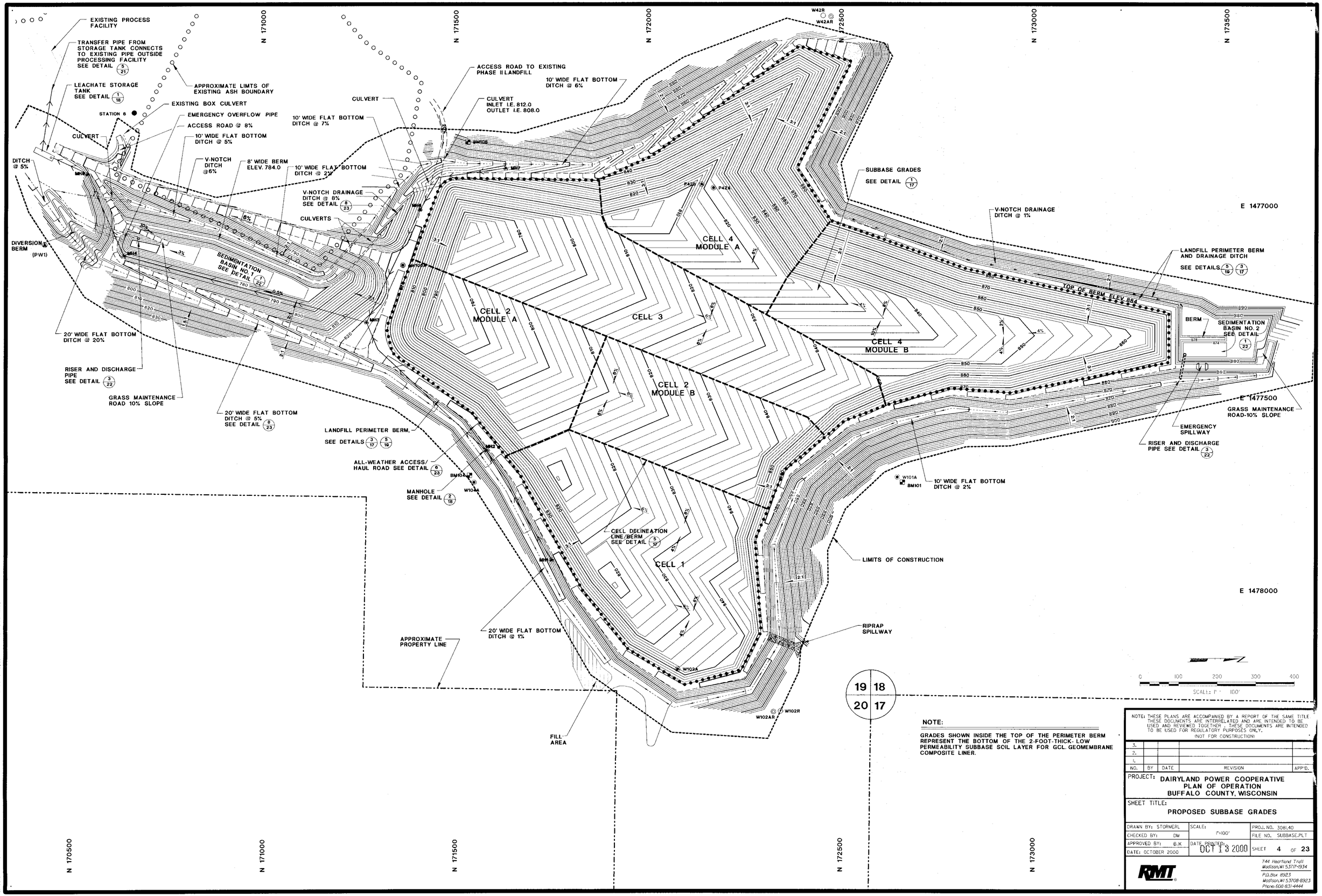


| 19 | 18 |
|---|---|
| 20 | 17 |

**NOTE:**

GRADES SHOWN INSIDE THE TOP OF THE PERIMETER BERM REPRESENT THE BOTTOM OF THE 2-FOOT-THICK- LOW PERMEABILITY SUBBASE SOIL LAYER FOR GCL GEOMEMBRANE COMPOSITE LINER.

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| 3. | | | | |
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PROJECT: DAIRYLAND POWER COOPERATIVE
PLAN OF OPERATION
BUFFALO COUNTY, WISCONSIN

SHEET TITLE:
PROPOSED SUBBASE GRADES

| | | |
|---|---|---|
| DRAWN BY: STORMERL | SCALE: 1"=100' | PROJ. NO. 3081.40 |
| CHECKED BY: DM | | FILE NO. SUBBASE.PLT |
| APPROVED BY: BJK | DATE PRINTED: OCT 13 2000 | SHEET 4 OF 23 |
| DATE: OCTOBER 2000 | | |

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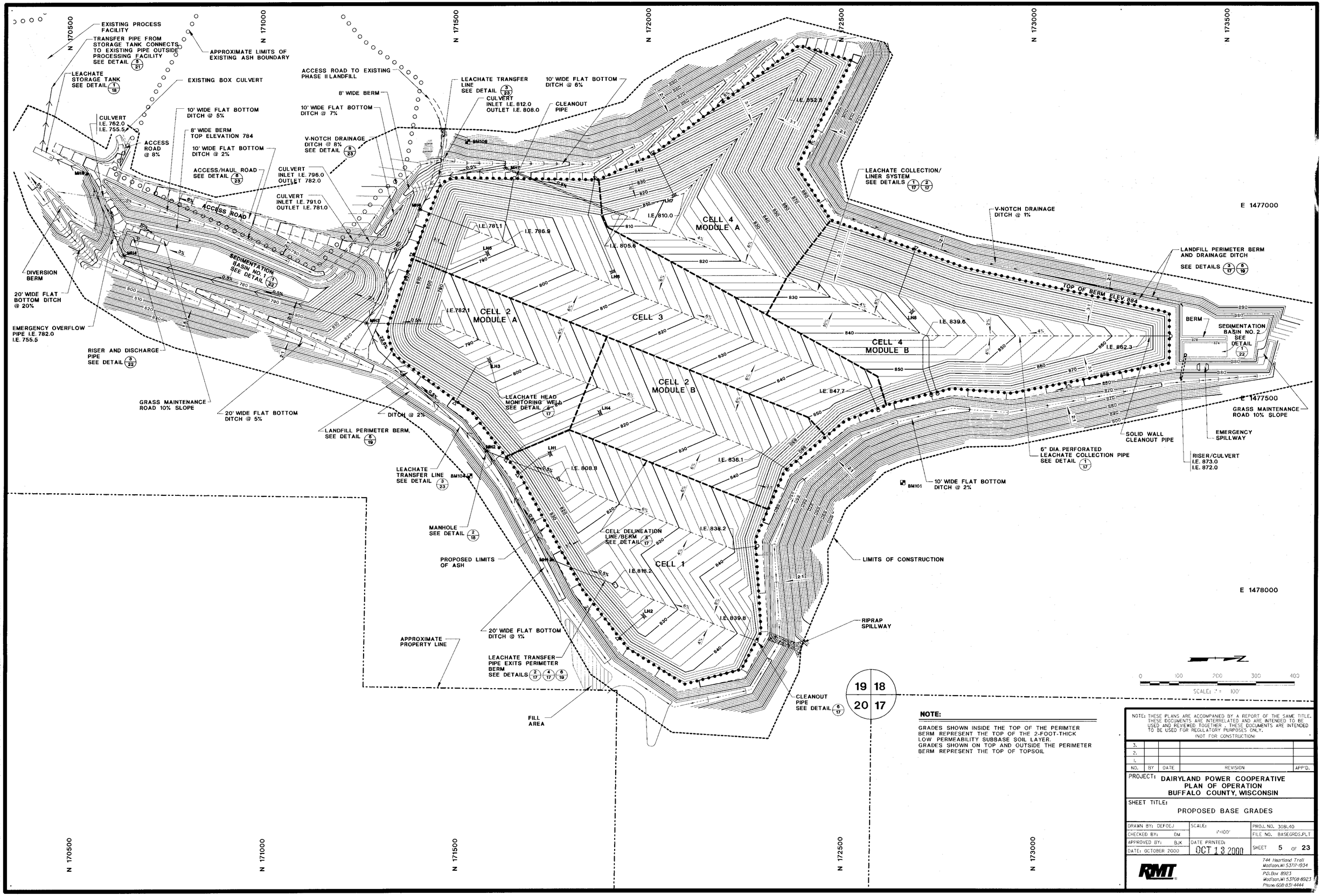


**NOTE:**

GRADES SHOWN INSIDE THE TOP OF THE PERIMTER BERM REPRESENT THE TOP OF THE 2-FOOT-THICK LOW PERMEABILITY SUBBASE SOIL LAYER.
GRADES SHOWN ON TOP AND OUTSIDE THE PERIMETER BERM REPRESENT THE TOP OF TOPSOIL

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PROJECT: DAIRYLAND POWER COOPERATIVE
PLAN OF OPERATION
BUFFALO COUNTY, WISCONSIN

SHEET TITLE:
PROPOSED BASE GRADES

| | | |
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| CHECKED BY: DM | | FILE NO. BASEGRDS.PLT |
| APPROVED BY: BJK | DATE PRINTED: OCT 13 2000 | SHEET 5 OF 23 |
| DATE: OCTOBER 2000 | | |

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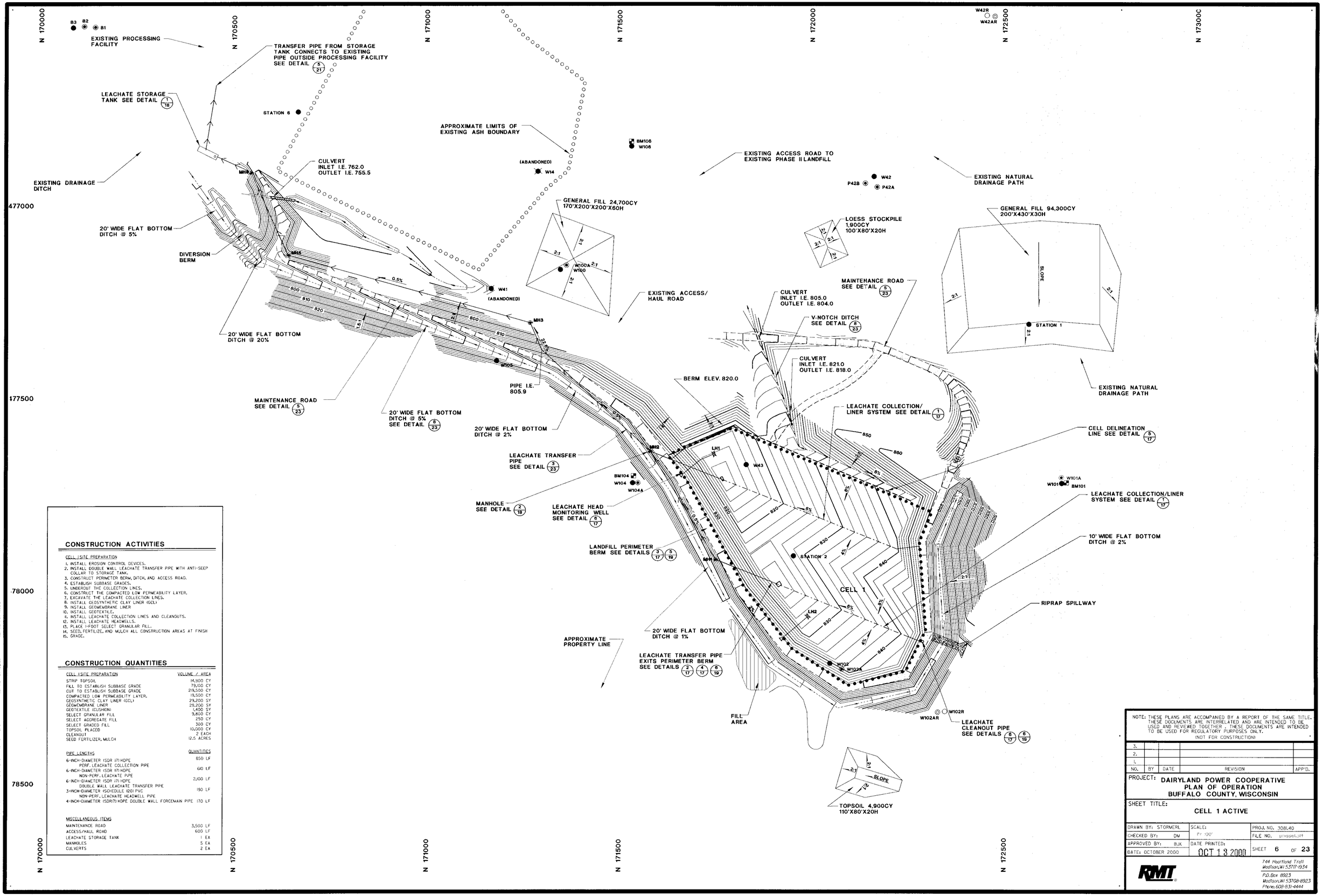


## CONSTRUCTION ACTIVITIES

CELL 1 SITE PREPARATION

1. INSTALL EROSION CONTROL DEVICES.
2. INSTALL DOUBLE WALL LEACHATE TRANSFER PIPE WITH ANTI-SEEP COLLAR TO STORAGE TANK.
3. CONSTRUCT PERIMETER BERM, DITCH, AND ACCESS ROAD.
4. ESTABLISH SUBBASE GRADES.
5. UNDERCUT THE COLLECTION LINES.
6. CONSTRUCT THE COMPACTED LOW PERMEABILITY LAYER.
7. EXCAVATE THE LEACHATE COLLECTION LINES.
8. INSTALL GEOSYNTHETIC CLAY LINER (GCL)
9. INSTALL GEOMEMBRANE LINER
10. INSTALL GEOTEXTILE.
11. INSTALL LEACHATE COLLECTION LINES AND CLEANOUTS.
12. INSTALL LEACHATE HEADWELLS.
13. PLACE 1-FOOT SELECT GRANULAR FILL.
14. SEED, FERTILIZE, AND MULCH ALL CONSTRUCTION AREAS AT FINISH
15. GRADE.

## CONSTRUCTION QUANTITIES

| CELL 1 SITE PREPARATION | VOLUME / AREA |
|---|---|
| STRIP TOPSOIL | 14,900 CY |
| FILL TO ESTABLISH SUBBASE GRADE | 79,100 CY |
| CUT TO ESTABLISH SUBBASE GRADE | 219,500 CY |
| COMPACTED LOW PERMEABILITY LAYER. | 19,500 CY |
| GEOSYNTHETIC CLAY LINER (GCL) | 29,200 SY |
| GEOMEMBRANE LINER | 29,200 SY |
| GEOTEXTILE (CUSHION) | 1,400 SY |
| SELECT GRANULAR FILL | 9,800 CY |
| SELECT AGGREGATE FILL | 250 CY |
| SELECT GRADED FILL | 300 CY |
| TOPSOIL PLACED | 10,900 CY |
| CLEANOUT | 2 EACH |
| SEED FERTILIZER, MULCH | 12.5 ACRES |

| PIPE LENGTHS | QUANTITIES |
|---|---|
| 6-INCH-DIAMETER (SDR 17) HDPE PERF. LEACHATE COLLECTION PIPE | 850 LF |
| 6-INCH-DIAMETER (SDR 17) HDPE NON-PERF. LEACHATE PIPE | 60 LF |
| 6-INCH-DIAMETER (SDR 17) HDPE DOUBLE WALL LEACHATE TRANSFER PIPE | 2,100 LF |
| 3-INCH-DIAMETER (SCHEDULE 80) PVC NON-PERF. LEACHATE HEADWELL PIPE | 190 LF |
| 4-INCH-DIAMETER (SDR17) HDPE DOUBLE WALL FORCEMAIN PIPE | 170 LF |

| MISCELLANEOUS ITEMS | |
|---|---|
| MAINTENANCE ROAD | 3,500 LF |
| ACCESS/HAUL ROAD | 600 LF |
| LEACHATE STORAGE TANK | 1 EA |
| MANHOLES | 5 EA |
| CULVERTS | 2 EA |

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(NOT FOR CONSTRUCTION)

| NO. | BY | DATE | REVISION | APP'D. |
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PROJECT: **DAIRYLAND POWER COOPERATIVE PLAN OF OPERATION BUFFALO COUNTY, WISCONSIN**

SHEET TITLE: **CELL 1 ACTIVE**

| | | |
|---|---|---|
| DRAWN BY: STORMERL | SCALE: 1" = 100' | PROJ. NO. 308L40 |
| CHECKED BY: DM | | FILE NO. pnaselt.dlf |
| APPROVED BY: BJK | DATE PRINTED: OCT 13 2000 | SHEET 6 OF 23 |
| DATE: OCTOBER 2000 | | |

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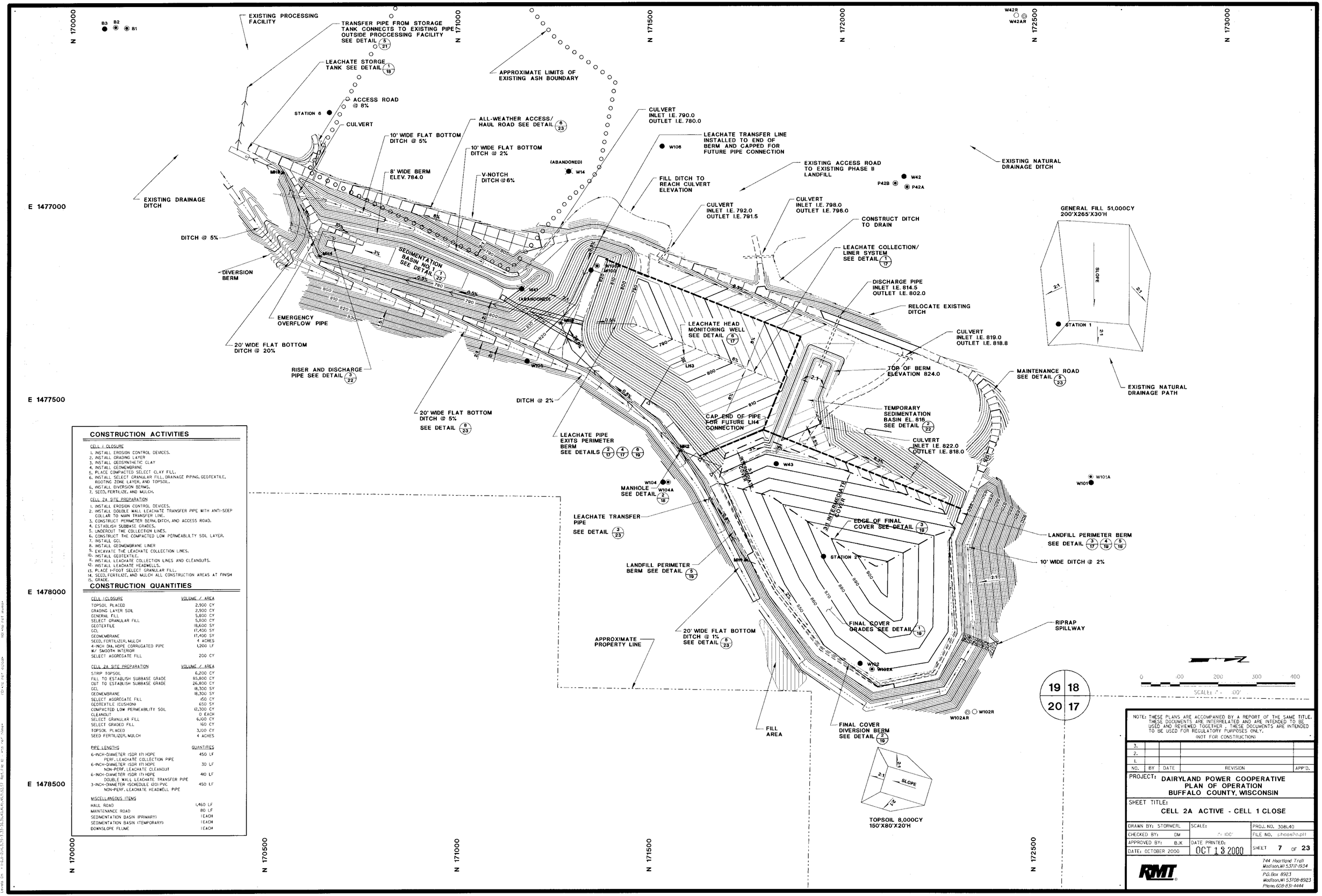


## CONSTRUCTION ACTIVITIES

CELL 1 CLOSURE

1. INSTALL EROSION CONTROL DEVICES.
2. INSTALL GRADING LAYER
3. INSTALL GEOSYNTHETIC CLAY
4. INSTALL GEOMEMBRANE.
5. PLACE COMPACTED SELECT CLAY FILL.
6. INSTALL SELECT GRANULAR FILL, DRAINAGE PIPING, GEOTEXTILE, ROOTING ZONE LAYER, AND TOPSOIL.
6. INSTALL DIVERSION BERMS.
7. SEED, FERTILIZE, AND MULCH.

CELL 2A SITE PREPARATION

1. INSTALL EROSION CONTROL DEVICES.
2. INSTALL DOUBLE WALL LEACHATE TRANSFER PIPE WITH ANTI-SEEP COLLAR TO MAIN TRANSFER LINE.
3. CONSTRUCT PERIMETER BERM, DITCH, AND ACCESS ROAD.
4. ESTABLISH SUBBASE GRADES.
5. UNDERCUT THE COLLECTION LINES.
6. CONSTRUCT THE COMPACTED LOW PERMEABILITY SOIL LAYER.
7. INSTALL GCL.
8. INSTALL GEOMEMBRANE LINER
9. EXCAVATE THE LEACHATE COLLECTION LINES.
10. INSTALL GEOTEXTILE.
11. INSTALL LEACHATE COLLECTION LINES AND CLEANOUTS.
12. INSTALL LEACHATE HEADWELLS.
13. PLACE 1-FOOT SELECT GRANULAR FILL.
14. SEED, FERTILIZE, AND MULCH ALL CONSTRUCTION AREAS AT FINISH 15. GRADE.

## CONSTRUCTION QUANTITIES

| CELL 1 CLOSURE | VOLUME / AREA |
|---|---|
| TOPSOIL PLACED | 2,900 CY |
| GRADING LAYER SOIL | 2,900 CY |
| GENERAL FILL | 5,800 CY |
| SELECT GRANULAR FILL | 5,800 CY |
| GEOTEXTILE | 18,600 SY |
| GCL | 17,400 SY |
| GEOMEMBRANE | 17,400 SY |
| SEED, FERTILIZER, MULCH | 4 ACRES |
| 4-INCH DIA. HDPE CORRUGATED PIPE W/ SMOOTH INTERIOR | 1,200 LF |
| SELECT AGGREGATE FILL | 200 CY |

| CELL 2A SITE PREPARATION | VOLUME / AREA |
|---|---|
| STRIP TOPSOIL | 6,200 CY |
| FILL TO ESTABLISH SUBBASE GRADE | 85,800 CY |
| CUT TO ESTABLISH SUBBASE GRADE | 26,800 CY |
| GCL | 18,300 SY |
| GEOMEMBRANE | 18,300 SY |
| SELECT AGGREGATE FILL | 150 CY |
| GEOTEXTILE (CUSHION) | 650 SY |
| COMPACTED LOW PERMEABILITY SOIL | 12,300 CY |
| CLEANOUT | 0 EACH |
| SELECT GRANULAR FILL | 6,000 CY |
| SELECT GRADED FILL | 160 CY |
| TOPSOIL PLACED | 3,100 CY |
| SEED FERTILIZER, MULCH | 4 ACRES |

| PIPE LENGTHS | QUANTITIES |
|---|---|
| 6-INCH-DIAMETER (SDR 17) HDPE PERF. LEACHATE COLLECTION PIPE | 450 LF |
| 6-INCH-DIAMETER (SDR 17) HDPE NON-PERF. LEACHATE CLEANOUT | 30 LF |
| 6-INCH-DIAMETER (SDR 17) HDPE DOUBLE WALL LEACHATE TRANSFER PIPE | 480 LF |
| 3-INCH-DIAMETER (SCHEDULE 120) PVC NON-PERF. LEACHATE HEADWELL PIPE | 450 LF |

| MISCELLANEOUS ITEMS | |
|---|---|
| HAUL ROAD | 1,460 LF |
| MAINTENANCE ROAD | 80 LF |
| SEDIMENTATION BASIN (PRIMARY) | 1 EACH |
| SEDIMENTATION BASIN (TEMPORARY) | 1 EACH |
| DOWNSLOPE FLUME | 1 EACH |

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(NOT FOR CONSTRUCTION)

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PROJECT: DAIRYLAND POWER COOPERATIVE
PLAN OF OPERATION
BUFFALO COUNTY, WISCONSIN

SHEET TITLE:
CELL 2A ACTIVE - CELL 1 CLOSE

| | | |
|---|---|---|
| DRAWN BY: STORMERL | SCALE: | PROJ. NO. 3081L40 |
| CHECKED BY: DM | 1" = 100' | FILE NO. phase2a.plt |
| APPROVED BY: BJK | DATE PRINTED: | SHEET 7 OF 23 |
| DATE: OCTOBER 2000 | OCT 13 2000 | |

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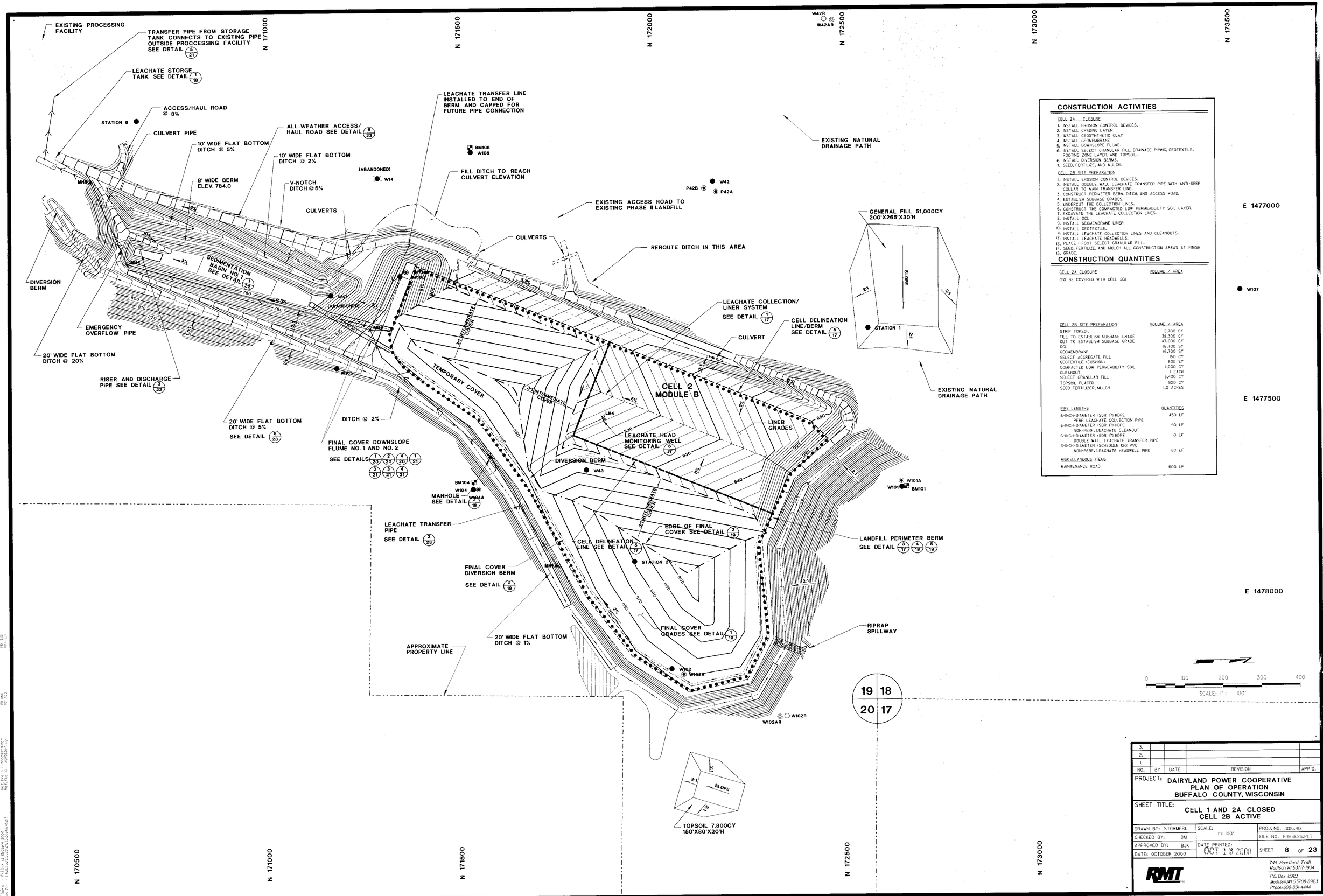
RMT COMPUTER AIDED DESIGN & DRAFTING




## CONSTRUCTION ACTIVITIES

CELL 2A CLOSURE

1. INSTALL EROSION CONTROL DEVICES.
2. INSTALL GRADING LAYER.
3. INSTALL GEOSYNTHETIC CLAY
4. INSTALL GEOMEMBRANE
5. INSTALL DOWNSLOPE FLUME.
6. INSTALL SELECT GRANULAR FILL, DRAINAGE PIPING, GEOTEXTILE, ROOTING ZONE LAYER, AND TOPSOIL.
6. INSTALL DIVERSION BERMS.
7. SEED, FERTILIZE, AND MULCH.

CELL 2B SITE PREPARATION

1. INSTALL EROSION CONTROL DEVICES.
2. INSTALL DOUBLE WALL LEACHATE TRANSFER PIPE WITH ANTI-SEEP COLLAR TO MAIN TRANSFER LINE.
3. CONSTRUCT PERIMETER BERM, DITCH, AND ACCESS ROAD.
4. ESTABLISH SUBBASE GRADES.
5. UNDERCUT THE COLLECTION LINES.
6. CONSTRUCT THE COMPACTED LOW PERMEABILITY SOIL LAYER.
7. EXCAVATE THE LEACHATE COLLECTION LINES.
8. INSTALL GCL
9. INSTALL GEOMEMBRANE LINER
10. INSTALL GEOTEXTILE.
11. INSTALL LEACHATE COLLECTION LINES AND CLEANOUTS.
12. INSTALL LEACHATE HEADWELLS.
13. PLACE 1-FOOT SELECT GRANULAR FILL.
14. SEED, FERTILIZE, AND MULCH ALL CONSTRUCTION AREAS AT FINISH
15. GRADE.

## CONSTRUCTION QUANTITIES

| CELL 2A CLOSURE | VOLUME / AREA |
|---|---|
| (TO BE COVERED WITH CELL 2B) | |

| CELL 2B SITE PREPARATION | VOLUME / AREA |
|---|---|
| STRIP TOPSOIL | 2,700 CY |
| FILL TO ESTABLISH SUBBASE GRADE | 38,300 CY |
| CUT TO ESTABLISH SUBBASE GRADE | 47,600 CY |
| GCL | 16,700 SY |
| GEOMEMBRANE | 16,700 SY |
| SELECT AGGREGATE FILL | 150 CY |
| GEOTEXTILE (CUSHION) | 800 SY |
| COMPACTED LOW PERMEABILITY SOIL | 11,000 CY |
| CLEANOUT | 1 EACH |
| SELECT GRANULAR FILL | 5,400 CY |
| TOPSOIL PLACED | 900 CY |
| SEED FERTILIZER, MULCH | 1.0 ACRES |

| PIPE LENGTHS | QUANTITIES |
|---|---|
| 6-INCH-DIAMETER (SDR 17) HDPE PERF. LEACHATE COLLECTION PIPE | 450 LF |
| 6-INCH-DIAMETER (SDR 17) HDPE NON-PERF. LEACHATE CLEANOUT | 90 LF |
| 6-INCH-DIAMETER (SDR 17) HDPE DOUBLE WALL LEACHATE TRANSFER PIPE | 0 LF |
| 3-INCH-DIAMETER (SCHEDULE 120) PVC NON-PERF. LEACHATE HEADWELL PIPE | 80 LF |
| MISCELLANEOUS ITEMS | |
| MAINTENANCE ROAD | 600 LF |

| NO. | BY | DATE | REVISION | APP'D. |
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PROJECT: DAIRYLAND POWER COOPERATIVE
PLAN OF OPERATION
BUFFALO COUNTY, WISCONSIN

SHEET TITLE: CELL 1 AND 2A CLOSED
CELL 2B ACTIVE

| | | |
|---|---|---|
| DRAWN BY: STORMERL | SCALE: 1" = 100' | PROJ. NO. 3081.40 |
| CHECKED BY: DM | | FILE NO. PHASE2B.PLT |
| APPROVED BY: BJK | DATE PRINTED: OCT 13 2000 | SHEET 8 OF 23 |
| DATE: OCTOBER 2000 | | |

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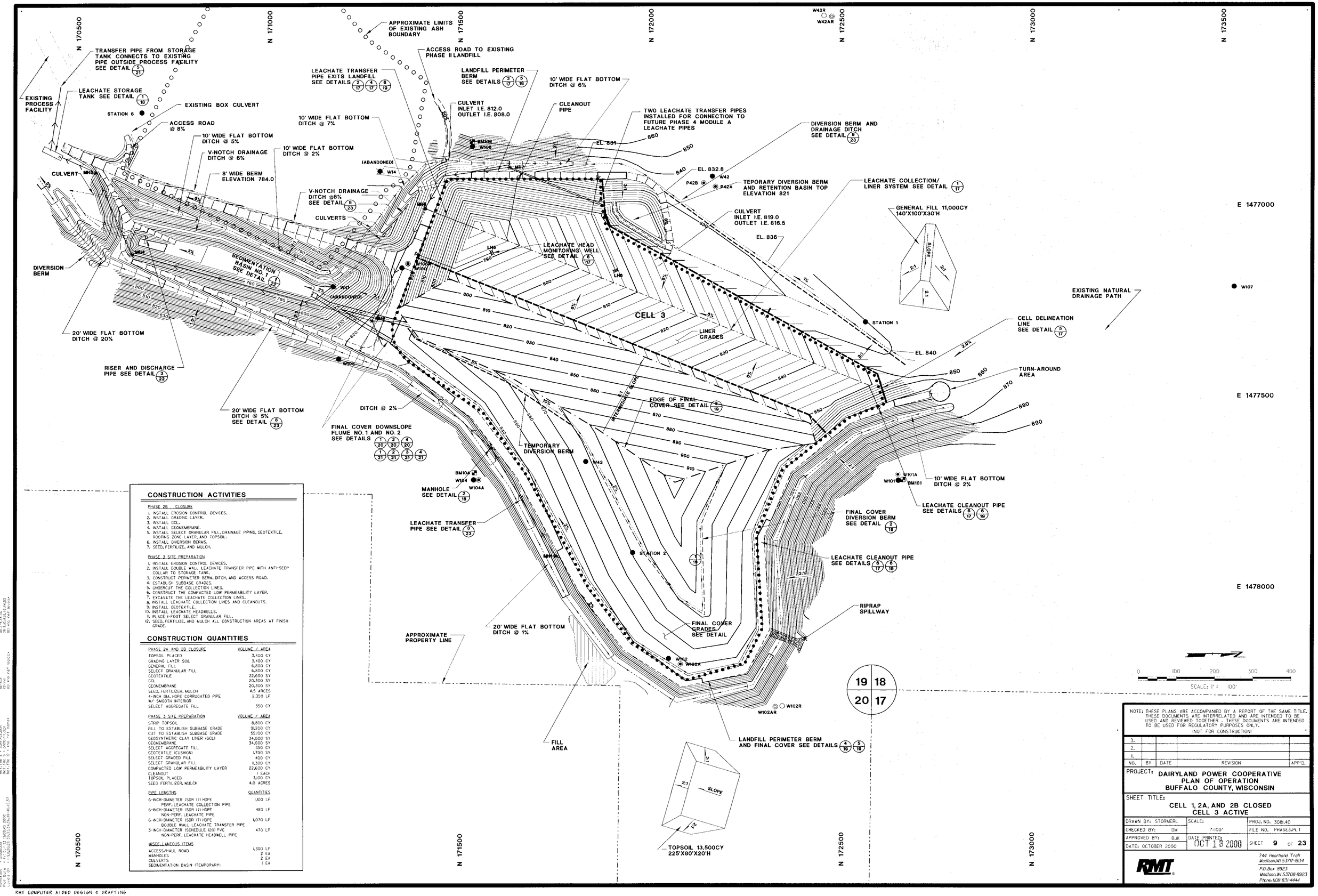


## CONSTRUCTION ACTIVITIES

PHASE 2B CLOSURE

1. INSTALL EROSION CONTROL DEVICES.
2. INSTALL GRADING LAYER.
3. INSTALL GCL.
4. INSTALL GEOMEMBRANE.
5. INSTALL SELECT GRANULAR FILL, DRAINAGE PIPING, GEOTEXTILE, ROOTING ZONE LAYER, AND TOPSOIL.
6. INSTALL DIVERSION BERMS.
7. SEED, FERTILIZE, AND MULCH.

PHASE 3 SITE PREPARATION

1. INSTALL EROSION CONTROL DEVICES.
2. INSTALL DOUBLE WALL LEACHATE TRANSFER PIPE WITH ANTI-SEEP COLLAR TO STORAGE TANK.
3. CONSTRUCT PERIMETER BERM, DITCH, AND ACCESS ROAD.
4. ESTABLISH SUBBASE GRADES.
5. UNDERCUT THE COLLECTION LINES.
6. CONSTRUCT THE COMPACTED LOW PERMEABILITY LAYER.
7. EXCAVATE THE LEACHATE COLLECTION LINES.
8. INSTALL LEACHATE COLLECTION LINES AND CLEANOUTS.
9. INSTALL GEOTEXTILE.
10. INSTALL LEACHATE HEADWELLS.
11. PLACE 1-FOOT SELECT GRANULAR FILL.
12. SEED, FERTILIZE, AND MULCH ALL CONSTRUCTION AREAS AT FINISH GRADE.

## CONSTRUCTION QUANTITIES

| PHASE 2A AND 2B CLOSURE | VOLUME / AREA |
|---|---|
| TOPSOIL PLACED | 3,400 CY |
| GRADING LAYER SOIL | 3,400 CY |
| GENERAL FILL | 6,800 CY |
| SELECT GRANULAR FILL | 6,800 CY |
| GEOTEXTILE | 22,600 SY |
| GCL | 20,300 SY |
| GEOMEMBRANE | 20,300 SY |
| SEED, FERTILIZER, MULCH | 4.5 ARCES |
| 4-INCH DIA. HDPE CORRUGATED PIPE W/ SMOOTH INTERIOR | 2,350 LF |
| SELECT AGGREGATE FILL | 350 CY |

| PHASE 3 SITE PREPARATION | VOLUME / AREA |
|---|---|
| STRIP TOPSOIL | 8,800 CY |
| FILL TO ESTABLISH SUBBASE GRADE | 91,200 CY |
| CUT TO ESTABLISH SUBBASE GRADE | 55,100 CY |
| GEOSYNTHETIC CLAY LINER (GCL) | 34,000 SY |
| GEOMEMBRANE | 34,000 SY |
| SELECT AGGREGATE FILL | 350 CY |
| GEOTEXTILE (CUSHION) | 1,700 SY |
| SELECT GRADED FILL | 400 CY |
| SELECT GRANULAR FILL | 11,300 CY |
| COMPACTED LOW PERMEABILITY LAYER | 22,600 CY |
| CLEANOUT | 1 EACH |
| TOPSOIL PLACED | 3,100 CY |
| SEED FERTILIZER, MULCH | 4.0 ACRES |

| PIPE LENGTHS | QUANTITIES |
|---|---|
| 6-INCH-DIAMETER (SDR 17) HDPE PERF. LEACHATE COLLECTION PIPE | 1,100 LF |
| 6-INCH-DIAMETER (SDR 17) HDPE NON-PERF. LEACHATE PIPE | 480 LF |
| 6-INCH-DIAMETER (SDR 17) HDPE DOUBLE WALL LEACHATE TRANSFER PIPE | 1,070 LF |
| 3-INCH-DIAMETER (SCHEDULE 120) PVC NON-PERF. LEACHATE HEADWELL PIPE | 470 LF |

| MISCELLANEOUS ITEMS | |
|---|---|
| ACCESS/HAUL ROAD | 1,300 LF |
| MANHOLES | 2 EA |
| CULVERTS | 2 EA |
| SEDIMENTATION BASIN (TEMPORARY) | 1 EA |

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PROJECT: DAIRYLAND POWER COOPERATIVE
PLAN OF OPERATION
BUFFALO COUNTY, WISCONSIN

SHEET TITLE:
CELL 1, 2A, AND 2B CLOSED
CELL 3 ACTIVE

| | | |
|---|---|---|
| DRAWN BY: STORMERL | SCALE: 1"=100' | PROJ. NO. 3081.40 |
| CHECKED BY: DM | | FILE NO. PHASE3.PLT |
| APPROVED BY: BJK | DATE PRINTED: OCT 13 2000 | SHEET 9 OF 23 |
| DATE: OCTOBER 2000 | | |

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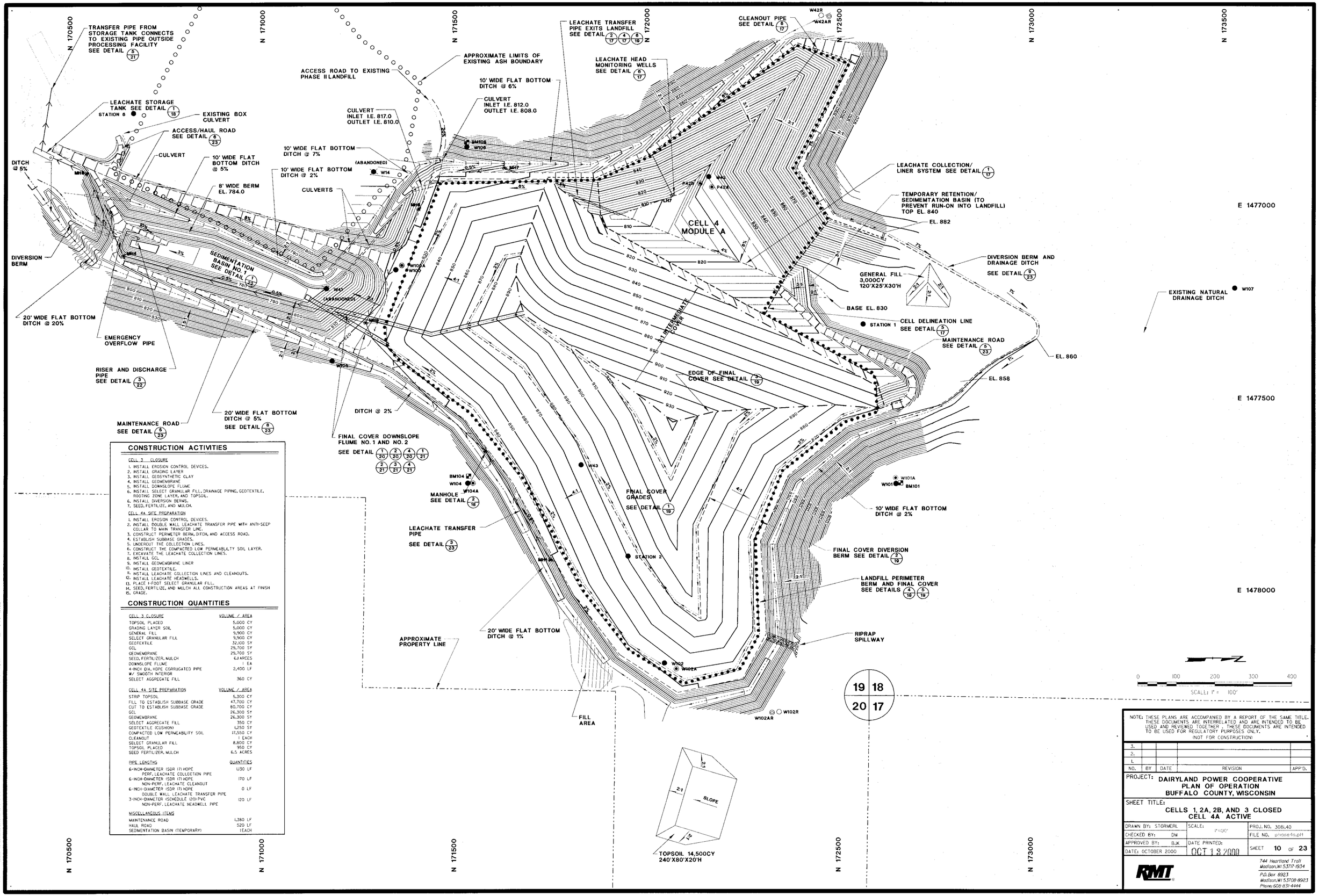


## CONSTRUCTION ACTIVITIES

CELL 3 CLOSURE

1. INSTALL EROSION CONTROL DEVICES.
2. INSTALL GRADING LAYER
3. INSTALL GEOSYNTHETIC CLAY
4. INSTALL GEOMEMBRANE
5. INSTALL DOWNSLOPE FLUME
6. INSTALL SELECT GRANULAR FILL, DRAINAGE PIPING, GEOTEXTILE, ROOTING ZONE LAYER, AND TOPSOIL.
6. INSTALL DIVERSION BERMS.
7. SEED, FERTILIZE, AND MULCH.

CELL 4A SITE PREPARATION

1. INSTALL EROSION CONTROL DEVICES.
2. INSTALL DOUBLE WALL LEACHATE TRANSFER PIPE WITH ANTI-SEEP COLLAR TO MAIN TRANSFER LINE.
3. CONSTRUCT PERIMETER BERM, DITCH, AND ACCESS ROAD.
4. ESTABLISH SUBBASE GRADES.
5. UNDERCUT THE COLLECTION LINES.
6. CONSTRUCT THE COMPACTED LOW PERMEABILITY SOIL LAYER.
7. EXCAVATE THE LEACHATE COLLECTION LINES.
8. INSTALL GCL
9. INSTALL GEOMEMBRANE LINER
10. INSTALL GEOTEXTILE.
11. INSTALL LEACHATE COLLECTION LINES AND CLEANOUTS.
12. INSTALL LEACHATE HEADWELLS.
13. PLACE 1-FOOT SELECT GRANULAR FILL.
14. SEED, FERTILIZE, AND MULCH ALL CONSTRUCTION AREAS AT FINISH
15. GRADE.

## CONSTRUCTION QUANTITIES

| CELL 3 CLOSURE | VOLUME / AREA |
|---|---|
| TOPSOIL PLACED | 5,000 CY |
| GRADING LAYER SOIL | 5,000 CY |
| GENERAL FILL | 9,900 CY |
| SELECT GRANULAR FILL | 9,900 CY |
| GEOTEXTILE | 32,000 SY |
| GCL | 29,700 SY |
| GEOMEMBRANE | 29,700 SY |
| SEED, FERTILIZER, MULCH | 6.4 ARCES |
| DOWNSLOPE FLUME | 1 EA |
| 4-INCH DIA. HDPE CORRUGATED PIPE W/ SMOOTH INTERIOR | 2,400 LF |
| SELECT AGGREGATE FILL | 360 CY |

| CELL 4A SITE PREPARATION | VOLUME / AREA |
|---|---|
| STRIP TOPSOIL | 5,300 CY |
| FILL TO ESTABLISH SUBBASE GRADE | 47,700 CY |
| CUT TO ESTABLISH SUBBASE GRADE | 80,700 CY |
| GCL | 26,300 SY |
| GEOMEMBRANE | 26,300 SY |
| SELECT AGGREGATE FILL | 350 CY |
| GEOTEXTILE (CUSHION) | 1,250 SY |
| COMPACTED LOW PERMEABILITY SOIL | 17,550 CY |
| CLEANOUT | 1 EACH |
| SELECT GRANULAR FILL | 8,800 CY |
| TOPSOIL PLACED | 950 CY |
| SEED FERTILIZER, MULCH | 6.5 ACRES |

| PIPE LENGTHS | QUANTITIES |
|---|---|
| 6-INCH-DIAMETER (SDR 17) HDPE PERF. LEACHATE COLLECTION PIPE | 1,130 LF |
| 6-INCH-DIAMETER (SDR 17) HDPE NON-PERF. LEACHATE CLEANOUT | 170 LF |
| 6-INCH-DIAMETER (SDR 17) HDPE DOUBLE WALL LEACHATE TRANSFER PIPE | 0 LF |
| 3-INCH-DIAMETER (SCHEDULE 120) PVC NON-PERF. LEACHATE HEADWELL PIPE | 120 LF |

| MISCELLANEOUS ITEMS | |
|---|---|
| MAINTENANCE ROAD | 1,380 LF |
| HAUL ROAD | 520 LF |
| SEDIMENTATION BASIN (TEMPORARY) | 1 EACH |

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(NOT FOR CONSTRUCTION)

| NO. | BY | DATE | REVISION | APP'D. |
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| 3. | | | | |
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PROJECT: DAIRYLAND POWER COOPERATIVE
PLAN OF OPERATION
BUFFALO COUNTY, WISCONSIN

SHEET TITLE:
CELLS 1, 2A, 2B, AND 3 CLOSED
CELL 4A ACTIVE

| | | |
|---|---|---|
| DRAWN BY: STORMERL | SCALE: 1"=100' | PROJ. NO. 3081.40 |
| CHECKED BY: DM | | FILE NO. phase4a.pl1 |
| APPROVED BY: BJK | DATE PRINTED: OCT 13 2000 | SHEET 10 OF 23 |
| DATE: OCTOBER 2000 | | |

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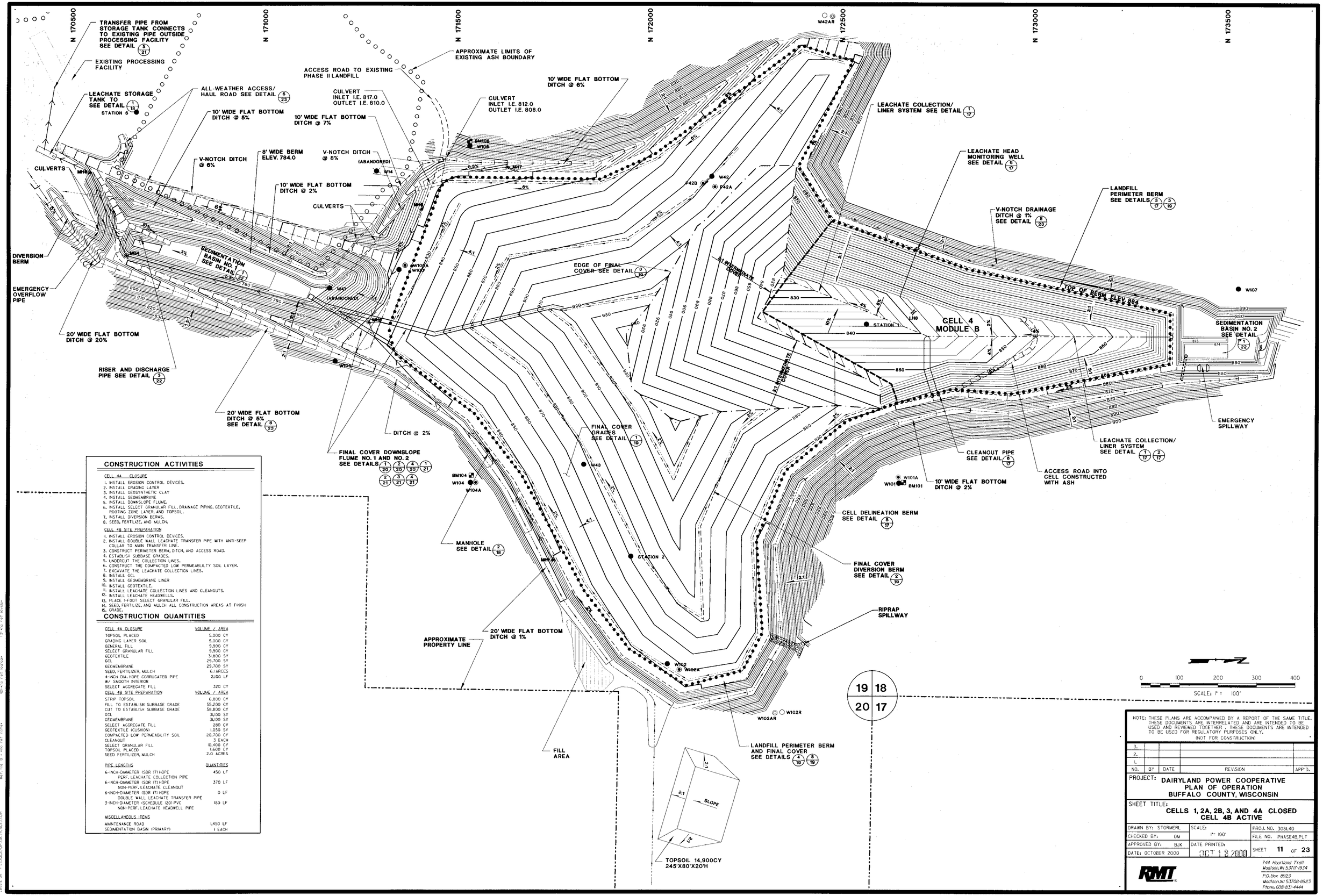


## CONSTRUCTION ACTIVITIES

CELL 4A CLOSURE

1. INSTALL EROSION CONTROL DEVICES.
2. INSTALL GRADING LAYER
3. INSTALL GEOSYNTHETIC CLAY
4. INSTALL GEOMEMBRANE
5. INSTALL DOWNSLOPE FLUME.
6. INSTALL SELECT GRANULAR FILL, DRAINAGE PIPING, GEOTEXTILE, ROOTING ZONE LAYER, AND TOPSOIL.
7. INSTALL DIVERSION BERMS.
8. SEED, FERTILIZE, AND MULCH.

CELL 4B SITE PREPARATION

1. INSTALL EROSION CONTROL DEVICES.
2. INSTALL DOUBLE WALL LEACHATE TRANSFER PIPE WITH ANTI-SEEP COLLAR TO MAIN TRANSFER LINE.
3. CONSTRUCT PERIMETER BERM, DITCH, AND ACCESS ROAD.
4. ESTABLISH SUBBASE GRADES.
5. UNDERCUT THE COLLECTION LINES.
6. CONSTRUCT THE COMPACTED LOW PERMEABILITY SOIL LAYER.
7. EXCAVATE THE LEACHATE COLLECTION LINES.
8. INSTALL GCL
9. INSTALL GEOMEMBRANE LINER
10. INSTALL GEOTEXTILE.
11. INSTALL LEACHATE COLLECTION LINES AND CLEANOUTS.
12. INSTALL LEACHATE HEADWELLS.
13. PLACE 1-FOOT SELECT GRANULAR FILL.
14. SEED, FERTILIZE, AND MULCH ALL CONSTRUCTION AREAS AT FINISH
15. GRADE.

## CONSTRUCTION QUANTITIES

| CELL 4A CLOSURE | VOLUME / AREA |
|---|---|
| TOPSOIL PLACED | 5,000 CY |
| GRADING LAYER SOIL | 5,000 CY |
| GENERAL FILL | 9,900 CY |
| SELECT GRANULAR FILL | 9,900 CY |
| GEOTEXTILE | 31,800 SY |
| GCL | 29,700 SY |
| GEOMEMBRANE | 29,700 SY |
| SEED, FERTILIZER, MULCH | 6.1 ARCES |
| 4-INCH DIA. HDPE CORRUGATED PIPE W/ SMOOTH INTERIOR | 200 LF |
| SELECT AGGREGATE FILL | 320 CY |
| **CELL 4B SITE PREPARATION** | **VOLUME / AREA** |
| STRIP TOPSOIL | 6,800 CY |
| FILL TO ESTABLISH SUBBASE GRADE | 55,200 CY |
| CUT TO ESTABLISH SUBBASE GRADE | 58,800 CY |
| GCL | 31,100 SY |
| GEOMEMBRANE | 31,100 SY |
| SELECT AGGREGATE FILL | 280 CY |
| GEOTEXTILE (CUSHION) | 1,050 SY |
| COMPACTED LOW PERMEABILITY SOIL | 20,700 CY |
| CLEANOUT | 3 EACH |
| SELECT GRANULAR FILL | 10,400 CY |
| TOPSOIL PLACED | 1,600 CY |
| SEED FERTILIZER, MULCH | 2.0 ACRES |
| **PIPE LENGTHS** | **QUANTITIES** |
| 6-INCH-DIAMETER (SDR 17) HDPE PERF. LEACHATE COLLECTION PIPE | 450 LF |
| 6-INCH-DIAMETER (SDR 17) HDPE NON-PERF. LEACHATE CLEANOUT | 370 LF |
| 6-INCH-DIAMETER (SDR 17) HDPE DOUBLE WALL LEACHATE TRANSFER PIPE | 0 LF |
| 3-INCH-DIAMETER (SCHEDULE 120) PVC NON-PERF. LEACHATE HEADWELL PIPE | 180 LF |
| **MISCELLANEOUS ITEMS** | |
| MAINTENANCE ROAD | 1,450 LF |
| SEDIMENTATION BASIN (PRIMARY) | 1 EACH |

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| NO. | BY | DATE | REVISION | APP'D. |
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| 3. | | | | |
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PROJECT: **DAIRYLAND POWER COOPERATIVE PLAN OF OPERATION BUFFALO COUNTY, WISCONSIN**

SHEET TITLE: **CELLS 1, 2A, 2B, 3, AND 4A CLOSED CELL 4B ACTIVE**

| | | |
|---|---|---|
| DRAWN BY: STORMERL | SCALE: 1" = 100' | PROJ. NO. 3081.40 |
| CHECKED BY: DM | | FILE NO. PHASE4B.PLT |
| APPROVED BY: BJK | DATE PRINTED: OCT 13 2000 | SHEET 11 OF 23 |
| DATE: OCTOBER 2000 | | |

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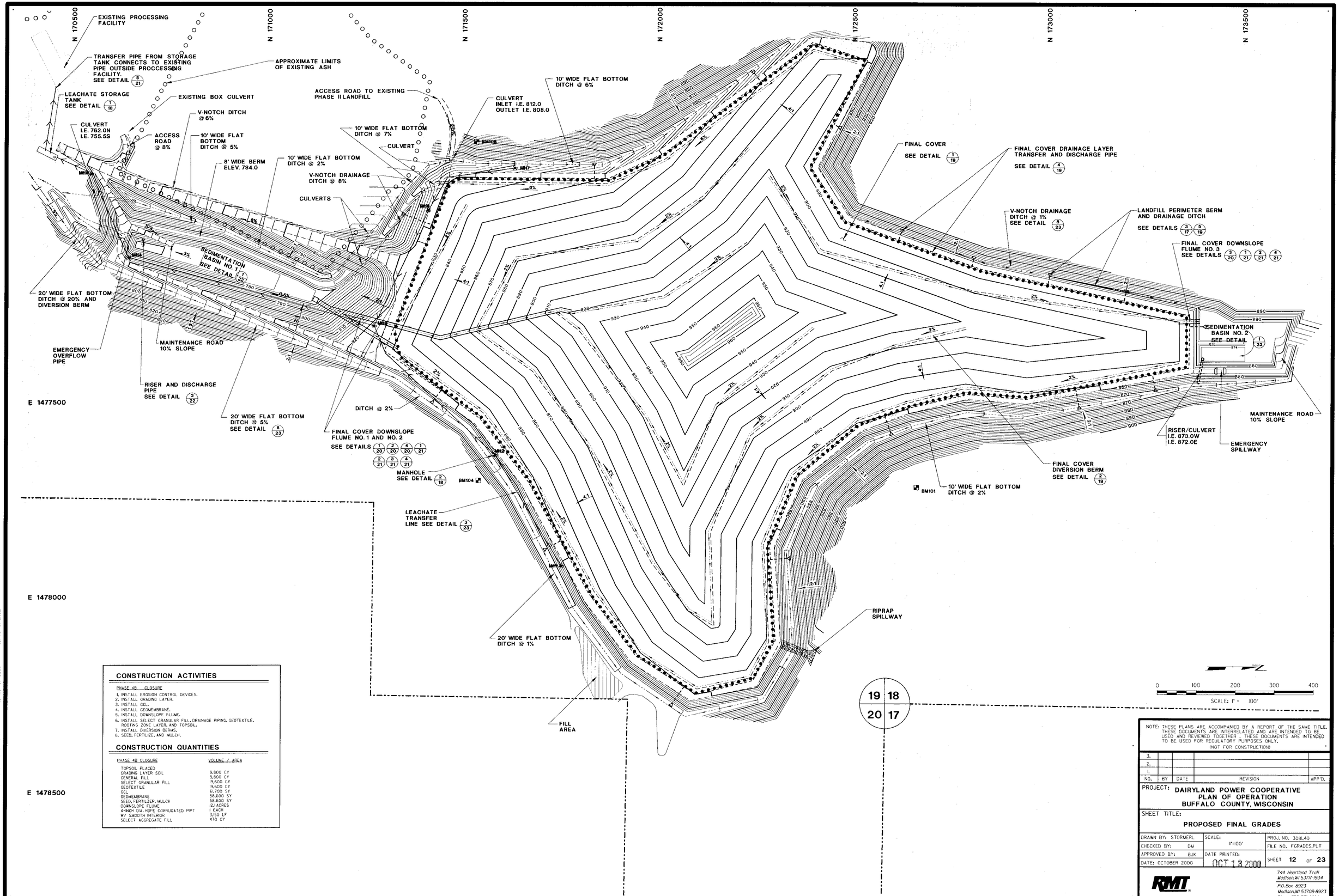
RMT COMPUTER AIDED DESIGN & DRAFTING




## CONSTRUCTION ACTIVITIES

PHASE 4B CLOSURE

1. INSTALL EROSION CONTROL DEVICES.
2. INSTALL GRADING LAYER.
3. INSTALL GCL.
4. INSTALL GEOMEMBRANE.
5. INSTALL DOWNSLOPE FLUME.
6. INSTALL SELECT GRANULAR FILL, DRAINAGE PIPING, GEOTEXTILE, ROOTING ZONE LAYER, AND TOPSOIL.
7. INSTALL DIVERSION BERMS.
8. SEED, FERTILIZE, AND MULCH.

## CONSTRUCTION QUANTITIES

| PHASE 4B CLOSURE | VOLUME / AREA |
|---|---|
| TOPSOIL PLACED | 9,600 CY |
| GRADING LAYER SOIL | 9,600 CY |
| GENERAL FILL | 19,600 CY |
| SELECT GRANULAR FILL | 19,600 CY |
| GEOTEXTILE | 19,600 CY |
| GCL | 61,700 SY |
| GEOMEMBRANE | 58,600 SY |
| SEED, FERTILIZER, MULCH | 58,600 SY |
| DOWNSLOPE FLUME | 12.1 ACRES |
| 4-INCH DIA. HDPE CORRUGATED PIPT W/ SMOOTH INTERIOR | 1 EACH 3,150 LF |
| SELECT AGGREGATE FILL | 470 CY |

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| 3. | | | | |
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PROJECT: **DAIRYLAND POWER COOPERATIVE PLAN OF OPERATION BUFFALO COUNTY, WISCONSIN**

SHEET TITLE: **PROPOSED FINAL GRADES**

| | | |
|---|---|---|
| DRAWN BY: STORMERL | SCALE: 1"=100' | PROJ. NO. 3081.40 |
| CHECKED BY: DM | | FILE NO. FGRADES.PLT |
| APPROVED BY: BJK | DATE PRINTED: OCT 13 2000 | SHEET 12 OF 23 |
| DATE: OCTOBER 2000 | | |

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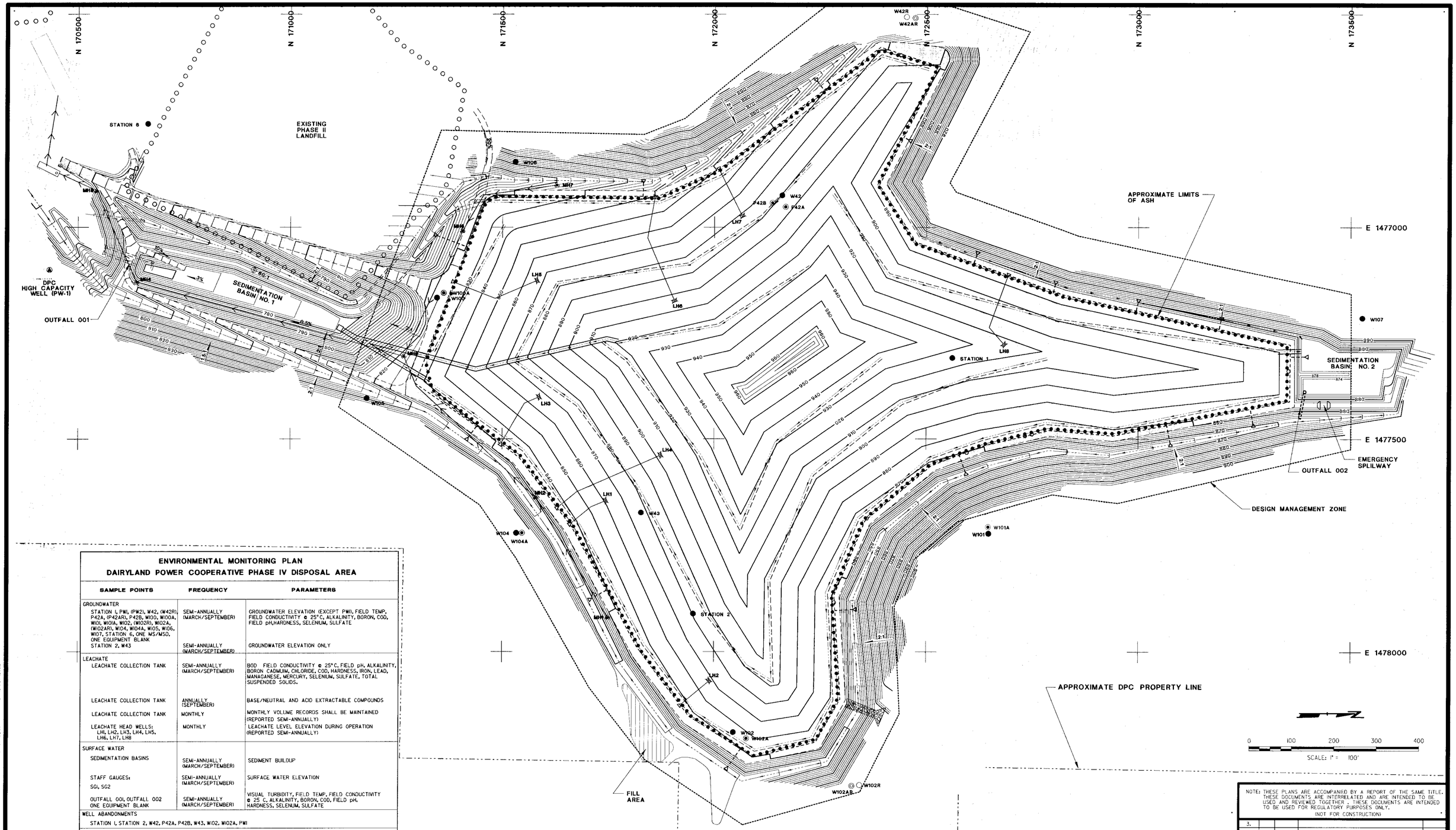
RMT COMPUTER AIDED DESIGN & DRAFTING




## ENVIRONMENTAL MONITORING PLAN
## DAIRYLAND POWER COOPERATIVE PHASE IV DISPOSAL AREA

| SAMPLE POINTS | FREQUENCY | PARAMETERS |
|---|---|---|
| GROUNDWATER | | |
| STATION 1, PW1, (PW2), W42, (W42R), P42A, (P42AR), P42B, W100, W100A, W101, W101A, W102, (W102R), W102A, (W102AR), W104, W104A, W105, W106, W107, STATION 6, ONE MS/MSD, ONE EQUIPMENT BLANK | SEMI-ANNUALLY (MARCH/SEPTEMBER) | GROUNDWATER ELEVATION (EXCEPT PW1), FIELD TEMP, FIELD CONDUCTIVITY @ 25°C, ALKALINITY, BORON, COD, FIELD pH, HARDNESS, SELENIUM, SULFATE |
| STATION 2, W43 | SEMI-ANNUALLY (MARCH/SEPTEMBER) | GROUNDWATER ELEVATION ONLY |
| LEACHATE | | |
| LEACHATE COLLECTION TANK | SEMI-ANNUALLY (MARCH/SEPTEMBER) | BOD FIELD CONDUCTIVITY @ 25°C, FIELD pH, ALKALINITY, BORON CADMIUM, CHLORIDE, COD, HARDNESS, IRON, LEAD, MANAGANESE, MERCURY, SELENIUM, SULFATE, TOTAL SUSPENDED SOLIDS. |
| LEACHATE COLLECTION TANK | ANNUALLY (SEPTEMBER) | BASE/NEUTRAL AND ACID EXTRACTABLE COMPOUNDS |
| LEACHATE COLLECTION TANK | MONTHLY | MONTHLY VOLUME RECORDS SHALL BE MAINTAINED (REPORTED SEMI-ANNUALLY) |
| LEACHATE HEAD WELLS: LH1, LH2, LH3, LH4, LH5, LH6, LH7, LH8 | MONTHLY | LEACHATE LEVEL ELEVATION DURING OPERATION (REPORTED SEMI-ANNUALLY) |
| SURFACE WATER | | |
| SEDIMENTATION BASINS | SEMI-ANNUALLY (MARCH/SEPTEMBER) | SEDIMENT BUILDUP |
| STAFF GAUGES: SG1, SG2 | SEMI-ANNUALLY (MARCH/SEPTEMBER) | SURFACE WATER ELEVATION |
| OUTFALL 001, OUTFALL 002 ONE EQUIPMENT BLANK | SEMI-ANNUALLY (MARCH/SEPTEMBER) | VISUAL TURBIDITY, FIELD TEMP, FIELD CONDUCTIVITY @ 25 C, ALKALINITY, BORON, COD, FIELD pH, HARDNESS, SELENIUM, SULFATE |
| WELL ABANDONMENTS | | |
| STATION 1, STATION 2, W42, P42A, P42B, W43, W102, W102A, PW1 | | |
| WELL REPLACEMENTS | | |
| W42R, P42AR, W102R, W102AR, PW2 | | |

NOTE: WELLS STATION 1, STATION 2, W42, P42A, P42B, W43, W102, AND W102A WILL BE INCLUDED IN THE MONITORING PROGRAM UNTIL THEY ARE ABANDONED OR REPLACED TO FACILITATE CONSTRUCTION OF THE FACILITY. ALL GROUNDWATER SAMPLES EXCEPT PW1 WILL BE FILTERED. THE EXISTING HIGH CAPACITY WELL (PW1) WILL BE ABANDONED DURING CONSTRUCTION OF CELL 1. THE NEW HIGH-CAPACITY WATER SUPPLY WELL (PW2) WILL BE INSTALLED AT (OR NEAR) 168470N, 1476700E, APPROXIMATELY SOUTHEAST OF PW1. (SEE PLAN SHEET 3).

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| 3. | | | | |
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PROJECT: DAIRYLAND POWER COOPERATIVE
PLAN OF OPERATION
BUFFALO COUNTY, WISCONSIN

SHEET TITLE:
PROPOSED ENVIRONMENTAL MONITORING PLAN

| | | |
|---|---|---|
| DRAWN BY: STORMERL | SCALE: 1"=100' | PROJ. NO. 3081.40 |
| CHECKED BY: COB | | FILE NO. ENVIMON.PLT |
| APPROVED BY: BJK | DATE PRINTED: OCT 13 2000 | SHEET 13 OF 23 |
| DATE: OCTOBER 2000 | | |

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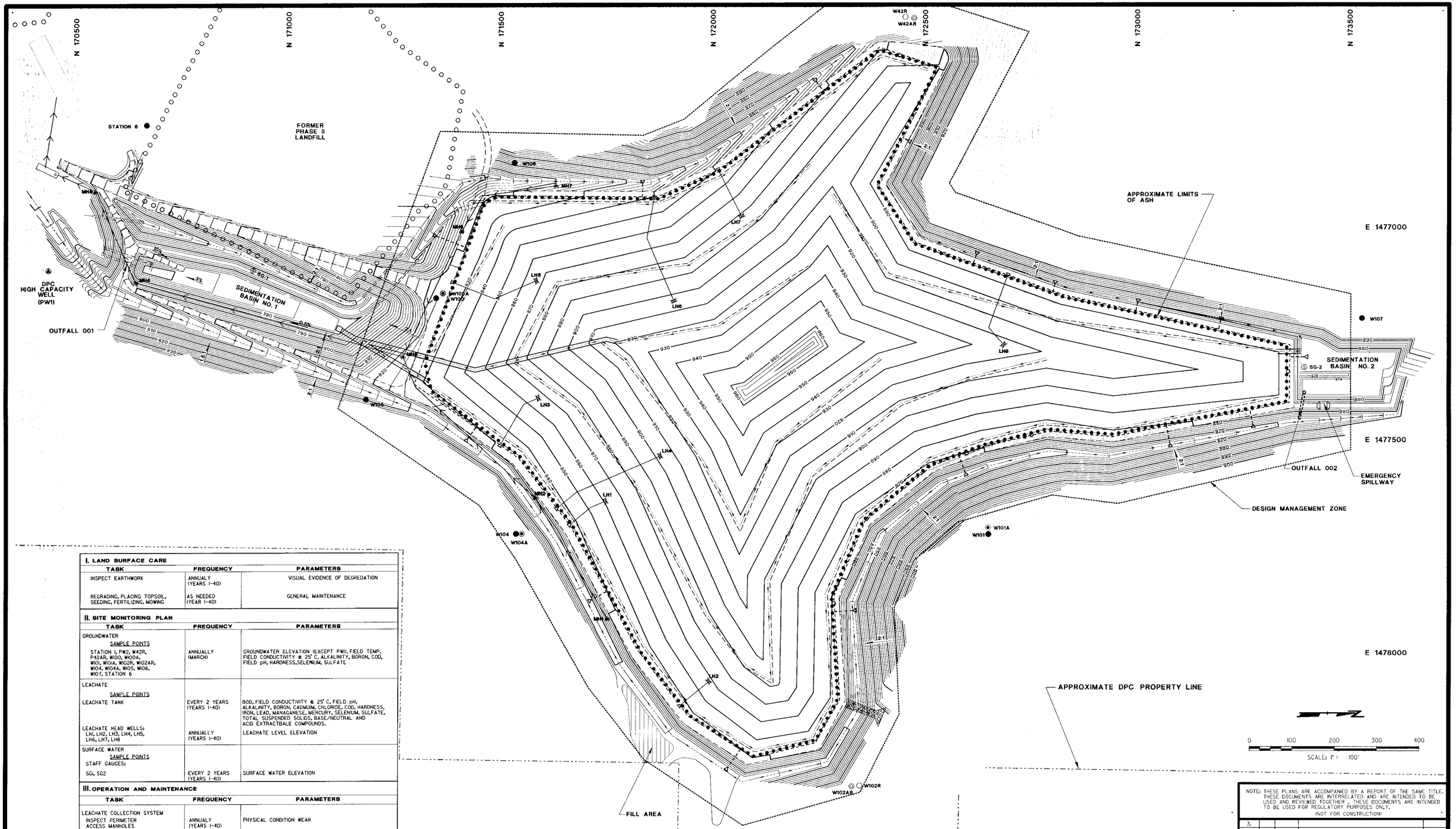


## I. LAND SURFACE CARE

| TASK | FREQUENCY | PARAMETERS |
|---|---|---|
| INSPECT EARTHWORK | ANNUALY (YEARS 1-40) | VISUAL EVIDENCE OF DEGREDATION |
| REGRADING, PLACING TOPSOIL, SEEDING, FERTILIZING, MOWING | AS NEEDED (YEAR 1-40) | GENERAL MAINTENANCE |

## II. SITE MONITORING PLAN

| TASK | FREQUENCY | PARAMETERS |
|---|---|---|
| GROUNDWATER<br>SAMPLE POINTS<br>STATION 1, PW2, W42R, P42AR, W100, W100A, W101, W101A, W102R, W102AR, W104, W104A, W105, W106, W107, STATION 6 | ANNUALLY (MARCH) | GROUNDWATER ELEVATION (EXCEPT PW1), FIELD TEMP, FIELD CONDUCTIVITY @ 25° C, ALKALINITY, BORON, COD, FIELD pH, HARDNESS, SELENIUM, SULFATE |
| LEACHATE<br>SAMPLE POINTS<br>LEACHATE TANK | EVERY 2 YEARS (YEARS 1-40) | BOD, FIELD CONDUCTIVITY @ 25° C, FIELD pH, ALKALINITY, BORON, CADMIUM, CHLORIDE, COD, HARDNESS, IRON, LEAD, MANAGANESE, MERCURY, SELENIUM, SULFATE, TOTAL SUSPENDED SOLIDS, BASE/NEUTRAL AND ACID EXTRACTBALE COMPOUNDS. |
| LEACHATE HEAD WELLS: LH1, LH2, LH3, LH4, LH5, LH6, LH7, LH8 | ANNUALLY (YEARS 1-40) | LEACHATE LEVEL ELEVATION |
| SURFACE WATER<br>SAMPLE POINTS<br>STAFF GAUGES:<br>SG1, SG2 | EVERY 2 YEARS (YEARS 1-40) | SURFACE WATER ELEVATION |

## III. OPERATION AND MAINTENANCE

| TASK | FREQUENCY | PARAMETERS |
|---|---|---|
| LEACHATE COLLECTION SYSTEM<br>INSPECT PERIMETER ACCESS MANHOLES MH1, MH2, MH3, MH4, MH5, MH6, MH7 | ANNUALY (YEARS 1-40) | PHYSICAL CONDITION WEAR |
| LEACHATE COLLECTION LINES | ANNUALY (YEARS 1-40) | CLEANOUT LINES, INSPECT |
| LEACHATE COLLECTION AND TREATMENT | AS NEEDED (YEARS 1-40) | TREAT AND DISPOSE |
| SEDIMENTATION BASIN | AS NEEDED YEARS (1-40) | CLEANOUT/ INSPECT |

NOTE: WELL STATION 1, STATION 2, W42, P42A, P42B, W43, W102, AND W102A WILL BE ABANDONED DURING CONSTRUCTION. THE ESISTING HIGH CAPACITY WELL (PW1) WILL BE ABANDONED DURING CONSTRUCTION OF CELL 1. THE NEW HIGH-CAPACITY WATER SUPPLY WELL (PW2) WILL BE INSTALLED AT (OR NEAR) 168470N,1476700E, APPROXIMATELY SOUTHEAST OF PW1. (SEE PLAN SHEET 3).

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PROJECT: **DAIRYLAND POWER COOPERATIVE PLAN OF OPERATION BUFFALO COUNTY, WISCONSIN**

SHEET TITLE: **LONG TERM CARE PLAN**

| | | | |
|---|---|---|---|
| DRAWN BY: STORMERL | SCALE: 1"=100' | PROJ. NO. 3081.40 | |
| CHECKED BY: COB | | FILE NO. LONGTERM.PLT | |
| APPROVED BY: BJK | DATE PRINTED: OCT 13 2000 | SHEET 14 OF 23 | |
| DATE: OCTOBER 2000 | | | |

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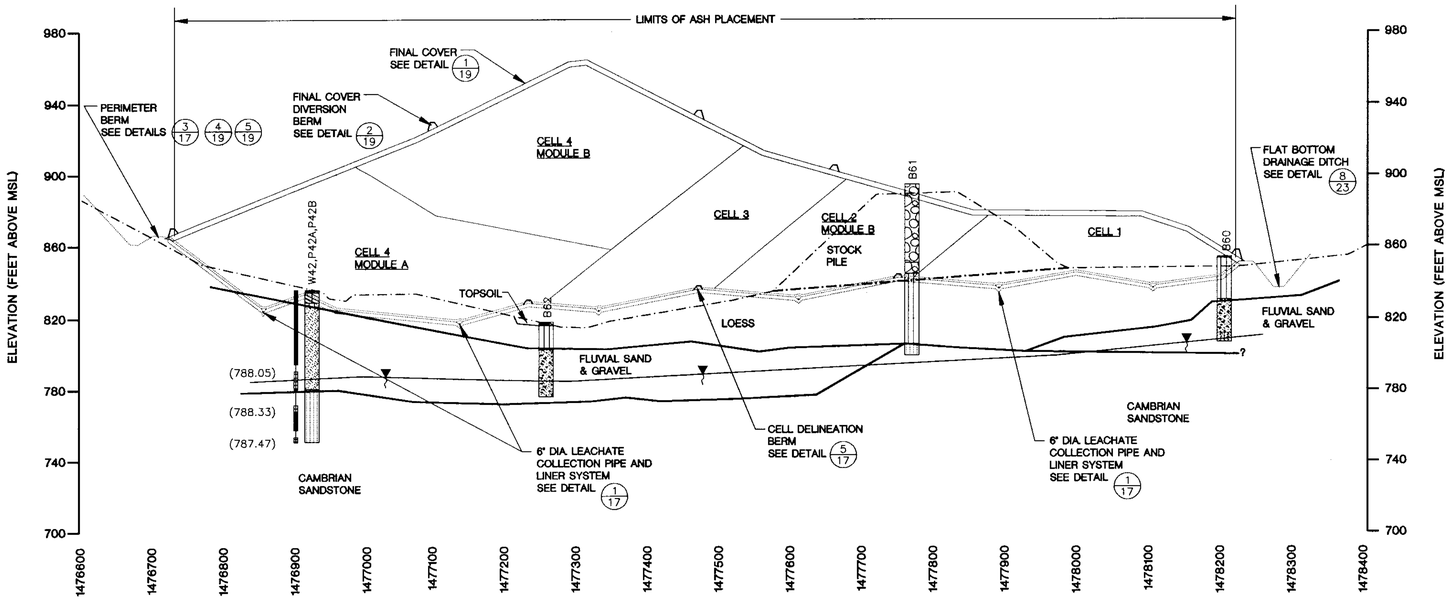
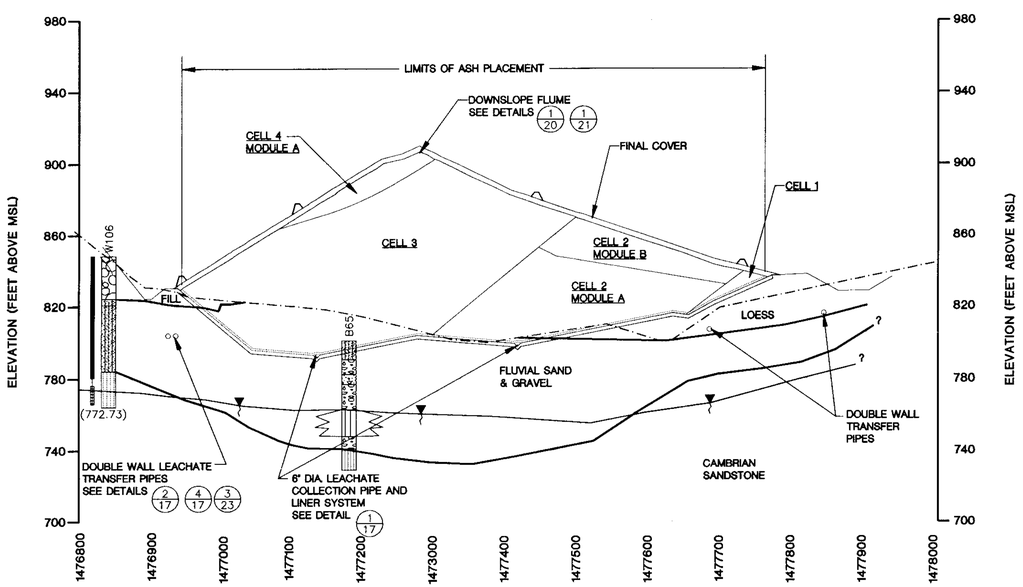
RMT COMPUTER AIDED DESIGN & DRAFTING




## CROSS SECTION 172200N




## CROSS SECTION 171700N

## LEGEND

- PROPOSED FINAL COVER/BASE LINER
- 6" DIA. PERFORATED GRADIENT CONTROL/ LEACHATE COLLECTION PIPE
- APPROXIMATE DIVERSION BERM LOCATION
- MAIN GRADIENT CONTROL TRANSFER PIPE
- (745.03) WATER TABLE OR PIEZOMETRIC ELEVATION
- UNIT B AND C BOUNDARY
- B61 BORING OR WELL NUMBER
- EXISTING GROUND SURFACE
- WATER TABLE LINE
- STRATIGRAPHIC BOUNDARY, DASHED WHERE INFERRED

WELL CONSTRUCTION

- WELL SEAL
- WELL CASING
- WELL SCREEN

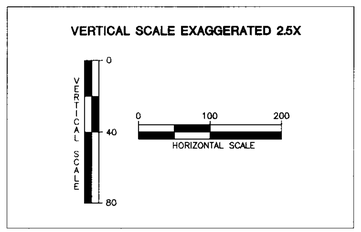
LITHOLOGIC UNITS (USCS CLASSIFICATION)

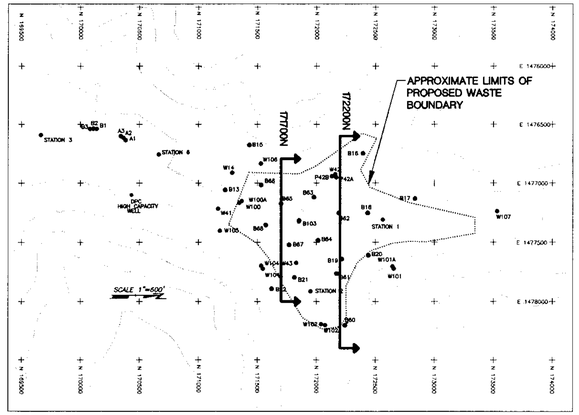
- TOPSOIL
- FILL
- SILT (ML)
- CLAY (CL)
- SILTY CLAY (CL)
- CLAYEY SILT (ML)
- SAND (SP)
- POORLY GRADED GRAVEL
- SILTY GRAVEL WITH SAND (GM)
- SILTY SAND WITH GRAVEL (SM)
- SILTY SAND (SM)
- SANDSTONE
- DOLOMITE
- SANDY SILT

## NOTES

1. EXISTING GROUND SURFACE TAKEN FROM PLAN SHEET 3.
2. ELEVATION REFERENCED TO USGS MEAN SEA LEVEL (MSL) DATUM, 1929.
3. GROUNDWATER ELEVATIONS BASED ON MEASUREMENTS OBTAINED BY DPC ON APRIL 26, 1996.
4. THE STRATUM LINES ARE BASED ON INTERPOLATION BETWEEN BORINGS AND ON INFORMATION CONTAINED ON THE HIGHWATER TABLE CONTOUR MAP (PLAN SHEET 12) AND THE TOP OF COMPETENT BEDROCK CONTOUR MAP (PLAN SHEET 13) IN THE FEASIBILITY REPORT, AND ON THE BOTTOM OF LOESS EXISTING CONDITIONS (FIGURE 2) SHEET INCLUDED IN THE APRIL 30, 1999, SUPPLEMENTAL INFORMATION TO SUPPORT FEASIBILITY DETERMINATION. ACTUAL SUBSURFACE CONDITOINS BETWEEN BORINGS MAY VARY. CORRELATIONS ARE SHOWN IN MORE DETAIL IN FEASIBILITY REPORT PLAN SHEETS 4–10 (RMT, SEPTEMBER 1997).
5. SOIL BORINGS AND WELLS HAVE BEEN PROJECTED ONTO THE CROSS SECTION.
6. SEE SHEET 4 FOR SUBBASE GRADES, SHEET 5 FOR BASE GRADES AND SHEET 12 FOR FINAL GRADES.

**(SEE SHEET 2 FOR STANDARD NOTES AND LEGEND)**




## CROSS SECTION LOCATOR MAP

NOTE: THESE PLANS ARE ACCOMPAINIED BY A REPORT OF THE SAME TITLE. THESE DOCUMENTS ARE INTERRELATED AND ARE INTENDED TO BE USED AND REVIEWED TOGETHER. THESE DOCUMENTS ARE INTENDED TO BE USED FOR REGULATORY PURPOSES ONLY.
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| 3. | | | | |
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PROJECT: **DAIRLYAND POWER COOPERATIVE PLAN OF OPERATION BUFFALO COUNTY, WISCONSIN**

SHEET TITLE: **ENGINEERING CROSS SECTIONS 171700N AND 172200N**

| | | |
|---|---|---|
| DRAWN BY: DEFOEJ | SCALE: HORIZ. 1"=100' VERT. 1"=40' | PROJ. NO. 3081.40 |
| CHECKED BY: | | FILE NO. 30814001.DWG |
| APPROVED BY: | DATE PRINTED: OCT 13 2000 | SHEET 15 OF 24 |
| DATE: OCTOBER 2000 | | |

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R02.B/X
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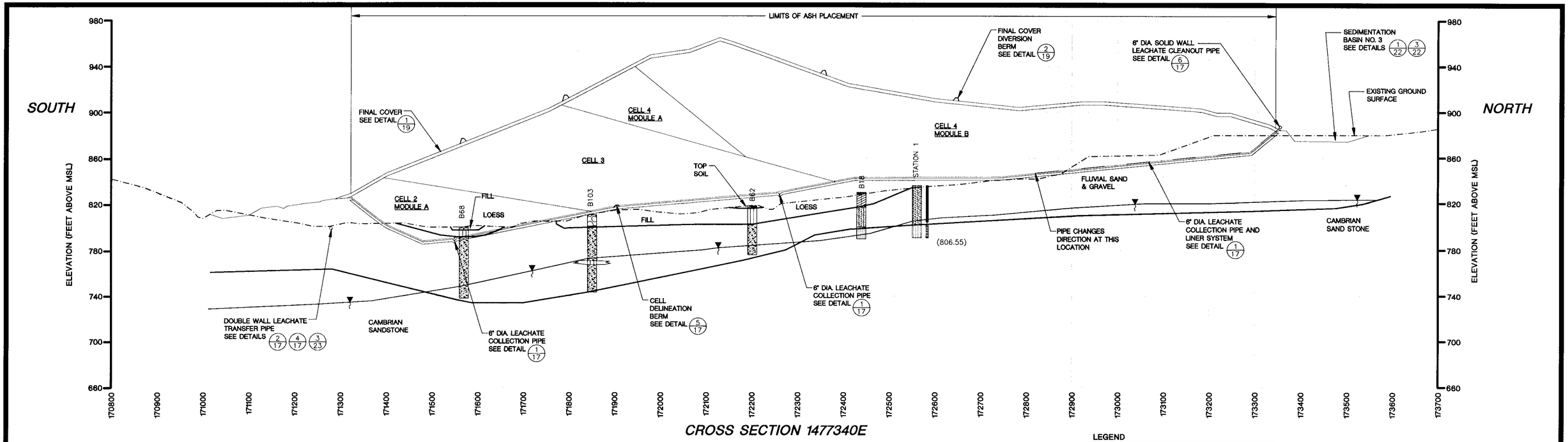
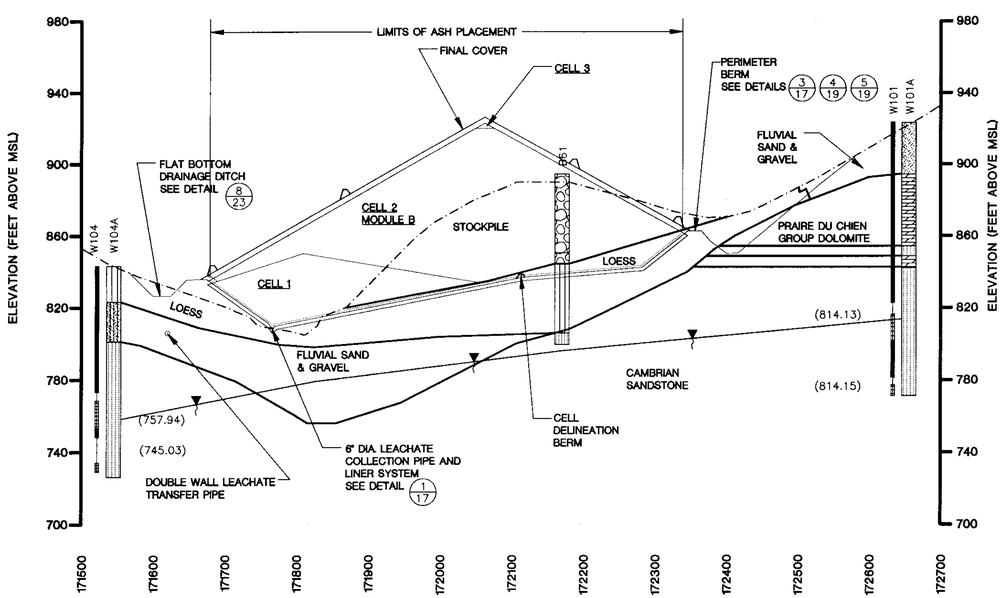



## CROSS SECTION 1477340E




## CROSS SECTION 1477710E

### LEGEND

- PROPOSED FINAL COVER/BASE LINER
- 6" DIA. PERFORATED GRADIENT CONTROL/ LEACHATE COLLECTION PIPE
- APPROXIMATE DIVERSION BERM LOCATION
- MAIN GRADIENT CONTROL TRANSFER PIPE
- (745.03) WATER TABLE OR PIEZOMETRIC ELEVATION
- UNIT B AND C BOUNDARY
- B61 BORING OR WELL NUMBER
- EXISTING GROUND SURFACE
- WATER TABLE LINE
- STRATIGRAPHIC BOUNDARY, DASHED WHERE INFERRED

WELL CONSTRUCTION

- WELL SEAL
- WELL CASING
- WELL SCREEN

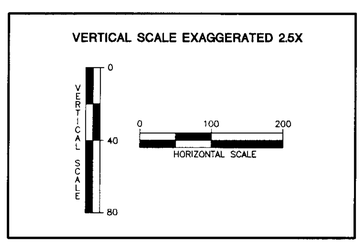
LITHOLOGIC UNITS (USCS CLASSIFICATION)

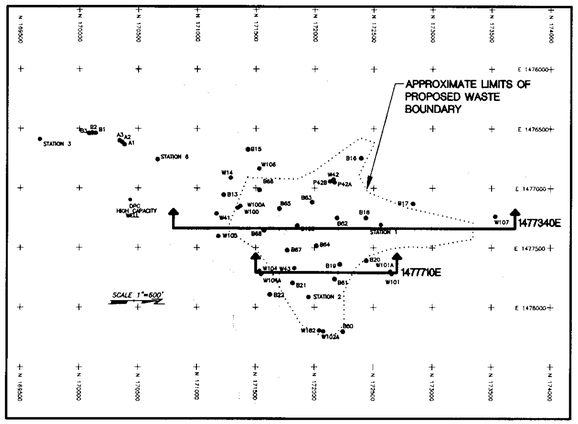
- TOPSOIL
- FILL
- SILT (ML)
- CLAY (CL)
- SILTY CLAY (CL)
- CLAYEY SILT (ML)
- SAND (SP)
- POORLY GRADED GRAVEL
- SILTY GRAVEL WITH SAND (GM)
- SILTY SAND WITH GRAVEL (SM)
- SILTY SAND (SM)
- SANDSTONE
- DOLOMITE
- SANDY SILT

### NOTES

1. EXISTING GROUND SURFACE TAKEN FROM PLAN SHEET 3.
2. ELEVATION REFERENCED TO USGS MEAN SEA LEVEL (MSL) DATUM, 1929.
3. GROUNDWATER ELEVATIONS BASED ON MEASUREMENTS OBTAINED BY DPC ON APRIL 26, 1996.
4. THE STRATUM LINES ARE BASED ON INTERPOLATION BETWEEN BORINGS AND ON INFORMATION CONTAINED ON THE HIGHWATER TABLE CONTOUR MAP (PLAN SHEET 12) AND THE TOP OF COMPETENT BEDROCK CONTOUR MAP (PLAN SHEET 13) IN THE FEASIBILITY REPORT, AND ON THE BOTTOM OF LOESS EXISTING CONDITIONS (FIGURE 2) SHEET INCLUDED IN THE APRIL 30, 1999, SUPPLEMENTAL INFORMATION TO SUPPORT FEASIBILITY DETERMINATION. ACTUAL SUBSURFACE CONDITOINS BETWEEN BORINGS MAY VARY. CORRELATIONS ARE SHOWN IN MORE DETAIL IN FEASIBILITY REPORT PLAN SHEETS 4–10 (RMT, SEPTEMBER 1997).
5. SOIL BORINGS AND WELLS HAVE BEEN PROJECTED ONTO THE CROSS SECTION.
6. SEE SHEET 4 FOR SUBBASE GRADES, SHEET 5 FOR BASE GRADES AND SHEET 12 FOR FINAL GRADES.

(SEE SHEET 2 FOR STANDARD NOTES AND LEGEND)




CROSS SECTION LOCATOR MAP

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| 3. | | | | |
| 2. | | | | |
| 1. | | | | |

PROJECT: DAIRLYAND POWER COOPERATIVE
PLAN OF OPERATION
BUFFALO COUNTY, WISCONSIN

SHEET TITLE: ENGINEERING CROSS SECTIONS
1477340E AND 1477710E

| | | |
|---|---|---|
| DRAWN BY: DEFOEJ | SCALE: HORIZ. 1"=100 VERT. 1"=40' | PROJ. NO. 3081.40 |
| CHECKED BY: | | FILE NO. 30814002.DWG |
| APPROVED BY: | DATE PRINTED: OCT 13 2000 | SHEET 16 OF 24 |
| DATE: OCTOBER 2000 | | |

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Phone: 608/831–4444

PLOT INFO
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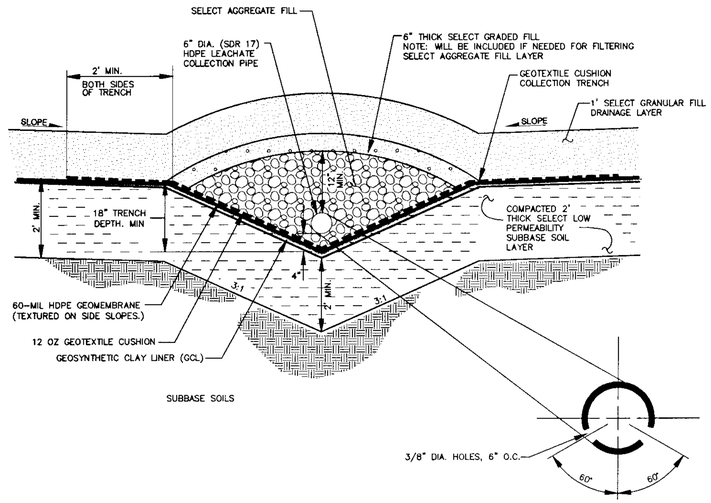
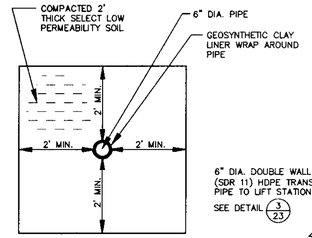
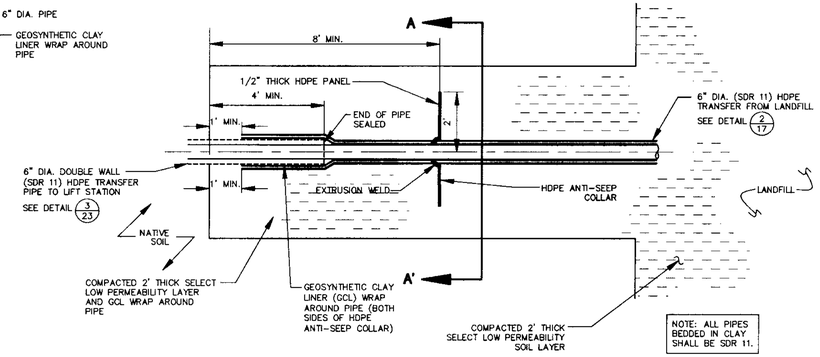



1/17 LEACHATE COLLECTION/LINER SYSTEM

(NOT TO SCALE)

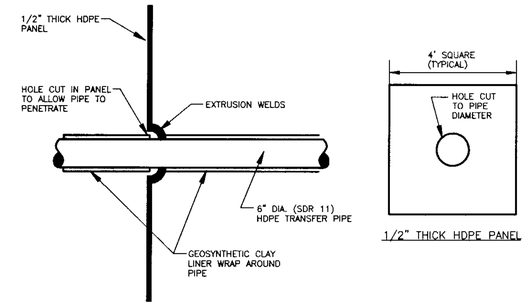



SECTION A-A'

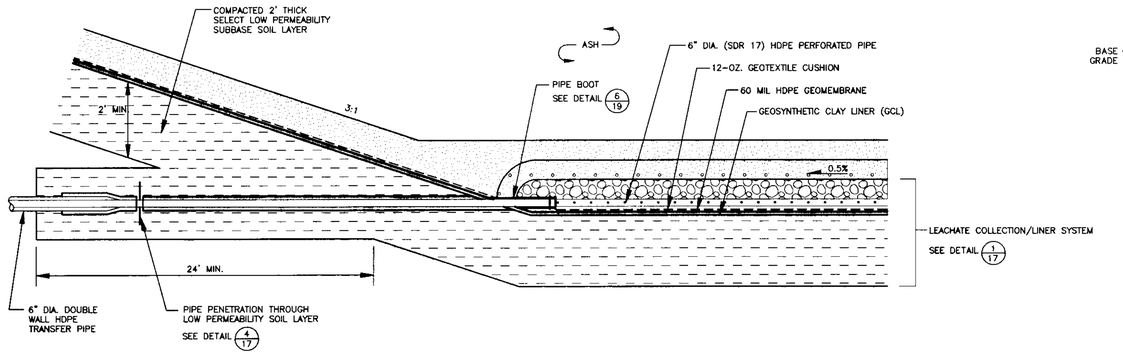



4/17 LEACHATE TRANSFER PIPE CLAY TRENCH CUT-OFF THROUGH PERIMETER BERM (TYPICAL)

(NOT TO SCALE)

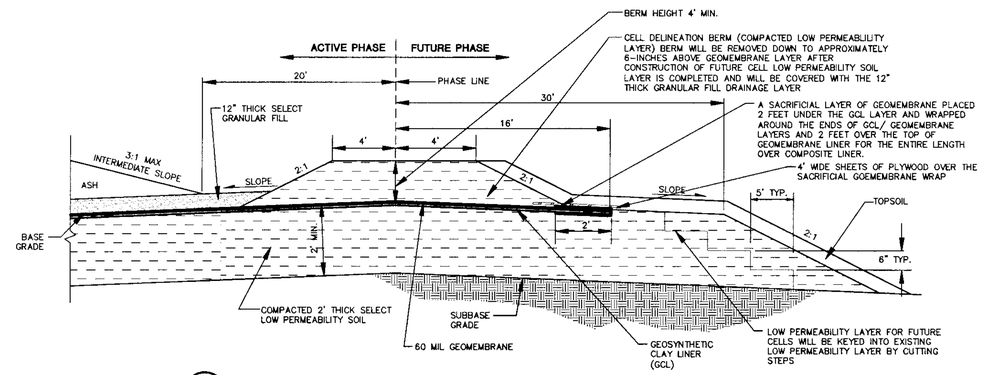



HDPE ANTI-SEEP COLLAR DETAIL (TYPICAL)



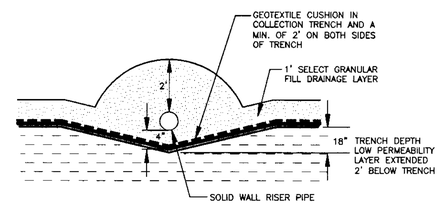

2/17 PIPE PENETRATION THROUGH LANDFILL PERIMETER BERM (TYPICAL)

(NOT TO SCALE)
LOOKING EAST



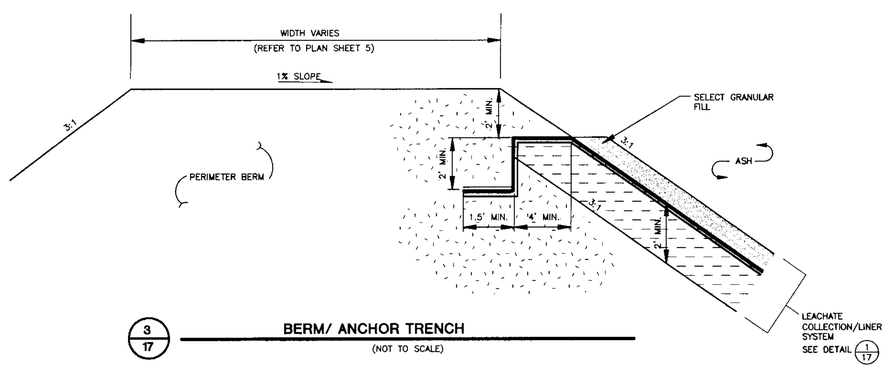

5/17 CELL DELINEATION BERM

(NOT TO SCALE)



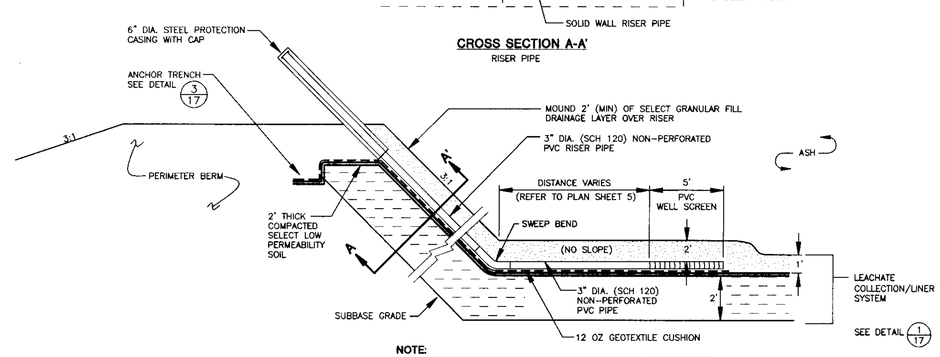

CROSS SECTION A-A'

RISER PIPE




3/17 BERM/ ANCHOR TRENCH

(NOT TO SCALE)




**NOTE:**
**LEACHATE HEADWELL WILL LIE HORIZONTALLY ON TOP OF LINER AND WITHIN 12" SELECT GRANULAR FILL DRAINAGE LAYER.**

**PIPE CONSTRUCTION ON BERM SIDE SLOPE IS ALSO TYPICAL FOR LEACHATE CLEANOUT PIPES.**

6/17 LEACHATE HEADWELL

(NOT TO SCALE)

## LINE AND SHADING LEGEND

| | |
|---|---|
| GEOTEXTILE | GEOMEMBRANE |
| GEOCOMPOSITE | GEOSYNTHETIC CLAY LINER (GCL) |
| TOPSOIL | NATIVE SOIL |
| SELECT GRANULAR FILL DRAINAGE LAYER | CONCRETE |
| PIPE BEDDING MATERIAL | RIPRAP |
| SELECT AGGREGATE FILL | GRAVEL |
| COMPACTED SELECT LOW PERMEABILITY SOIL | GENERAL FILL |

NOTE: THESE PLANS ARE ACCOMPANIED BY A REPORT OF THE TITLE. THESE DOCUMENTS ARE INTERRELATED AND ARE INTENDED TO BE USED AND REVIEWED TOGETHER. THESE DOCUMENTS ARE INTENDED TO BE USED FOR REGULATORY PURPOSES ONLY.

NOT FOR CONSTRUCTION

| NO. | BY | DATE | REVISION | APP'D. |
|---|---|---|---|---|
| 3. | | | | |
| 2. | | | | |
| 1. | | | | |

PROJECT: **DAIRYLAND POWER COOPERATIVE PLAN OF OPERATION BUFFALO COUNTY, WISCONSIN**

SHEET TITLE: **DETAILS- LINER AND COLLECTION PIPES**

| | | |
|---|---|---|
| DRAWN BY: DEFOEJ | SCALE: | PROJ. NO. 3081.40 |
| CHECKED BY: DM | NOT TO SCALE | FILE NO. 30814005.DWG |
| APPROVED BY: BJK | DATE PRINTED: | SHEET 17 OF 23 |
| DATE: OCTOBER 2000 | | |

RMT
744 Heartland Trail
Madison, WI 53717-1934
P.O. Box 8923
Madison, WI 53708-8923
Phone: 608/831-4444

PLOT DATA
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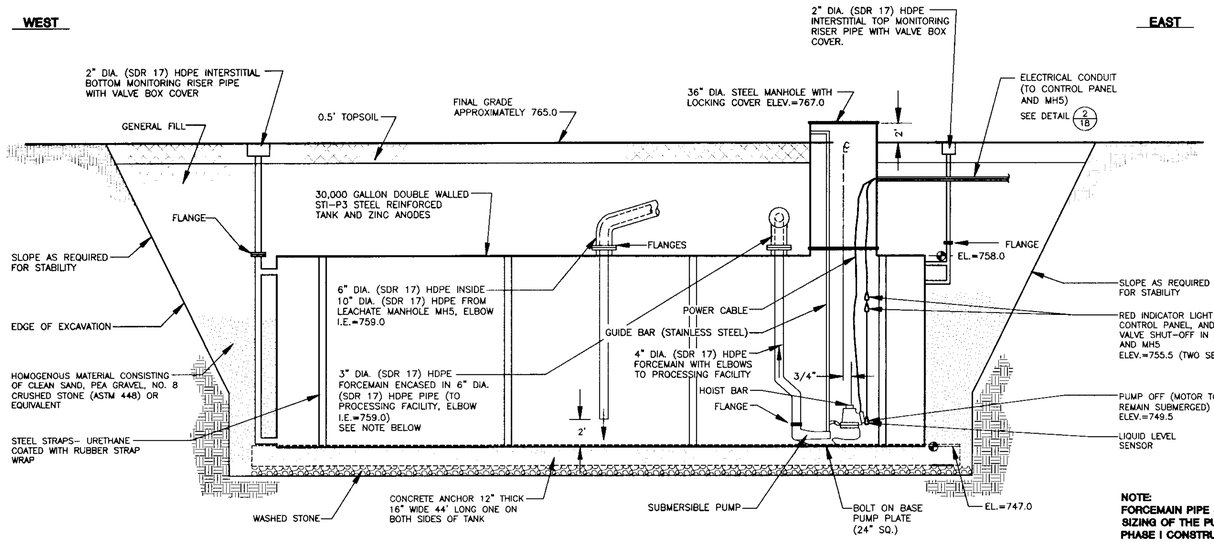
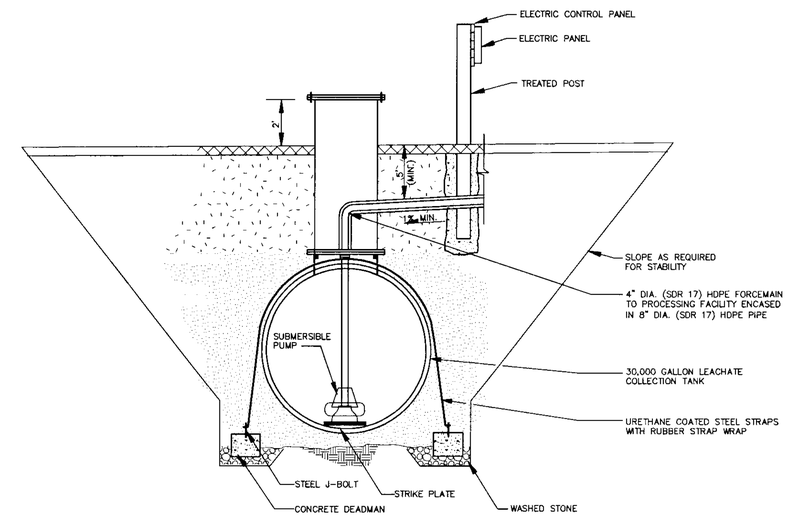
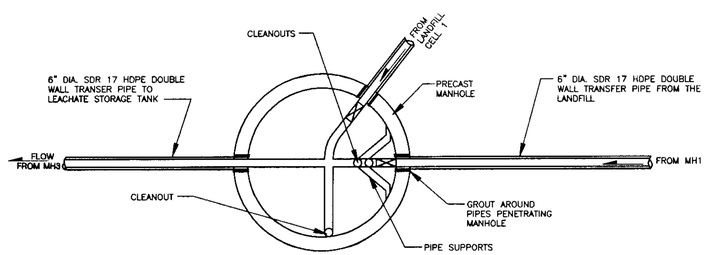



**NOTE:**
**FORCEMAIN PIPE SIZE TO BE VARIFIED DURING SIZING OF THE PUMP AT DEVELOPMENT OF THE PHASE I CONSTRUCTION PLANS.**

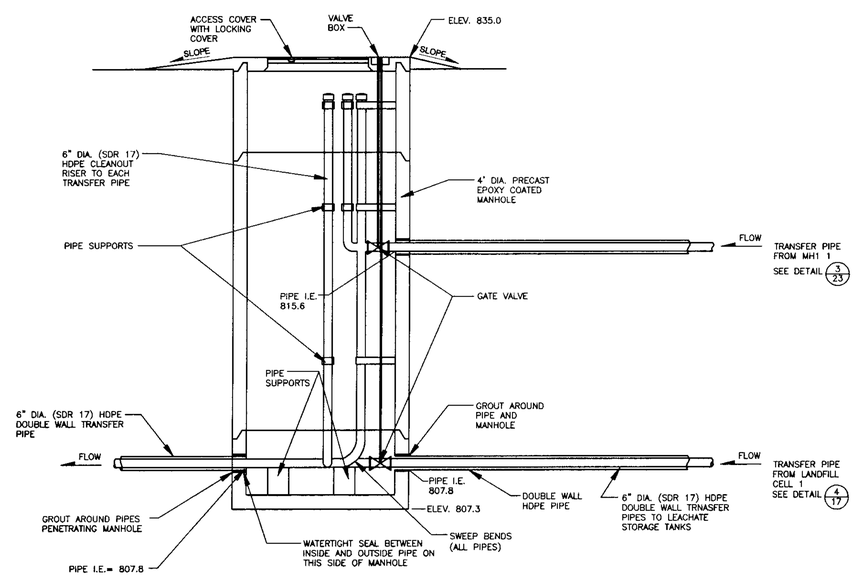



1/18 LEACHATE STORAGE TANK SECTION

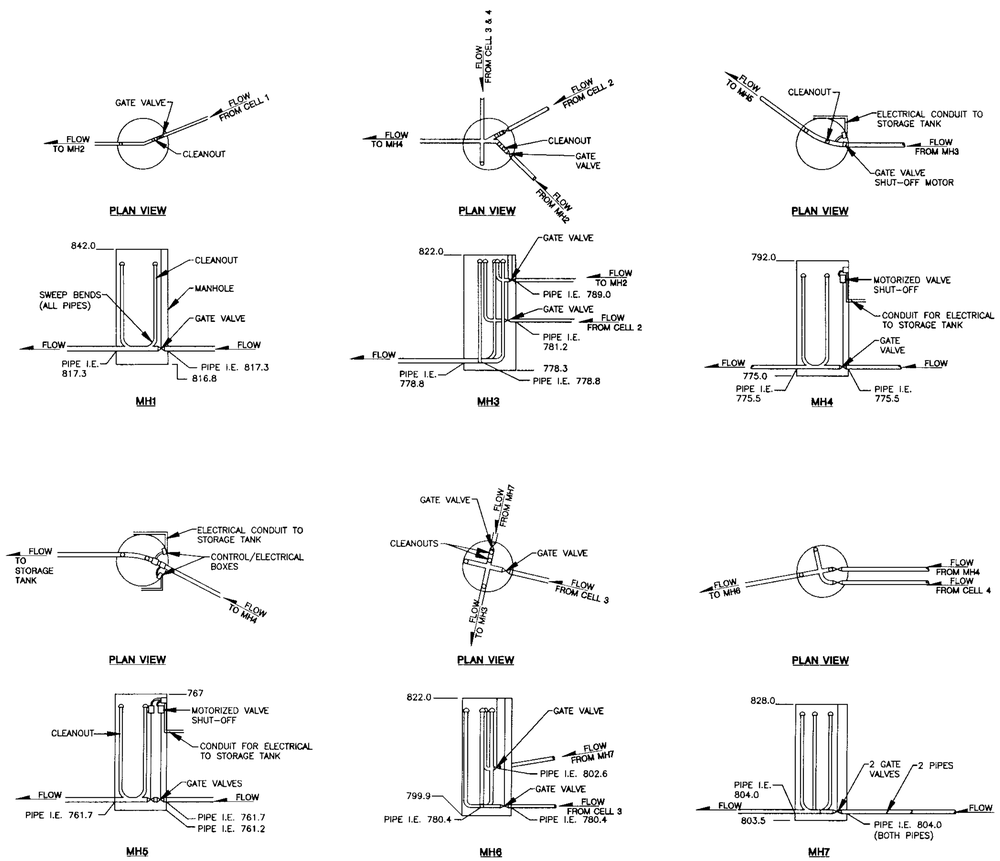
(NOT TO SCALE)




PLAN VIEW




PROFILE FOR MH2 (TYPICAL FOR ALL DETAILS)




2/18 MANHOLE DETAILS

(NOT TO SCALE)

## LINE AND SHADING LEGEND

| | |
|---|---|
| GEOTEXTILE | GEOMEMBRANE |
| GEOCOMPOSITE | GEOSYNTHETIC CLAY LINER (GCL) |
| TOPSOIL | NATIVE SOIL |
| SELECT GRANULAR FILL DRAINAGE LAYER | CONCRETE |
| PIPE BEDDING MATERIAL | RIPRAP |
| SELECT AGGREGATE FILL | GRAVEL |
| COMPACTED SELECT LOW PERMEABILITY SOIL | GENERAL FILL |

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NOT FOR CONSTRUCTION

| NO. | BY | DATE | REVISION | APP'D. |
|---|---|---|---|---|
| 3. | | | | |
| 2. | | | | |
| 1. | | | | |

PROJECT: **DAIRYLAND POWER COOPERATIVE PLAN OF OPERATION BUFFALO COUNTY, WISCONSIN**

SHEET TITLE: **DETAILS- LEACHATE STORAGE TANK AND MANHOLE**

| | | |
|---|---|---|
| DRAWN BY: DEFOEJ | SCALE: | PROJ. NO. 3081.40 |
| CHECKED BY: DM | NOT TO SCALE | FILE NO. 30814006.DWG |
| APPROVED BY: BJK | DATE PRINTED: | SHEET 18 OF 23 |
| DATE: OCTOBER 2000 | | |

RMT
744 Heartland Trail
Madison, WI 53717-1934
P.O. Box 8923
Madison, WI 53708-8923
Phone: 608/831-4444

RMT-MAP
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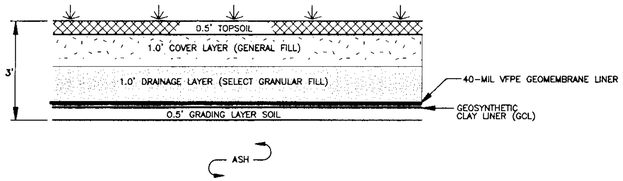
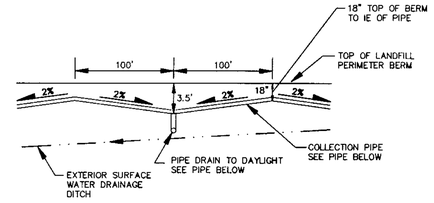


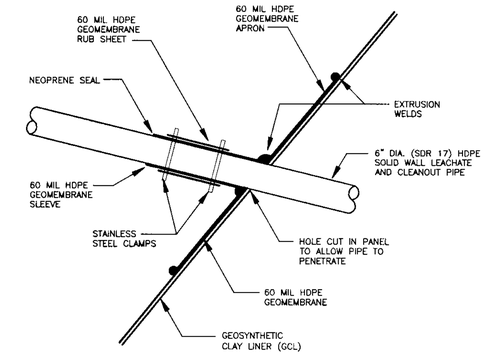

1/19 **FINAL COVER**

(NOT TO SCALE)



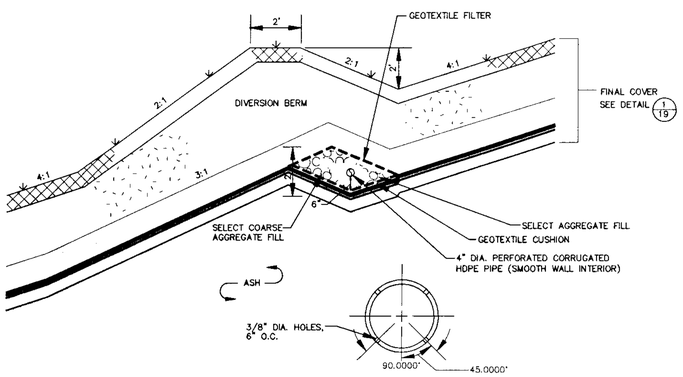

**NOTE: IN AREAS WHERE THE TOP OF BERM SLOPES, THE COLLECTION PIPE WILL FOLLOW THE SAME SLOPE AS THE TOP OF BERM AND WILL OUTLET THROUGH DISCHARGE PIPES LOCATED AT SPECIFIED INTERVALS. REFER TO PLAN SHEET 12.**

**SECTION A-A' OF FINAL COVER DRAINAGE LAYER**




6/19 **PIPE BOOT- PIPES PENETRATING THROUGH FINAL COVER AND LOW PERMEABILITY LAYER (TYPICAL)**

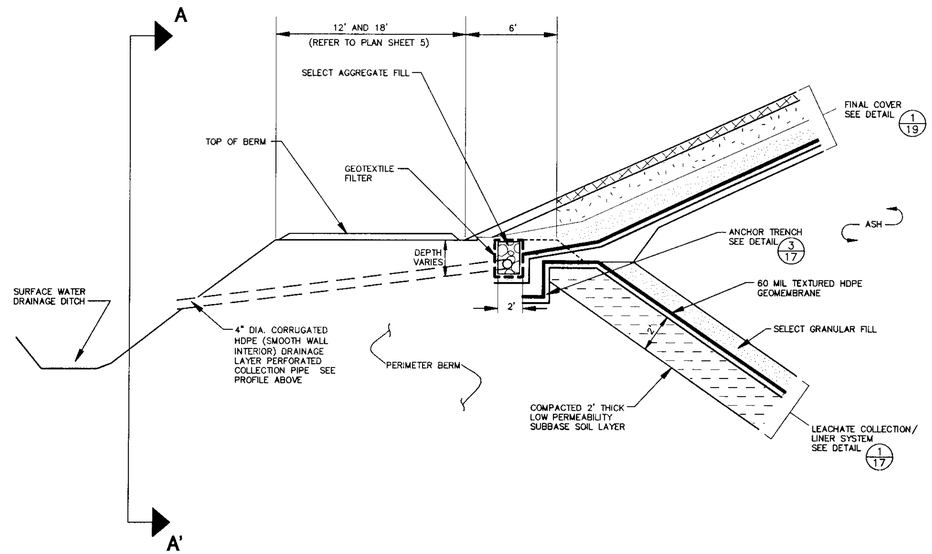
(NOT TO SCALE)




**NOTE:**
**A 4" DIA. PERFORATED CORRUGATED HDPE PIPE WILL BE LOCATED BELOW EVERY DIVERSION BERM ABOVE THE FINAL COVER EXCEPT THE LOWEST BERM LOCATED NEXT TO THE LANDFILL PERIMETER BERM. TO COLLECT WATER IN THE DRAINAGE LAYER ALONG THE PERIMETER BERM PIPES WILL BE CONSTRUCTED IN THE BERM AS SHOWN ON DETAIL 4 OF 19.**

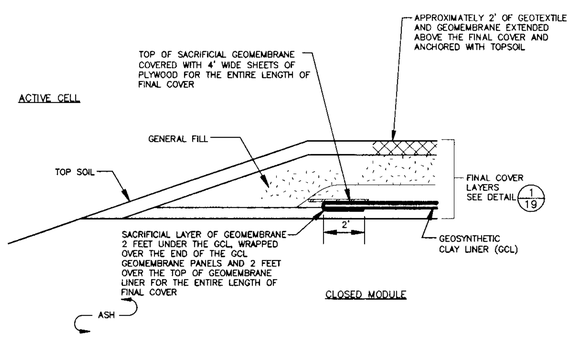
2/19 **SURFACE WATER DIVERSION BERM ON FINAL COVER (TYPICAL)**

(NOT TO SCALE)



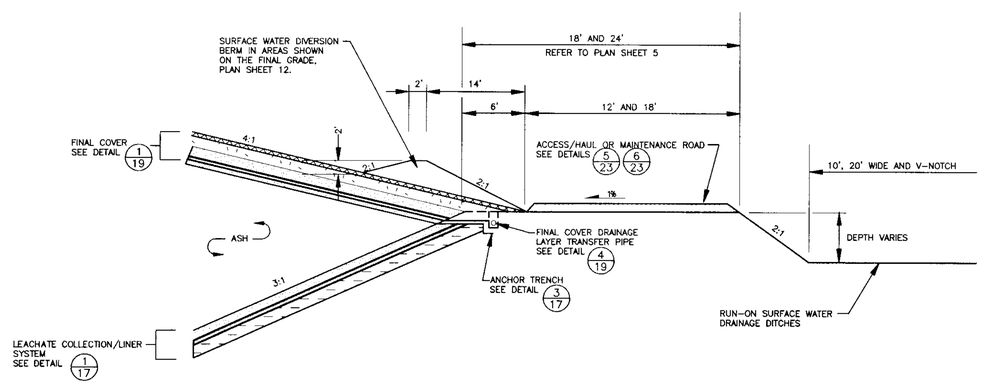

4/19 **PERIMETER BERM FINAL COVER DRAINAGE LAYER DISCHARGE PIPE (TYPICAL)**

(NOT TO SCALE)




3/19 **CONSTRUCTION OF FINAL COVER FOR SPLICING FUTURE FINAL COVER**

(NOT TO SCALE)




5/19 **LANDFILL PERIMETER BERM AND SURFACE WATER DRAINAGE DITCHES (TYPICAL)**

(NOT TO SCALE)

**LINE AND SHADING LEGEND**

| | |
|---|---|
| GEOTEXTILE | GEOMEMBRANE |
| GEOCOMPOSITE | GEOSYNTHETIC CLAY LINER (GCL) |
| TOPSOIL | NATIVE SOIL |
| SELECT GRANULAR FILL DRAINAGE LAYER | CONCRETE |
| PIPE BEDDING MATERIAL | RIPRAP |
| SELECT AGGREGATE FILL | GRAVEL |
| COMPACTED SELECT LOW PERMEABILITY SOIL | GENERAL FILL |

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NOT FOR CONSTRUCTION

| NO. | BY | DATE | REVISION | APP'D. |
|---|---|---|---|---|
| 3. | | | | |
| 2. | | | | |
| 1. | | | | |

PROJECT: **DAIRYLAND POWER COOPERATIVE PLAN OF OPERATION BUFFALO COUNTY, WISCONSIN**

SHEET TITLE: **DETAILS- FINAL COVER**

| | | |
|---|---|---|
| DRAWN BY: DEFOEJ | SCALE: NOT TO SCALE | PROJ. NO. 3081.40 |
| CHECKED BY: DM | | FILE NO.3081 4004.dwg |
| APPROVED BY: BJK | DATE PRINTED: | SHEET 19 OF 23 |
| DATE: OCTOBER 2000 | | |

RMT.
744 Heartland Trail
Madison, WI 53717-1934
P.O. Box 8923
Madison, WI 53708-8923
Phone: 608/831-4444

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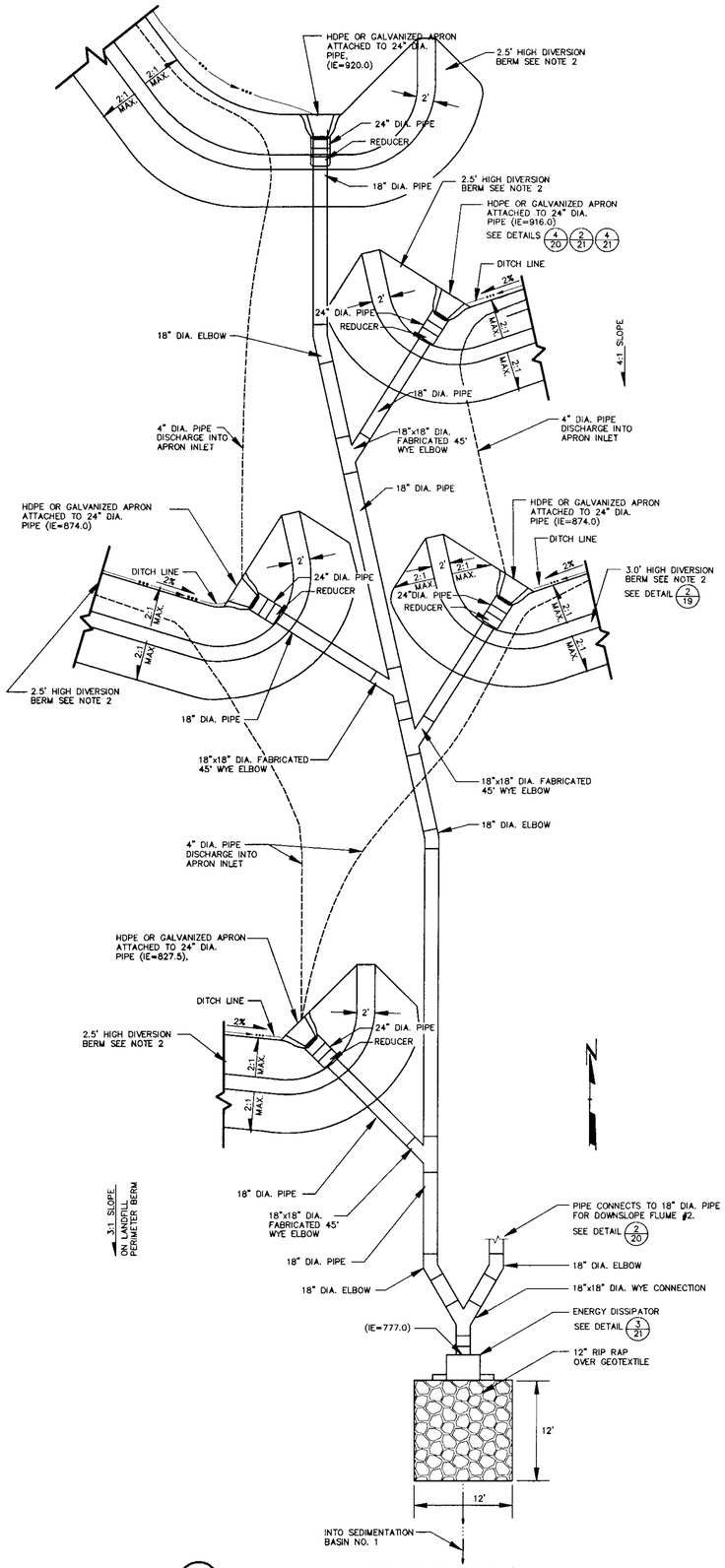
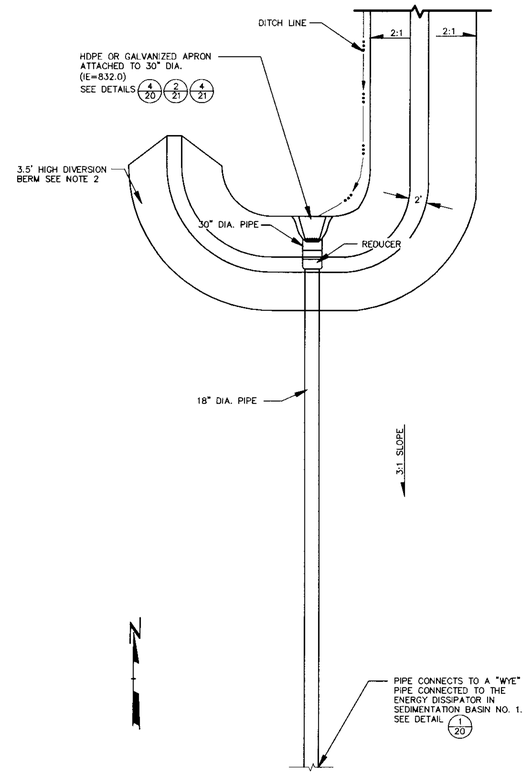
Plotted By = Bertosam, Brian E. Bertosam



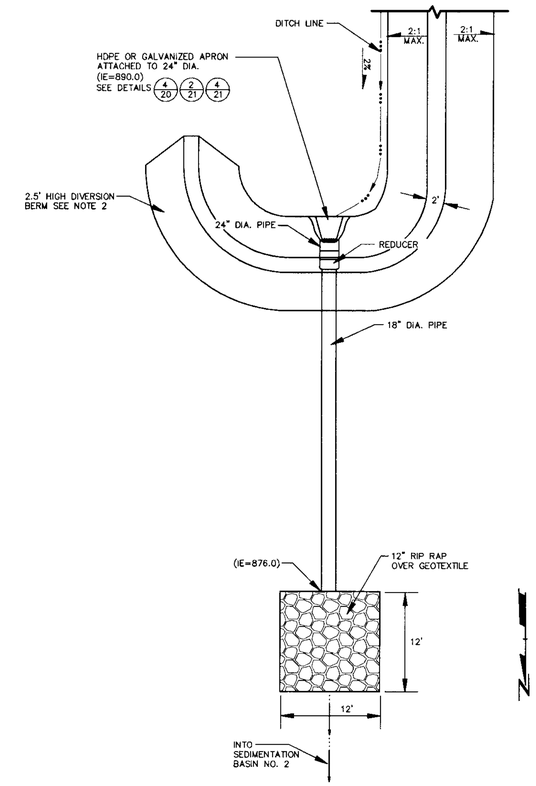

1/20 **DOWNSLOPE FLUME #1**

(NOT TO SCALE)



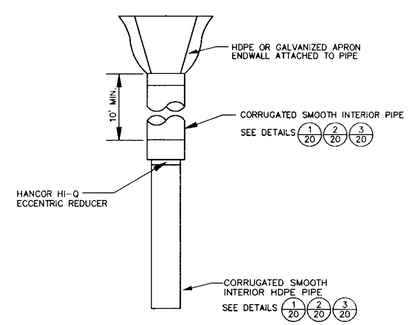

2/20 **DOWNSLOPE FLUME #2**

(NOT TO SCALE)




3/20 **DOWNSLOPE FLUME #3**

(NOT TO SCALE)




4/20 **DOWNSLOPE FLUME INLET STRUCTURE (TYPICAL)**

(NOT TO SCALE)

## NOTES

1. ALL PIPE CONNECTORS ARE CORRUGATED SMOOTH HDPE.
2. 2.5 FOOT DIVERSION BERM AT PIPE INLET WILL TAPER TO A 2-FOOT DIVERSION BERM 50-FEET FROM PIPE INLET. 3.0 FOOT DIVERSION BERM AT PIPE INLET WILL TAPER TO A 2-FOOT DIVERSION BERM 100-FEET FROM PIPE INLET. 3.5 FOOT DIVERSION BERM AT PIPE INLET WILL TAPER TO A 2-FOOT DIVERSION BERM 150-FEET FROM PIPE INLET.

### LINE AND SHADING LEGEND

| | |
|---|---|
| GEOTEXTILE | GEOMEMBRANE |
| GEOCOMPOSITE | GEOSYNTHETIC CLAY LINER (GCL) |
| TOPSOIL | NATIVE SOIL |
| SELECT GRANULAR FILL DRAINAGE LAYER | CONCRETE |
| PIPE BEDDING MATERIAL | RIPRAP |
| SELECT AGGREGATE FILL | GRAVEL |
| COMPACTED SELECT LOW PERMEABILITY SOIL | GENERAL FILL |

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NOT FOR CONSTRUCTION

| NO. | BY | DATE | REVISION | APP'D. |
|---|---|---|---|---|
| 3. | | | | |
| 2. | | | | |
| 1. | | | | |

PROJECT: **DAIRYLAND POWER COOPERATIVE PLAN OF OPERATION BUFFALO COUNTY, WISCONSIN**

SHEET TITLE: **DETAILS- DOWNSLOPE FLUMES**

| | | |
|---|---|---|
| DRAWN BY: DEFOEJ | SCALE: | PROJ. NO. 3081.40 |
| CHECKED BY: DM | NOT TO SCALE | FILE NO. 30814008.DWG |
| APPROVED BY: BJK | DATE PRINTED: | SHEET 20 OF 23 |
| DATE: OCTOBER 2000 | | |

RMT
744 Heartland Trail
Madison, WI 53717-1934
P.O. Box 8923
Madison, WI 53708-8923
Phone: 608/831-4444

PLOT INFO
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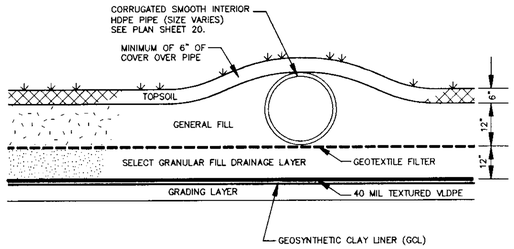
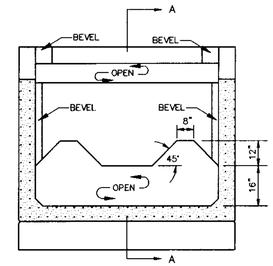
Attached Xref's: No xref's Attached




SECTION A-A'

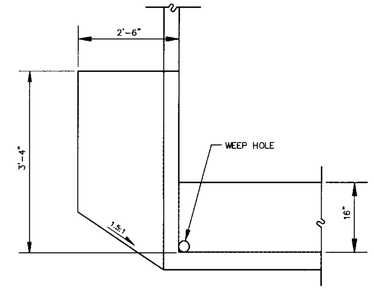
1/21 **FINAL COVER WITH DOWNSLOPE FLUME PIPE**

(NOT TO SCALE)



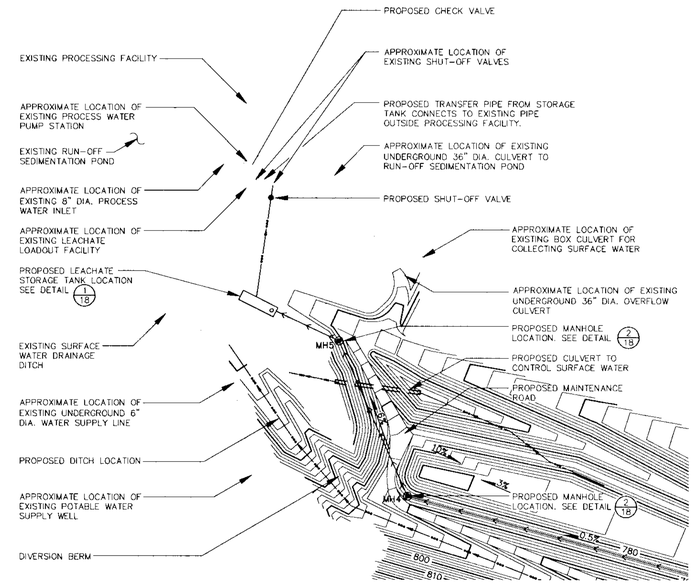

SECTION B-B'

(NOT TO SCALE)




SECTION C-C'

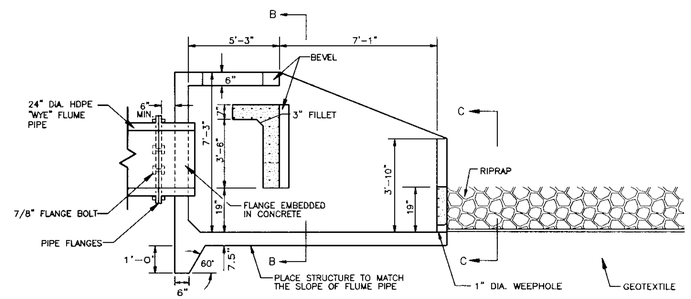
(NOT TO SCALE)




NOTE:
SCREENED INFORMATION REPRESENTS EXISTING CONDITIONS.
BOLD INFORMATION REPRESENTS DESIGNED FEATURES.

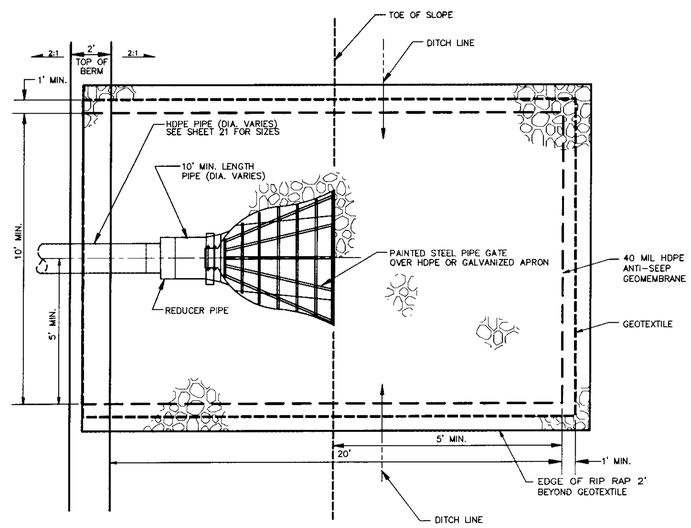
5/21 **LEACHATE TRANSFER SYSTEM AND EXISTING PROCESSING FACILITY LAYOUT**

1"=100'

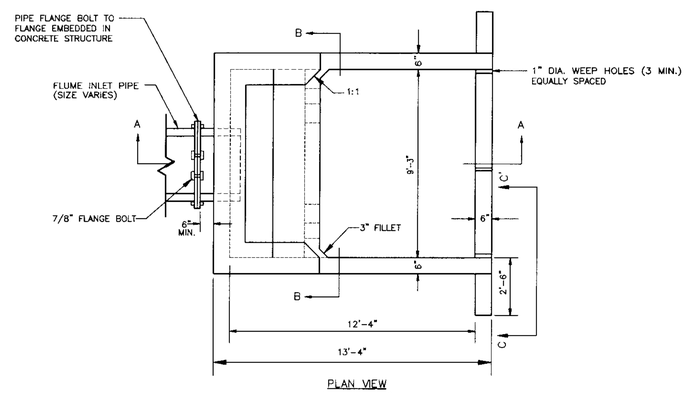



SECTION A-A'

(NOT TO SCALE)




TOP VIEW

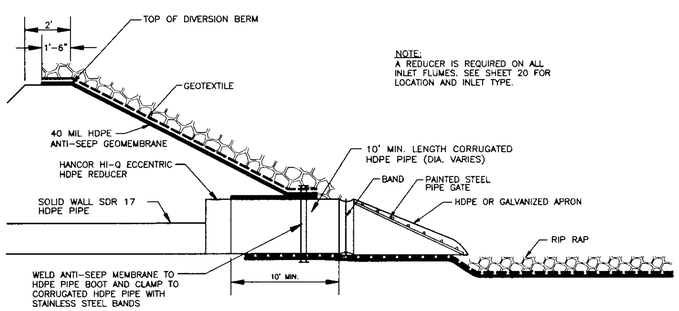



PLAN VIEW

(NOT TO SCALE)

3/21 **OUTLET STRUCTURE**

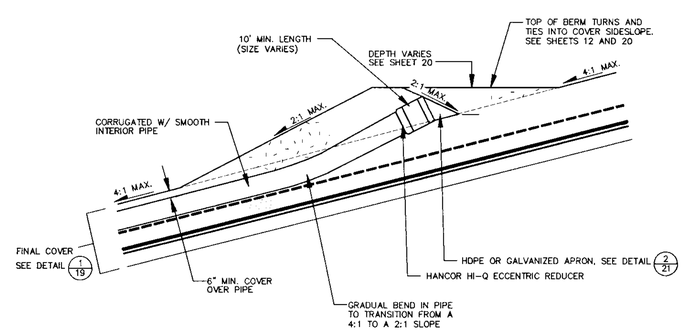
(NOT TO SCALE)




NOTE:
A REDUCER IS REQUIRED ON ALL INLET FLUMES. SEE SHEET 20 FOR LOCATION AND INLET TYPE.

2/21 **INLET STRUCTURE DETAIL (TYPICAL)**

(NOT TO SCALE)




4/21 **DOWNSLOPE FLUME CROSS SECTION CROSS SECTION ON SIDESLOPE**

(NOT TO SCALE)

**NOTES:**

1. CORRUGATED HDPE PIPE HAS A SMOOTH INTERIOR.

**LINE AND SHADING LEGEND**

| | | | |
|---|---|---|---|
| | GEOTEXTILE | | GEOMEMBRANE |
| | GEOCOMPOSITE | | GEOSYNTHETIC CLAY LINER (GCL) |
| | TOPSOIL | | NATIVE SOIL |
| | SELECT GRANULAR FILL DRAINAGE LAYER | | CONCRETE |
| | PIPE BEDDING MATERIAL | | RIPRAP |
| | SELECT AGGREGATE FILL | | GRAVEL |
| | COMPACTED SELECT LOW PERMEABILITY SOIL | | GENERAL FILL |

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| NO. | BY | DATE | REVISION | APP'D. |
|---|---|---|---|---|
| 3. | | | | |
| 2. | | | | |
| 1. | | | | |

PROJECT: **DAIRYLAND POWER COOPERATIVE PLAN OF OPERATION BUFFALO COUNTY, WISCONSIN**

SHEET TITLE: **DETAILS- DOWNSLOPE FLUMES**

| | | |
|---|---|---|
| DRAWN BY: DEFOEJ | SCALE: NOT TO SCALE | PROJ. NO. 3081.40 |
| CHECKED BY: DM | | FILE NO. 30814009.dwg |
| APPROVED BY: BJK | DATE PRINTED: | SHEET 21 OF 23 |
| DATE: OCTOBER 2000 | | |

RMT.
744 Heartland Trail
Madison, WI 53717-1934
P.O. Box 8923
Madison, WI 53708-8923
Phone: 608/831-4444

PLOT DATA
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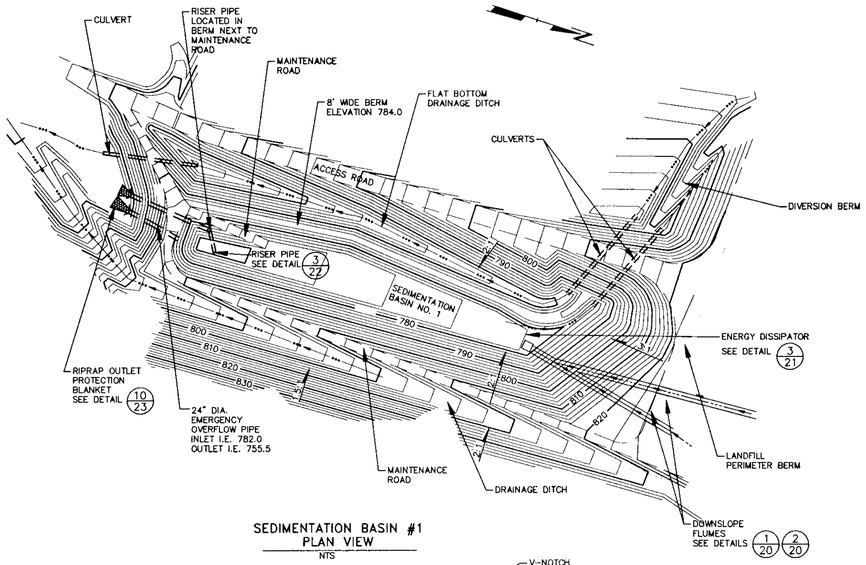
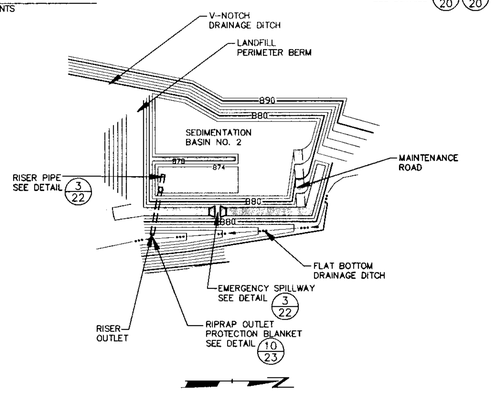
Opened By = Mark Jones



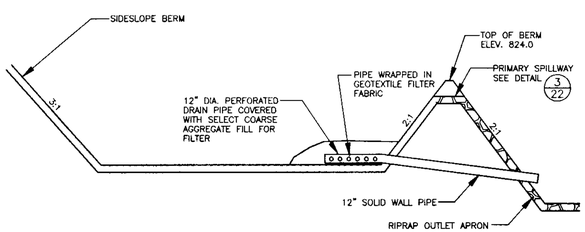

SEDIMENTATION BASIN #1
PLAN VIEW
NTS




SEDIMENTATION BASIN #2
PLAN VIEW
NTS

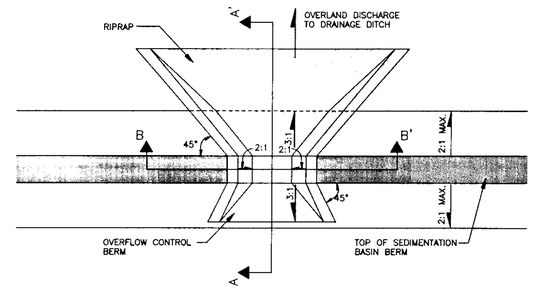
1/22 **SEDIMENTATION BASINS NO. 1 AND NO. 2**

(NOT TO SCALE)



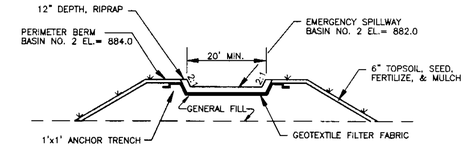

2/22 **TEMPORARY SEDIMENTATION BASIN (TYPICAL)**

(NOT TO SCALE)

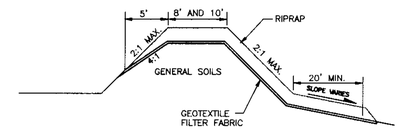



SURFACE WATER PRIMARY OR EMERGENCY SPILLWAY
PLAN VIEW

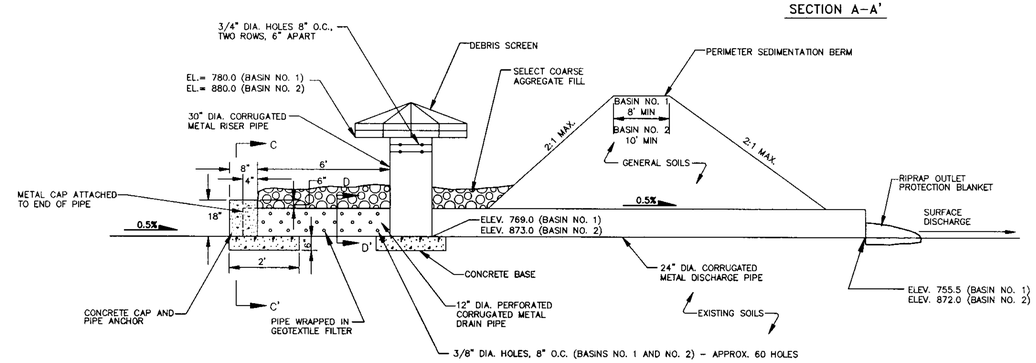
**NOTE:**
**SEDIMENTATION BASIN NO. 1 WILL HAVE A CULVERT PIPE INSTALLED FOR THE EMERGENCY OVERFLOW. SEE DETAIL 1 OF 22.**



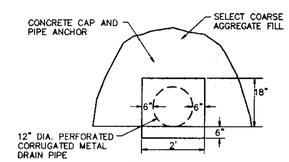

PRIMARY OR EMERGENCY SPILLWAY AT
CROSSECTION B-B'



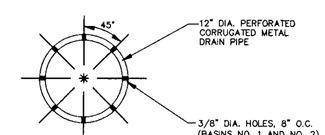

SECTION A-A'




RISER/DISCHARGE PIPE CROSS SECTION (TYPICAL)




SECTION C-C'




SECTION D-D'

3/22 **RISER/DISCHARGE PIPE/EMERGENCY SPILLWAY**

(NOT TO SCALE)

**LINE AND SHADING LEGEND**

| | |
|---|---|
| GEOTEXTILE | GEOMEMBRANE |
| GEOCOMPOSITE | GEOSYNTHETIC CLAY LINER (GCL) |
| TOPSOIL | NATIVE SOIL |
| SELECT GRANULAR FILL DRAINAGE LAYER | CONCRETE |
| PIPE BEDDING MATERIAL | RIPRAP |
| SELECT AGGREGATE FILL | GRAVEL |
| COMPACTED SELECT LOW PERMEABILITY SOIL | GENERAL FILL |

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| NO. | BY | DATE | REVISION | APP'D. |
|---|---|---|---|---|
| 3. | | | | |
| 2. | | | | |
| 1. | | | | |

PROJECT: **DAIRYLAND POWER COOPERATIVE PLAN OF OPERATION BUFFALO COUNTY, WISCONSIN**

SHEET TITLE: **DETAILS- SEDIMENTATION BASINS**

| | | |
|---|---|---|
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| CHECKED BY: DM | NOT TO SCALE | FILE NO. 30814007.dwg |
| APPROVED BY: BJK | DATE PRINTED: | SHEET 22 OF 23 |
| DATE: OCTOBER 2000 | | |

RMT.
744 Heartland Trail
Madison, WI 53717-1934
P.O. Box 8923
Madison, WI 53708-8923
Phone: 608/831-4444

PLOT INFO
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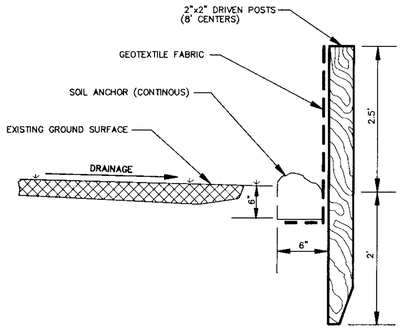
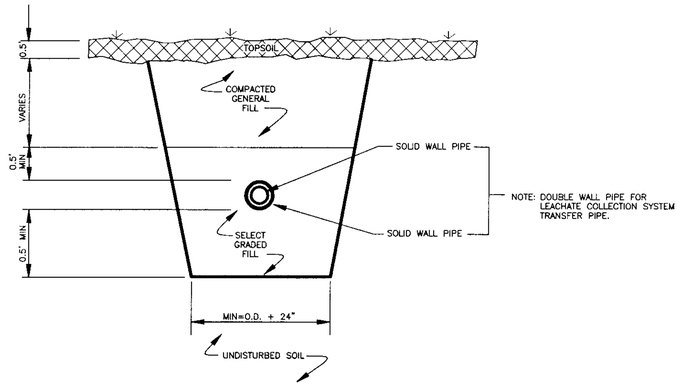
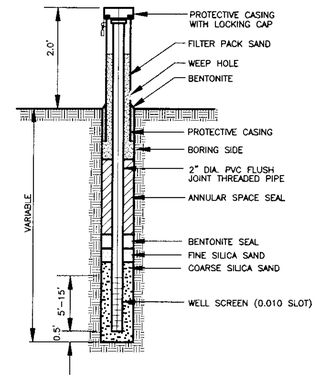



**NOTE:**
DETAIL SHOWN FOR PURPOSES OF IDENTIFYING INSTALLATION METHOD. LOCATION OF FENCE WILL BE DETERMINED AT DEVELOPMENT OF ENGINEERING PLANS FOR EACH PHASE OF CONSTRUCTION AND IN THE FIELD DURING ACTUAL CONSTRUCTION OF EACH PHASE.

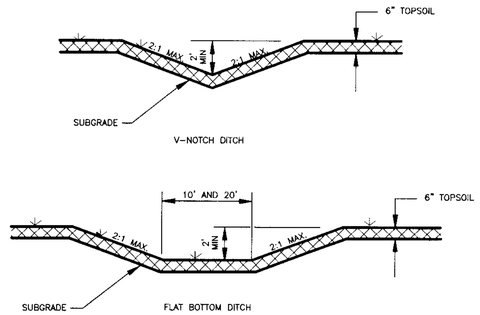
1/23 **SEDIMENT CONTROL FENCE**
(NOT TO SCALE)



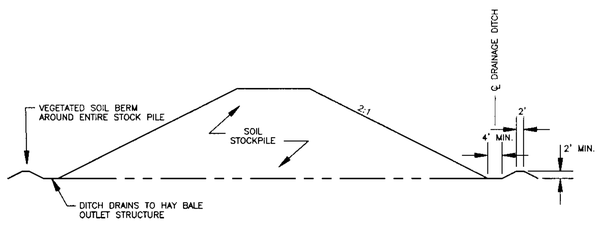

3/23 **DOUBLE WALL TRANSFER PIPE**
(NOT TO SCALE)



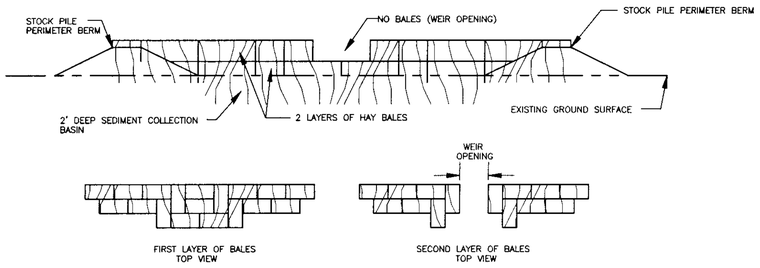

4/23 **WATER TABLE MONITORING WELL**
NOT TO SCALE



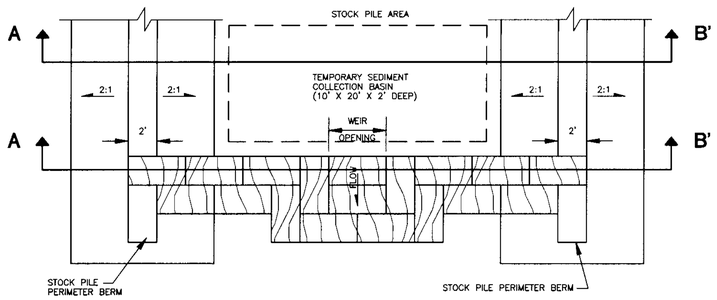

8/23 **DRAINAGE DITCH DETAILS OUTSIDE LANDFILL COVER**
(NOT TO SCALE)



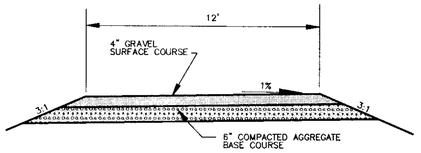

## SECTION B-B'



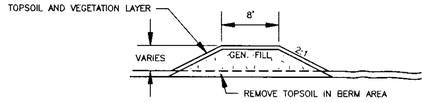

## SECTION A-A'



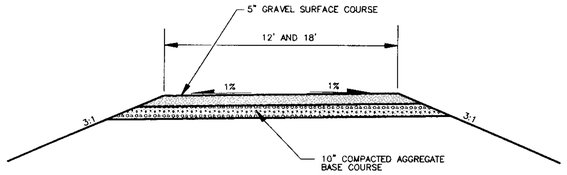

2/23 **SURFACE WATER OUTLET FOR STOCKPILES**
(NOT TO SCALE)



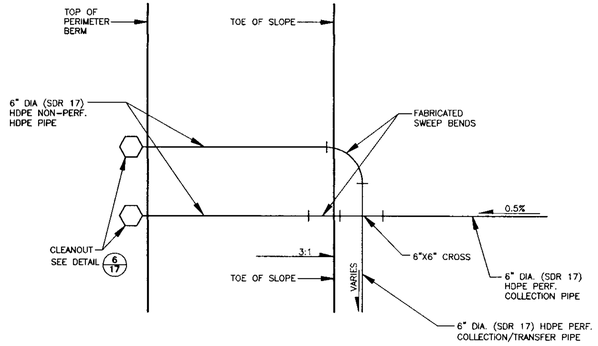

5/23 **MAINTENACE ROAD**
(NOT TO SCALE)



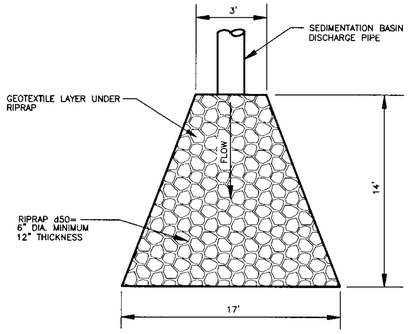

9/23 **TEMPORARY BERM FOR CONTROLLING WATER**
(NOT TO SCALE)




6/23 **ALL WEATHER ACCESS/ HAUL ROAD**
(NOT TO SCALE)




7/23 **PIPE CONNECTIONS (TYPICAL)**
(NOT TO SCALE)




10/23 **DISCHARGE PIPE RIPRAP OUTLET PROTECTION BLANKET**
(NOT TO SCALE)

### LINE AND SHADING LEGEND

| | |
|---|---|
| GEOTEXTILE | GEOMEMBRANE |
| GEOCOMPOSITE | GEOSYNTHETIC CLAY LINER (GCL) |
| TOPSOIL | NATIVE SOIL |
| SELECT GRANULAR FILL DRAINAGE LAYER | CONCRETE |
| PIPE BEDDING MATERIAL | RIPRAP |
| SELECT AGGREGATE FILL | GRAVEL |
| COMPACTED SELECT LOW PERMEABILITY SOIL | GENERAL FILL |

NOTE: THESE PLANS ARE ACCOMPANIED BY A REPORT OF THE TITLE. THESE DOCUMENTS ARE INTERRELATED AND ARE INTENDED TO BE USED AND REVIEWED TOGETHER. THESE DOCUMENTS ARE INTENDED TO BE USED FOR REGULATORY PURPOSES ONLY.
NOT FOR CONSTRUCTION

| NO. | BY | DATE | REVISION | APP'D. |
|---|---|---|---|---|
| 3. | | | | |
| 2. | | | | |
| 1. | | | | |

PROJECT: **DAIRYLAND POWER COOPERATIVE PLAN OF OPERATION BUFFALO COUNTY, WISCONSIN**

SHEET TITLE: **DETAILS- MISCELLANEOUS**

| | | |
|---|---|---|
| DRAWN BY: DEFOEJ | SCALE: NOT TO SCALE | PROJ. NO. 3081.40 |
| CHECKED BY: DM | | FILE NO.30814003.dwg |
| APPROVED BY: BJK | DATE PRINTED: | SHEET 23 OF 23 |
| DATE: OCTOBER 2000 | | |

RMT
744 Heartland Trail
Madison, WI 53717-1934
P.O. Box 8923
Madison, WI 53708-8923
Phone: 608/831-4444

PLOT INFO
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Attached Xref's: No Xref's Attached

# F.3
# Appendix E Excerpt – Geomembrane Compatibility

**CHEMICAL COMPATIBILITY**
**EPA 9090 STUDIES**

**FURNACE BOTTOM & FLY ASH**
**VS.**
**POLY-FLEX & DURA-FLEX**

## INTRODUCTION

This report contains the results of the chemical compatibility studies of municipal power plant furnace bottom ash and fly ash in contact with Poly-Flex (HDPE) and Dura-Flex (VLDPE).

Municipal power plants generate wastes of furnace bottom ash and fly ash. These wastes are collected and often times disposed of through the use of a landfill. In order to prevent chemicals, metals or other materials from leaching out of the ash and possibly contaminating the ground water, a flexible membrane liner (FML) is placed beneath the ash at the waste disposal facility.

One of the most important criteria in specifying a FML for this application is to verify that the ash does not adversely effect the liner's performance. The most widely accepted practice for assessing chemical compatibility of geomembranes is to perform and EPA 9090 study. In this study, the samples of the liner are immersed in the waste leachate or other chemicals for four months at 23° and 50° C. Once a month, the liner is removed from the waste leachate and the liner's material properties are measured. The changes in these properties over this four month period of time are compared to the liner's original values. Chemical compatibility is then determined by assessing the magnitude of changes that took place, and by looking for overall trends in these changes.

In these particular EPA 9090 studies, 60 mil Poly-Flex (HDPE) and Dura-Flex (VLDPE) were tested against furnace bottom ash and fly ash obtained by Northern States Power from a municipal power plant in North Dakota.

Since most EPA 9090 studies are conducted with liquid leachates, there is little problem in obtaining intimate contact with the liners during the immersion process. To obtain intimate contact with the solid ash, the liners had to be first buried in the ash and then water was added to make a sludge. To keep the 50° C. immersion tank at temperature, the entire tank was placed in a heated water bath.

## DISCUSSION OF RESULTS

The tests which are used to evaluate the liner can be broken down into two groups. The first group of tests relates to intrinsic change in the polymer. These tests reflect whether the polymer has degraded in some form, absorbed material out of the leachate, or whether the leachate has absorbed (extracted) something out of the polymer (i.e. additive package). Even small changes in these properties can be significant. The second group of tests evaluate changes in the liner's performance by measuring changes in key physical properties. Because of the nature of the testing and sample variation, changes in these properties are harder to evaluate. Overall trends in the property changes have to be considered.

**STUDY I** **POLY-FLEX VS BOTTOM ASH**

As will be noted in the table of results, no changes were evident (within testing precision) in the polymer performance properties of gauge, dimensions, hardness, mass and density. In the case of total volatile loss, even though some values were more than twice the control result, the numbers are still so small as to be considered negligible.

With physical properties of the liner (tensile, C-tear and puncture), significant changes occurred in these values from month to month when compared to the control. For example, after three months, stress @ 100% and 200% elongation was approximately 15-20% lower than the control. However, after four months, these same properties yielded values equivalent to the control samples. Therefore, it is suspected that the low values generated at the three month mark were more likely due to sample variation or test error, rather than a real change in the liner. Similarly, a consistent 10% drop in C-tear values was experienced on samples from the 23°C immersion tank. However, if the ash had caused an actual change in the liner, a similar drop in C-tear values should be observed in the samples from the 50°C immersion tank. This was not the case.

Hence, based on the review of this data, which indicated no change in polymer performance (gauge, mass, etc.) and with no clear consistent trends showing changes in the liner's physical performance (tensile, C-tear and puncture) it is concluded that Poly-Flex is chemically compatible with furnace bottom ash.

**STUDY II** **POLY-FLEX VS FLY ASH**

The results from this study are similar to that of Poly-Flex in contact with bottom ash. No changes in polymer performance properties (mass, gauge, etc.) occurred even after four months. Changes in physical performance properties showed some variation in results. Overall, the variation in data was less than in Study I (Poly-Flex vs bottom ash) and like Study I, no consistent changes or trends were evident. Due to problems with the chart recorder, values for tensile strength at 100% and 200% elongation at three months were not available.

Since the results of this study are similar to the results previously given in Study I, it is also concluded that Poly-Flex in contact with fly ash is chemically compatible.

**STUDY III** **DURA-FLEX VS BOTTOM ASH**

All the tests performed on Dura-Flex are the same as those performed on Poly-Flex, except for tensile yield and elongation at yield, because Dura-Flex does not have a clear yield point.

As with Poly-Flex, the polymer performance property table shows Dura-Flex is unaffected by the bottom ash in both the 23° and 50° C immersion tests. The higher total volatile loss value at three months is believed to be a testing error, as it is not consistent with the results from the 1st, 2nd and 4th month tests.

The physical performance property table shows that from one month to the next, test values could flip-flop from being higher or lower than the control sample, resulting in percent change numbers being positive or negative. This lack of clear consistent trends would indicate that Dura-Flex is chemically resistant to the chemical components that constitute bottom ash.

**STUDY IV** **DURA-FLEX VS FLY ASH**

With the three previous studies, the percent change in gauge values were either zero or yielded values that would fall within testing error (± 1 mil). During this study the change in gauge was slightly higher than expected. As much as a 6% change occurred. However, all other polymer performance tests showed no changes. If a true change in the Dura-Flex had occurred, it should have affected some of the other tests. Since the rest of the tests indicate no change in the original value (within test error), this change in gauge is not considered critical.

Under the physical performance property table, C-tear and puncture results are all within normal test variation. Likewise, tensile break and elongation at break values all fall within this ± 10% range. Somewhat higher in variation are the results for tensile stress at 100% and 200% elongation, but this is consistent with the percent change values exhibited in the other studies.

Hence this data supports the conclusion that Dura-Flex is unaffected by fly ash.

CONCLUSIONS

With each of the four EPA 9090 studies in this report, data has been analyzed on changes that occur in the polymer structure and changes in the performance of physical properties. In all these studies, both the 23° and 50° C tanks failed to produce any change to the original properties which characterize the polymer's performance. In regards to the sheet's physical properties, changes in values from month to month did occur, but failed to produce a consistent trend which would cause concern about the liners' chemical resistance.

In conclusion, the results from these studies demonstrate that Poly-Flex and Dura-Flex are chemically compatible with furnace bottom and fly ash from municipal power plants.

EPA 9090 with BOTTOM ASH
POLY-FLEX @ room temperature

| | GAUGE ORIGIN (MIL) | GAUGE AFTER (MIL) | STRESS @ YIELD (LB.-IN) | | ELONG @ YIELD (%) | | STRESS @ 100% (LB.-IN) | | STRESS @ 200% (LB.-IN) | | STRESS @ BREAK (LB.-IN) | | ELONG @ BREAK (%) | | SECANT MODULUS (PSI) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MD | CD | MD | CD | MD | CD | MD | CD | MD | CD | MD | CD | MD | CD |
| CONTROL 1 | 62 | 62 | 169 | 173 | 13 | 12 | 132 | 125 | 137 | 126 | 252 | 246 | 753 | 718 | 98000 | 99000 |
| CONTROL 2 | 60 | 60 | 152 | 162 | 13 | 12 | 126 | 115 | 127 | 116 | 241 | 230 | 779 | 789 | 97000 | 97000 |
| CONTROL AVE | 61 | 61 | 161 | 168 | 13 | 12 | 129 | 120 | 132 | 121 | 247 | 238 | 766 | 754 | 97500 | 98000 |
| 1 MONTH | 57 | 56 | 144 | 151 | 14 | 14 | 121 | 114 | 126 | 116 | 240 | 221 | 788 | 780 | 98000 | 105000 |
| 2 MONTHS | 57 | 57 | 151 | 162 | 13 | 12 | 121 | 116 | 124 | 119 | 275 | 279 | 883 | 951 | 95000 | 96000 |
| 3 MONTHS | 57 | 56 | 149 | 158 | 13 | 12 | 91 | 86 | 93 | 91 | 261 | 250 | 828 | 858 | 84000 | 98000 |
| 4 MONTHS | 60 | 60 | 155 | 160 | 14 | 12 | 122 | 121 | 117 | 117 | 280 | 262 | 877 | 858 | 93000 | 90000 |
| (% CHANGE) | | | | | | | | | | | | | | | | |
| 1 MONTH | | -2 | -10 | -10 | 8 | 17 | -6 | -5 | -5 | -4 | -3 | -7 | 3 | 4 | 1 | 7 |
| 2 MONTHS | | 0 | -6 | -3 | 0 | 0 | -6 | -3 | -6 | -2 | 12 | 17 | 15 | 26 | -3 | -2 |
| 3 MONTHS | | -2 | -7 | -6 | 0 | 0 | -29 | -28 | -30 | -25 | 6 | 5 | 8 | 14 | -14 | 0 |
| 4 MONTHS | | 0 | -3 | -4 | 8 | 0 | -5 | 1 | -11 | -3 | 14 | 10 | 14 | 14 | -5 | -8 |

EPA 9090 with BOTTOM ASH
POLY-FLEX @ 50 degrees centigrade

| | GAUGE ORIGIN (MIL) | GAUGE AFTER (MIL) | STRESS @ YIELD (LB.-IN) | | ELONG @ YIELD (%) | | STRESS @ 100% (LB.-IN) | | STRESS @ 200% (LB.-IN) | | STRESS @ BREAK (LB.-IN) | | ELONG @ BREAK (%) | | SECANT MODULUS (PSI) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MD | CD | MD | CD | MD | CD | MD | CD | MD | CD | MD | CD | MD | CD |
| CONTROL 1 | 62 | 62 | 169 | 173 | 13 | 12 | 132 | 125 | 137 | 126 | 252 | 246 | 753 | 718 | 98000 | 99000 |
| CONTROL 2 | 60 | 60 | 152 | 162 | 13 | 12 | 126 | 115 | 127 | 116 | 241 | 230 | 779 | 789 | 97000 | 97000 |
| CONTROL AVG | 61 | 61 | 161 | 168 | 13 | 12 | 129 | 120 | 132 | 121 | 247 | 238 | 766 | 754 | 97500 | 98000 |
| 1 MONTH | 61 | 61 | 161 | 169 | 13 | 12 | 130 | 125 | 134 | 130 | 243 | 240 | 733 | 779 | 84000 | 98000 |
| 2 MONTHS | 60 | 60 | 158 | 171 | 13 | 19 | 126 | 124 | 129 | 128 | 259 | 286 | 801 | 933 | 97000 | 87000 |
| 3 MONTHS | 60 | 60 | 165 | 173 | 14 | 20 | 101 | 94 | 102 | 95 | 296 | 275 | 880 | 872 | 82000 | 90000 |
| 4 MONTHS | 61 | 61 | 168 | 177 | 13 | 13 | 129 | 119 | 130 | 125 | 279 | 269 | 820 | 865 | 83000 | 100000 |
| (% CHANGE) | | | | | | | | | | | | | | | | |
| 1 MONTH | | 0 | 0 | 1 | 0 | 0 | 1 | 4 | 2 | 7 | -1 | 1 | -4 | 3 | -14 | 0 |
| 2 MONTHS | | 0 | -2 | 2 | 0 | 58 | -2 | 3 | -2 | 6 | 5 | 20 | 5 | 24 | -1 | -11 |
| 3 MONTHS | | 0 | 3 | 3 | 8 | 67 | -22 | -22 | -23 | -21 | 20 | 16 | 15 | 16 | -16 | -8 |
| 4 MONTHS | | 0 | 5 | 6 | 0 | 8 | 0 | -1 | -2 | 3 | 13 | 13 | 7 | 15 | -15 | 2 |

CONFIDENTIAL

EPA 9090 with BOTTOM ASH
POLY-FLEX @ room temperature

| | C-TEAR (LB.) | | 2065 PUNC. (LB) | DIMENSIONS BEFORE (CM) | DIMENSIONS AFTER (CM) | HARDNESS BEFORE (DURO D) | HARDNESS AFTER (DURO D) | MASS BEFORE (GM) | MASS AFTER (GM) | DENSITY (GM/CC) | VOLATILE LOSS AFTER DESIC. | VOLATILE LOSS AFTER 105 C | VOLATILE LOSS TOTAL VOL. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MD | CD | | | | | | | | | | | |
| CONTROL 1 | 54 | 51 | 109 | 96.30 | 96.30 | 63 | 63 | 88.5 | 88.5 | 0.950 | 0.00 | 0.04 | 0.04 |
| CONTROL 2 | 50 | 49 | 96 | 96.80 | 96.80 | 63 | 63 | 83.7 | 83.7 | 0.951 | 0.00 | 0.05 | 0.05 |
| CONTROL AVE | 52 | 50 | 103 | 96.55 | 96.55 | 63 | 63 | 86.1 | 86.1 | 0.951 | 0.00 | 0.05 | 0.05 |
| 1 MONTH | 47 | 45 | 94 | 96.10 | 96.40 | 63 | 64 | 78.5 | 78.3 | 0.952 | 0.08 | 0.00 | 0.08 |
| 2 MONTHS | 47 | 45 | 90 | 96.35 | 96.45 | 63 | 64 | 80.2 | 80.0 | 0.951 | 0.04 | 0.02 | 0.06 |
| 3 MONTHS | 47 | 44 | 86 | 96.30 | 96.50 | 63 | 65 | 79.9 | 79.7 | 0.952 | 0.10 | 0.02 | 0.12 |
| 4 MONTHS | 48 | 44 | 93 | 96.40 | 96.30 | 63 | 64 | 82.6 | 82.6 | 0.953 | 0.05 | 0.00 | 0.05 |
| (% CHANGE) | | | | | | | | | | | | | |
| 1 MONTH | -10 | -10 | -8 | | 0 | | 2 | | 0 | 0 | | | |
| 2 MONTHS | -10 | -10 | -12 | | 0 | | 2 | | 0 | 0 | | | |
| 3 MONTHS | -10 | -12 | -16 | | 0 | | 3 | | 0 | 0 | | | |
| 4 MONTHS | -8 | -12 | -9 | | 0 | | 2 | | 0 | 0 | | | |

EPA 9090 with BOTTOM ASH
POLY-FLEX @ 50 degrees centigrade

| | C-TEAR (LB.) | | 2065 PUNC. (LB) | DIMENSIONS BEFORE (CM) | DIMENSIONS AFTER (CM) | HARDNESS BEFORE (DURO D) | HARDNESS AFTER (DURO D) | MASS BEFORE (GM) | MASS AFTER (GM) | DENSITY (GM/CC) | VOLATILE LOSS AFTER DESIC. | VOLATILE LOSS AFTER 105 C | VOLATILE LOSS TOTAL VOL. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MD | CD | | | | | | | | | | | |
| CONTROL 1 | 54 | 51 | 109 | 96.30 | 96.30 | 63 | 63 | 88.5 | 88.5 | 0.950 | 0.00 | 0.04 | 0.04 |
| CONTROL 2 | 50 | 49 | 96 | 96.80 | 96.80 | 63 | 63 | 83.7 | 83.7 | 0.951 | 0.00 | 0.05 | 0.05 |
| CONTROL AVG | 52 | 50 | 103 | 96.55 | 96.55 | 63 | 63 | 86.1 | 86.1 | 0.951 | 0.00 | 0.05 | 0.05 |
| 1 MONTH | 52 | 51 | 104 | 96.65 | 96.75 | 63 | 64 | 85.9 | 86.0 | 0.953 | 0.04 | 0.00 | 0.04 |
| 2 MONTHS | 49 | 51 | 99 | 96.35 | 96.40 | 63 | 64 | 85.6 | 85.6 | 0.951 | 0.05 | 0.06 | 0.11 |
| 3 MONTHS | 51 | 48 | 96 | 99.60 | 96.45 | 63 | 65 | 84.9 | 85.1 | 0.953 | 0.10 | 0.02 | 0.12 |
| 4 MONTHS | 52 | 50 | 96 | 96.58 | 96.58 | 63 | 65 | 86.5 | 86.8 | 0.953 | 0.05 | 0.01 | 0.06 |
| (% CHANGE) | | | | | | | | | | | | | |
| 1 MONTH | 0 | 2 | 1 | | 0 | | 2 | | 0 | 0 | | | |
| 2 MONTHS | -6 | 2 | -3 | | 0 | | 2 | | 0 | 0 | | | |
| 3 MONTHS | -2 | -4 | -6 | | -3 | | 3 | | 0 | 0 | | | |
| 4 MONTHS | 0 | 0 | -6 | | 0 | | 3 | | 0 | 0 | | | |

EPA 9090 with BOTTOM ASH
DURA-FLEX @ room temperature

| | GAUGE ORIGIN (MIL) | GAUGE AFTER (MIL) | STRESS @ YIELD (LB.-IN) | | ELONG @ YIELD (%) | | STRESS @ 100% (LB.-IN) | | STRESS @ 200% (LB.-IN) | | STRESS @ BREAK (LB.-IN) | | ELONG @ BREAK (%) | | SECANT MODULUS (PSI) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MD | CD | MD | CD | MD | CD | MD | CD | MD | CD | MD | CD | MD | CD |
| CONTROL 1 | 47 | 47 | NA | NA | NA | NA | 53 | 51 | 57 | 52 | 200 | 175 | 926 | 893 | 28000 | 35000 |
| CONTROL 2 | 49 | 49 | NA | NA | NA | NA | 51 | 49 | 54 | 50 | 198 | 162 | 930 | 859 | 29000 | 24000 |
| CONTROL AVE | 48 | 48 | NA | NA | NA | NA | 52 | 50 | 56 | 51 | 199 | 169 | 928 | 876 | 28500 | 29500 |
| 1 MONTH | 53 | 53 | | | | | 58 | 58 | 60 | 60 | 206 | 175 | 910 | 822 | 23000 | 30000 |
| 2 MONTHS | 54 | 53 | | | | | 53 | 53 | 59 | 55 | 188 | 178 | 901 | 927 | 34000 | 33000 |
| 3 MONTHS | 53 | 53 | | | | | 62 | 59 | 64 | 61 | 199 | 183 | 909 | 907 | 27000 | 25000 |
| 4 MONTHS | 49 | 49 | | | | | 50 | 50 | 56 | 53 | 187 | 157 | 941 | 891 | 31000 | 31000 |
| (% CHANGE) | | | | | | | | | | | | | | | | |
| 1 MONTH | | 0 | | | | | 8 | 16 | 8 | 18 | 4 | 4 | -2 | -6 | -19 | 2 |
| 2 MONTHS | | -2 | | | | | 2 | 6 | 6 | 8 | -6 | 6 | -3 | 6 | 19 | 12 |
| 3 MONTHS | | 0 | | | | | 19 | 18 | 15 | 20 | 0 | 9 | -2 | 4 | -5 | -15 |
| 4 MONTHS | | 0 | | | | | -4 | 0 | 1 | 4 | -6 | -7 | 1 | 2 | 9 | 5 |

EPA 9090 with BOTTOM ASH
DURA-FLEX @ room temperature

| | GAUGE ORIGIN (MIL) | GAUGE AFTER (MIL) | STRESS @ YIELD (LB.-IN) | | ELONG @ YIELD (%) | | STRESS @ 100% (LB.-IN) | | STRESS @ 200% (LB.-IN) | | STRESS @ BREAK (LB.-IN) | | ELONG @ BREAK (%) | | SECANT MODULUS (PSI) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MD | CD | MD | CD | MD | CD | MD | CD | MD | CD | MD | CD | MD | CD |
| ONTROL 1 | 47 | 47 | NA | NA | NA | NA | 53 | 51 | 57 | 52 | 200 | 175 | 926 | 893 | 28000 | 35000 |
| ONTROL 2 | 49 | 49 | NA | NA | NA | NA | 51 | 49 | 54 | 50 | 198 | 162 | 930 | 859 | 29000 | 24000 |
| ONTROL AVE | 48 | 48 | NA | NA | NA | NA | 52 | 50 | 56 | 51 | 199 | 169 | 928 | 876 | 28500 | 29500 |
| 1 MONTH | 48.0 | 48.0 | | | | | 49 | 50 | 52 | 52 | 172 | 196 | 896 | 933 | 31000 | 28000 |
| 2 MONTHS | 54.0 | 54.0 | | | | | 53 | 54 | 55 | 58 | 187 | 160 | 919 | 852 | 33000 | 30000 |
| 3 MONTHS | 52.0 | 53.0 | | | | | 61 | 58 | 64 | 59 | 203 | 172 | 933 | 891 | 25000 | 23000 |
| 4 MONTHS | 52.0 | 51.0 | | | | | 62 | 59 | 64 | 60 | 189 | 172 | 917 | 904 | 27000 | 31000 |
| (% CHANGE) | | | | | | | | | | | | | | | | |
| 1 MONTH | | 0. | | | | | -6 | 0 | -6 | 2 | -14 | 16 | -3 | 7 | 9 | -12 |
| 2 MONTHS | | 0 | | | | | 2 | 8 | -1 | 14 | -6 | -5 | -1 | -3 | 16 | 2 |
| 3 MONTHS | | 2 | | | | | 17 | 16 | 15 | 16 | 2 | 2 | 1 | 2 | -12 | -22 |
| 4 MONTHS | | -2 | | | | | 19 | 18 | 15 | 18 | -5 | 2 | -1 | 3 | -5 | 5 |

CONFIDENTIAL

EPA 9090 with BOTTOM ASH
DURA-FLEX @ room temperature

| | C-TEAR (LB.) | | 2065 PUNC. (LB) | DIMENSIONS BEFORE (CM) | DIMENSIONS AFTER (CM) | HARDNESS BEFORE (DURO D) | HARDNESS AFTER (DURO D) | MASS BEFORE (GM) | MASS AFTER (GM) | DENSITY (GM/CC) | VOLATILE LOSS AFTER DESIC. | VOLATILE LOSS AFTER 105 C | VOLATILE LOSS TOTAL VOL. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MD | CD | | | | | | | | | | | |
| CONTROL 1 | 24 | 22 | 72 | 97.60 | 97.60 | 50 | 50 | 66.0 | 66.0 | 0.925 | 0.07 | 0.00 | 0.07 |
| CONTROL 2 | 22 | 21 | 74 | 97.80 | 97.80 | 50 | 50 | 66.2 | 66.2 | 0.927 | 0.10 | 0.00 | 0.10 |
| CONTROL AVE | 23 | 22 | 73 | 97.70 | 97.70 | 50 | 50 | 66.1 | 66.1 | 0.926 | 0.09 | 0.00 | 0.09 |
| 1 MONTH | 24 | 25 | 85 | 97.25 | 97.45 | 50 | 50 | 73.2 | 73.3 | 0.926 | 0.08 | 0.00 | 0.08 |
| 2 MONTHS | 24 | 23 | 72 | 97.50 | 97.50 | 49 | 51 | 73.7 | 73.8 | 0.925 | 0.04 | 0.02 | 0.06 |
| 3 MONTHS | 25 | 24 | 73 | 97.65 | 97.65 | 50 | 50 | 72.4 | 72.6 | 0.925 | 0.13 | 0.04 | 0.17 |
| 4 MONTHS | 23 | 21 | 64 | 97.40 | 97.60 | 50 | 51 | 66.5 | 66.8 | 0.925 | 0.05 | 0.00 | 0.05 |
| (% CHANGE) | | | | | | | | | | | | | |
| 1 MONTH | 4 | 16 | 16 | | 0 | | 0 | | 0 | 0 | | | |
| 2 MONTHS | 4 | 7 | -1 | | 0 | | 4 | | 0 | 0 | | | |
| 3 MONTHS | 9 | 12 | 0 | | 0 | | 0 | | 0 | 0 | | | |
| 4 MONTHS | 0 | -2 | -12 | | 0 | | 2 | | 0 | 0 | | | |

EPA 9090 with BOTTOM ASH
DURA-FLEX @ room temperature

| | C-TEAR (LB.) | | 2065 PUNC. (LB) | DIMENSIONS BEFORE (CM) | DIMENSIONS AFTER (CM) | HARDNESS BEFORE (DURO D) | HARDNESS AFTER (DURO D) | MASS BEFORE (GM) | MASS AFTER (GM) | DENSITY (GM/CC) | VOLATILE LOSS AFTER DESIC. | VOLATILE LOSS AFTER 105 C | VOLATILE LOSS TOTAL VOL. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MD | CD | | | | | | | | | | | |
| CONTROL 1 | 24 | 22 | 72 | 97.60 | 97.60 | 50 | 50 | 66.0 | 66.0 | 0.925 | 0.07 | 0.00 | 0.07 |
| CONTROL 2 | 22 | 21 | 74 | 97.80 | 97.80 | 50 | 50 | 66.2 | 66.2 | 0.927 | 0.10 | 0.00 | 0.10 |
| CONTROL AVE | 23 | 22 | 73 | 97.70 | 97.70 | 50 | 50 | 66.1 | 66.1 | 0.926 | 0.09 | 0.00 | 0.09 |
| 1 MONTH | 22 | 21 | 74 | 97.75 | 97.90 | 50 | 50 | 66.3 | 66.5 | 0.925 | 0.06 | 0.00 | 0.06 |
| 2 MONTHS | 23 | 22 | 65 | 97.35 | 97.40 | 51 | 48 | 72.3 | 72.2 | 0.926 | 0.05 | 0.03 | 0.08 |
| 3 MONTHS | 24 | 22 | 72 | 97.50 | 97.35 | 51 | 50 | 71.5 | 71.7 | 0.925 | 0.19 | 0.07 | 0.26 |
| 4 MONTHS | 24 | 23 | 67 | 97.60 | 97.68 | 50 | 49 | 71.7 | 72.2 | 0.924 | 0.05 | 0.00 | 0.05 |
| (% CHANGE) | | | | | | | | | | | | | |
| 1 MONTH | -4 | -2 | 1 | | 0 | | 0 | | 0 | 0 | | | |
| 2 MONTHS | 0 | 2 | -11 | | 0 | | -6 | | 0 | 0 | | | |
| 3 MONTHS | 4 | 2 | -1 | | 0 | | -2 | | 0 | 0 | | | |
| 4 MONTHS | 4 | 7 | -8 | | 0 | | -2 | | 1 | 0 | | | |

9090I-AS
10/15/90

EPA 9090 with BOTTOM ASH
POLY-FLEX @ room temperature
POLYMER PERFORMANCE PROPERTIES

| | GAUGE ORIGIN (MIL) | GAUGE AFTER (MIL) | DIMENSIONS BEFORE (CM) | DIMENSIONS AFTER (CM) | HARDNESS BEFORE (DURO D) | HARDNESS AFTER (DURO D) | MASS BEFORE (GM) | MASS AFTER (GM) | DENSITY (GM/CC) | VOLATILE LOSS AFTER DESIC. | VOLATILE LOSS AFTER 105 C | VOLATILE LOSS TOTAL VOL. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CONTROL 1 | 62 | 62 | 96.30 | 96.30 | 63 | 63 | 88.5 | 88.5 | 0.950 | 0.00 | 0.04 | 0.04 |
| CONTROL 2 | 60 | 60 | 96.80 | 96.80 | 63 | 63 | 83.7 | 83.7 | 0.951 | 0.00 | 0.05 | 0.05 |
| CONTROL AVE | 61 | 61 | 96.55 | 96.55 | 63 | 63 | 86.1 | 86.1 | 0.951 | 0.00 | 0.05 | 0.05 |
| 1 MONTH | 57 | 56 | 96.10 | 96.40 | 63 | 64 | 78.5 | 78.3 | 0.952 | 0.08 | 0.00 | 0.08 |
| 2 MONTHS | 57 | 57 | 96.35 | 96.45 | 63 | 64 | 80.2 | 80.0 | 0.951 | 0.04 | 0.02 | 0.06 |
| 3 MONTHS | 57 | 56 | 96.30 | 96.50 | 63 | 65 | 79.9 | 79.7 | 0.952 | 0.10 | 0.02 | 0.12 |
| 4 MONTHS | 60 | 60 | 96.40 | 96.30 | 63 | 64 | 82.6 | 82.6 | 0.953 | 0.05 | 0.00 | 0.05 |
| (% CHANGE) | | | | | | | | | | | | |
| 1 MONTH | | -2 | | 0 | | 2 | | 0 | 0 | | | |
| 2 MONTHS | | 0 | | 0 | | 2 | | 0 | 0 | | | |
| 3 MONTHS | | -2 | | 0 | | 3 | | 0 | 0 | | | |
| 4 MONTHS | | 0 | | 0 | | 2 | | 0 | 0 | | | |

EPA 9090 with BOTTOM ASH
POLY-FLEX @ 50 degrees centigrade
POLYMER PERFORMANCE PROPERTIES

| | GAUGE ORIGIN (MIL) | GAUGE AFTER (MIL) | DIMENSIONS BEFORE (CM) | DIMENSIONS AFTER (CM) | HARDNESS BEFORE (DURO D) | HARDNESS AFTER (DURO D) | MASS BEFORE (GM) | MASS AFTER (GM) | DENSITY (GM/CC) | VOLATILE LOSS AFTER DESIC. | VOLATILE LOSS AFTER 105 C | VOLATILE LOSS TOTAL VOL. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CONTROL 1 | 62 | 62 | 96.30 | 96.30 | 63 | 63 | 88.5 | 88.5 | 0.950 | 0.00 | 0.04 | 0.04 |
| CONTROL 2 | 60 | 60 | 96.80 | 96.80 | 63 | 63 | 83.7 | 83.7 | 0.951 | 0.00 | 0.05 | 0.05 |
| CONTROL AVG | 61 | 61 | 96.55 | 96.55 | 63 | 63 | 86.1 | 86.1 | 0.951 | 0.00 | 0.05 | 0.05 |
| 1 MONTH | 61 | 61 | 96.65 | 96.75 | 63 | 64 | 85.9 | 86.0 | 0.953 | 0.04 | 0.00 | 0.04 |
| 2 MONTHS | 60 | 60 | 96.35 | 96.40 | 63 | 64 | 85.6 | 85.6 | 0.951 | 0.05 | 0.06 | 0.11 |
| 3 MONTHS | 60 | 60 | 99.60 | 96.45 | 63 | 65 | 84.9 | 85.1 | 0.953 | 0.10 | 0.02 | 0.12 |
| 4 MONTHS | 61 | 61 | 96.58 | 96.58 | 63 | 65 | 86.5 | 86.8 | 0.953 | 0.05 | 0.01 | 0.06 |
| (% CHANGE) | | | | | | | | | | | | |
| 1 MONTH | | 0 | | 0 | | 2 | | 0 | 0 | | | |
| 2 MONTHS | | 0 | | 0 | | 2 | | 0 | 0 | | | |
| 3 MONTHS | | 0 | | -3 | | 3 | | 0 | 0 | | | |
| 4 MONTHS | | 0 | | 0 | | 3 | | 0 | 0 | | | |

3090I-AS
10/15/90

EPA 9090 with BOTTOM ASH
POLY-FLEX @ room temperature
PHYSICAL PERFORMANCE PROPERTIES

| | STRESS @ YIELD (LB.-IN) | | ELONG @ YIELD (%) | | STRESS @ 100% (LB.-IN) | | STRESS @ 200% (LB.-IN) | | STRESS @ BREAK (LB.-IN) | | ELONG @ BREAK (%) | | SECANT MODULUS (PSI) | | C-TEAR (LB.) | | 2065 PUNC. (LB) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MD | CD | MD | CD | MD | CD | MD | CD | MD | CD | MD | CD | MD | CD | MD | CD | |
| CONTROL 1 | 169 | 173 | 13 | 12 | 132 | 125 | 137 | 126 | 252 | 246 | 853 | 818 | 98000 | 99000 | 54 | 51 | 109 |
| CONTROL 2 | 152 | 162 | 13 | 12 | 126 | 115 | 127 | 116 | 241 | 250 | 779 | 789 | 97000 | 97000 | 50 | 49 | 96 |
| CONTROL AVE | 161 | 168 | 13 | 12 | 129 | 120 | 132 | 121 | 247 | 248 | 816 | 804 | 97500 | 98000 | 52 | 50 | 103 |
| 1 MONTH | 144 | 151 | 14 | 14 | 121 | 114 | 126 | 116 | 240 | 221 | 738 | 790 | 96000 | 105000 | 47 | 45 | 94 |
| 2 MONTHS | 151 | 162 | 13 | 12 | 121 | 116 | 124 | 119 | 275 | 279 | 883 | 951 | 95000 | 96000 | 47 | 45 | 90 |
| 3 MONTHS | 149 | 158 | 13 | 12 | 101 | 103 | 105 | 103 | 261 | 250 | 828 | 856 | 84000 | 98000 | 47 | 44 | 88 |
| 4 MONTHS | 155 | 160 | 14 | 12 | 122 | 121 | 117 | 117 | 280 | 262 | 877 | 952 | 90000 | 90000 | 48 | 44 | 93 |
| (% CHANGE) | | | | | | | | | | | | | | | | | |
| 1 MONTH | -10 | -10 | 8 | 17 | -6 | -5 | -5 | -4 | -3 | -11 | -3 | -2 | 1 | 7 | -10 | -10 | -8 |
| 2 MONTHS | -6 | -3 | 0 | 0 | -2 | -3 | -6 | -2 | 12 | 13 | 8 | 13 | -3 | -2 | -10 | -10 | -12 |
| 3 MONTHS | -7 | -6 | 0 | 0 | -22 | -14 | -20 | -15 | 6 | 1 | 1 | 7 | -14 | 0 | -10 | -12 | -16 |
| 4 MONTHS | -3 | -4 | 8 | 0 | -5 | 1 | -11 | -3 | 14 | 6 | 7 | 7 | -5 | -8 | -8 | -12 | -9 |

EPA 9090 with BOTTOM ASH
POLY-FLEX @ 50 degrees centigrade
PHYSICAL PERFORMANCE PROPERTIES

| | STRESS @ YIELD (LB.-IN) | | ELONG @ YIELD (%) | | STRESS @ 100% (LB.-IN) | | STRESS @ 200% (LB.-IN) | | STRESS @ BREAK (LB.-IN) | | ELONG @ BREAK (%) | | SECANT MODULUS (PSI) | | C-TEAR (LB.) | | 2065 PUNC. (LB) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MD | CD | MD | CD | MD | CD | MD | CD | MD | CD | MD | CD | MD | CD | MD | CD | |
| CONTROL 1 | 169 | 173 | 13 | 12 | 132 | 125 | 137 | 126 | 252 | 246 | 753 | 818 | 98000 | 99000 | 54 | 51 | 109 |
| CONTROL 2 | 152 | 162 | 13 | 12 | 126 | 115 | 127 | 116 | 241 | 250 | 779 | 789 | 97000 | 97000 | 50 | 49 | 96 |
| CONTROL AVG | 161 | 168 | 13 | 12 | 129 | 120 | 132 | 121 | 247 | 248 | 766 | 804 | 97500 | 98000 | 52 | 50 | 103 |
| 1 MONTH | 161 | 169 | 13 | 12 | 130 | 125 | 134 | 130 | 243 | 240 | 733 | 779 | 84000 | 98000 | 52 | 51 | 104 |
| 2 MONTHS | 158 | 171 | 13 | 12 | 126 | 124 | 129 | 128 | 259 | 286 | 801 | 933 | 97000 | 87000 | 49 | 51 | 99 |
| 3 MONTHS | 165 | 173 | 14 | 13 | 101 | 94 | 102 | 95 | 296 | 275 | 880 | 872 | 82000 | 90000 | 51 | 48 | 96 |
| 4 MONTHS | 168 | 177 | 13 | 13 | 129 | 119 | 130 | 125 | 279 | 269 | 820 | 865 | 83000 | 100000 | 52 | 50 | 96 |
| (% CHANGE) | | | | | | | | | | | | | | | | | |
| 1 MONTH | 0 | 1 | 0 | 0 | 1 | 4 | 2 | 7 | -1 | -3 | -4 | -3 | -14 | 0 | 0 | 2 | 1 |
| 2 MONTHS | -2 | 2 | 0 | 0 | -2 | 3 | -2 | 6 | 5 | 15 | 5 | 16 | -1 | -11 | -6 | 2 | -3 |
| 3 MONTHS | 3 | 3 | 8 | 8 | -22 | -22 | -23 | -21 | 20 | 11 | 15 | 9 | -16 | -8 | -2 | -4 | -6 |
| 4 MONTHS | 5 | 6 | 0 | 8 | 0 | -1 | -2 | 3 | 13 | 8 | 7 | 8 | -15 | 2 | 0 | 0 | -6 |

9090F-ASH
START DATE: 12-8-90

EPA 9090 with FLY ASH
POLY-FLEX @ room temperature
POLYMER PERFORMANCE PROPERTIES

| | GAUGE ORIGIN (MIL) | GAUGE AFTER (MIL) | DIMENSIONS BEFORE (CM) | DIMENSIONS AFTER (CM) | HARDNESS BEFORE (DURO D) | HARDNESS AFTER (DURO D) | MASS BEFORE (GM) | MASS AFTER (GM) | DENSITY (GM/CC) | VOLATILE LOSS AFTER DESIC. | VOLATILE LOSS AFTER 105 C | VOLATILE LOSS TOTAL VOL. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CONTROL 1 | 63 | 63 | 99.10 | 99.10 | 64 | 64 | 92.5 | 92.5 | 0.950 | 0.00 | 0.04 | 0.04 |
| CONTROL 2 | 62 | 62 | 98.95 | 98.95 | 64 | 64 | 91.0 | 91.0 | 0.951 | 0.00 | 0.07 | 0.07 |
| CONTROL 3 | 60 | 60 | 99.05 | 99.05 | 65 | 65 | 91.5 | 91.5 | 0.950 | 0.00 | 0.05 | 0.05 |
| CONTROL AVE | 62 | 62 | 99.03 | 99.03 | 64 | 64 | 91.7 | 91.7 | 0.950 | 0.00 | 0.05 | 0.05 |
| 1 MONTH | 62 | 61 | 99.10 | 98.80 | 64 | 64 | 92.0 | 92.1 | 0.951 | 0.08 | 0.09 | 0.17 |
| 2 MONTHS | 63 | 63 | 99.15 | 98.90 | 64 | 66 | 90.0 | 90.2 | 0.952 | 0.07 | 0.01 | 0.08 |
| 3 MONTHS | 61 | 62 | 99.20 | 98.90 | 64 | 65 | 92.3 | 92.3 | 0.952 | 0.04 | 0.03 | 0.07 |
| 4 MONTHS | 63 | 63 | 99.05 | 98.80 | 64 | 64 | 90.3 | 90.5 | 0.952 | 0.05 | 0.01 | 0.06 |
| (% CHANGE) | | | | | | | | | | | | |
| 1 MONTH | | -2 | | 0 | | 0 | | 0 | 0 | | | |
| 2 MONTHS | | 0 | | 0 | | 3 | | 0 | 0 | | | |
| 3 MONTHS | | 2 | | 0 | | 2 | | 0 | 0 | | | |
| 4 MONTHS | | 0 | | 0 | | 0 | | 0 | 0 | | | |

EPA 9090 with FLY ASH
POLY-FLEX @ 50 degrees centigrade
POLYMER PERFORMANCE PROPERTIES

| | GAUGE ORIGIN (MIL) | GAUGE AFTER (MIL) | DIMENSIONS BEFORE (CM) | DIMENSIONS AFTER (CM) | HARDNESS BEFORE (DURO D) | HARDNESS AFTER (DURO D) | MASS BEFORE (GM) | MASS AFTER (GM) | DENSITY (GM/CC) | VOLATILE LOSS AFTER DESIC. | VOLATILE LOSS AFTER 105 C | VOLATILE LOSS TOTAL VOL. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CONTROL 1 | 63 | 63 | 99.10 | 99.10 | 64 | 64 | 92.5 | 92.5 | 0.950 | 0.00 | 0.04 | 0.04 |
| CONTROL 2 | 62 | 62 | 98.95 | 98.95 | 64 | 64 | 91.0 | 91.0 | 0.951 | 0.00 | 0.07 | 0.07 |
| CONTROL 3 | 60 | 60 | 99.05 | 99.05 | 65 | 65 | 91.5 | 91.5 | 0.950 | 0.00 | 0.05 | 0.05 |
| CONTROL AVE | 62 | 62 | 99.03 | 99.03 | 64 | 64 | 91.7 | 91.7 | 0.950 | 0.00 | 0.05 | 0.05 |
| 1 MONTH | 59 | 61 | 99.10 | 98.80 | 64 | 64 | 92.0 | 92.1 | 0.951 | 0.06 | 0.07 | 0.13 |
| 2 MONTHS | 58 | 57 | 99.00 | 98.60 | 64 | 66 | 84.3 | 84.6 | 0.953 | 0.06 | 0.00 | 0.06 |
| 3 MONTHS | 57 | 57 | 98.50 | 98.30 | 64 | 64 | 85.0 | 83.7 | 0.952 | 0.07 | 0.07 | 0.14 |
| 4 MONTHS | 57 | 58 | 99.00 | 98.60 | 63 | 64 | 84.3 | 84.5 | 0.951 | 0.06 | 0.01 | 0.07 |
| (% CHANGE) | | | | | | | | | | | | |
| 1 MONTH | | 3 | | 0 | | 0 | | 0 | 0 | | | |
| 2 MONTHS | | -2 | | 0 | | 3 | | 0 | 0 | | | |
| 3 MONTHS | | 0 | | 0 | | 0 | | -2 | 0 | | | |
| 4 MONTHS | | 2 | | 0 | | 2 | | 0 | 0 | | | |

9090F-ASH
START DATE: 12/8/90

EPA 9090 with FLY ASH
POLY-FLEX @ room temperature
PHYSICAL PERFORMANCE PROPERTIES

| | STRESS @ YIELD (LB.-IN) | | ELONG @ YIELD (%) | | STRESS @ 100% (LB.-IN) | | STRESS @ 200% (LB.-IN) | | STRESS @ BREAK (LB.-IN) | | ELONG @ BREAK (%) | | SECANT MODULUS (PSI) | | C-TEAR (LB.) | | 2065 PUNC. (LB) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MD | CD | MD | CD | MD | CD | MD | CD | MD | CD | MD | CD | MD | CD | MD | CD | |
| CONTROL 1 | 164 | 169 | 14 | 12 | 127 | 118 | 127 | 123 | 272 | 283 | 787 | 886 | 86000 | 88000 | 51 | 49 | 98 |
| CONTROL 2 | 157 | 168 | 14 | 12 | 121 | 115 | 122 | 120 | 261 | 271 | 797 | 850 | 94000 | 90000 | 52 | 49 | 101 |
| CONTROL 3 | 159 | 162 | 14 | 12 | 132 | 122 | 133 | 126 | 298 | 274 | 858 | 857 | 83000 | 97000 | 52 | 49 | 100 |
| CONTROL AVE | 160 | 166 | 14 | 12 | 127 | 118 | 127 | 123 | 277 | 276 | 814 | 864 | 87667 | 91667 | 52 | 49 | 100 |
| 1 MONTH | 155 | 165 | 14 | 12 | 127 | 121 | 129 | 123 | 284 | 282 | 869 | 872 | 79000 | 85000 | 48 | 47 | 93 |
| 2 MONTHS | 162 | 164 | 14 | 12 | 135 | 128 | 138 | 128 | 291 | 259 | 847 | 857 | 89000 | 94000 | 50 | 47 | 96 |
| 3 MONTHS | 163 | 180 | 13 | 12 | | | | | 257 | 240 | 766 | 780 | 84000 | 90000 | 52 | 50 | 97 |
| 4 MONTHS | 164 | 168 | 14 | 12 | 128 | 119 | 130 | 125 | 274 | 275 | 812 | 868 | 86000 | 87000 | 50 | 48 | 98 |
| (% CHANGE) | | | | | | | | | | | | | | | | | |
| 1 MONTH | -3 | -1 | 0 | 0 | 0 | 2 | 1 | 0 | 3 | 2 | 7 | 1 | -10 | -7 | -7 | -4 | -7 |
| 2 MONTHS | 1 | -1 | 0 | 0 | 7 | 8 | 8 | 4 | 5 | -6 | 4 | -1 | 2 | 3 | -3 | -4 | -4 |
| 3 MONTHS | 2 | 8 | -7 | 0 | | | | | -7 | -13 | -6 | -10 | -4 | -2 | 1 | 2 | -3 |
| 4 MONTHS | 3 | 1 | 0 | 0 | 1 | 1 | 2 | 2 | -1 | 0 | 0 | 0 | -2 | -5 | -3 | -2 | -2 |

EPA 9090 with FLY ASH
POLY-FLEX @ 50 degrees centigrade
PHYSICAL PERFORMANCE PROPERTIES

| | STRESS @ YIELD (LB.-IN) | | ELONG @ YIELD (%) | | STRESS @ 100% (LB.-IN) | | STRESS @ 200% (LB.-IN) | | STRESS @ BREAK (LB.-IN) | | ELONG @ BREAK (%) | | SECANT MODULUS (PSI) | | C-TEAR (LB.) | | 2065 PUNC. (LB) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MD | CD | MD | CD | MD | CD | MD | CD | MD | CD | MD | CD | MD | CD | MD | CD | |
| CONTROL 1 | 164 | 169 | 14 | 12 | 127 | 118 | 127 | 123 | 272 | 283 | 787 | 886 | 86000 | 88000 | 51 | 49 | 98 |
| CONTROL 2 | 157 | 168 | 14 | 12 | 121 | 115 | 122 | 120 | 261 | 271 | 797 | 850 | 94000 | 91000 | 52 | 49 | 101 |
| CONTROL 3 | 159 | 162 | 14 | 12 | 132 | 122 | 133 | 126 | 298 | 274 | 858 | 857 | 83000 | 97000 | 52 | 49 | 100 |
| CONTROL AVE | 160 | 166 | 14 | 12 | 127 | 118 | 127 | 123 | 277 | 276 | 814 | 864 | 87667 | 92000 | 52 | 49 | 100 |
| 1 MONTH | 155 | 165 | 14 | 12 | 127 | 121 | 129 | 123 | 284 | 282 | 869 | 872 | 79000 | 85000 | 48 | 47 | 93 |
| 2 MONTHS | 153 | 163 | 15 | 12 | 129 | 121 | 131 | 122 | 254 | 270 | 796 | 910 | 90000 | 97000 | 46 | 43 | 91 |
| 3 MONTHS | 162 | 156 | 14 | 13 | | | | | 245 | 242 | 760 | 830 | 84000 | 83000 | 47 | 44 | 91 |
| 4 MONTHS | 158 | 169 | 14 | 13 | 130 | 121 | 131 | 124 | 271 | 278 | 797 | 895 | 96000 | 86000 | 49 | 46 | 93 |
| (% CHANGE) | | | | | | | | | | | | | | | | | |
| 1 MONTH | -3 | -1 | 0 | 0 | 0 | 2 | 1 | 0 | 3 | 2 | 7 | 1 | -10 | -8 | -7 | -4 | -7 |
| 2 MONTHS | -4 | -2 | 7 | 0 | 2 | 2 | 3 | -1 | -8 | -2 | -2 | 5 | 3 | 5 | -11 | -12 | -9 |
| 3 MONTHS | 1 | -6 | 0 | 8 | | | | | -12 | -12 | -7 | -4 | -4 | -10 | -9 | -10 | -9 |
| 4 MONTHS | -1 | 2 | 0 | 8 | 3 | 2 | 3 | 1 | -2 | 1 | -2 | 4 | 10 | -7 | -5 | -6 | -7 |

EPA 9090 with BOTTOM ASH
DURA-FLEX @ room temperature
PHYSICAL PERFORMANCE PROPERTIES

| | STRESS @ YIELD (LB.-IN) | | ELONG @ YIELD (%) | | STRESS @ 100% (LB.-IN) | | STRESS @ 200% (LB.-IN) | | STRESS @ BREAK (LB.-IN) | | ELONG @ BREAK (%) | | SECANT MODULUS (PSI) | | C-TEAR (LB.) | | 2065 PUNC. (LB) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MD | CD | MD | CD | MD | CD | MD | CD | MD | CD | MD | CD | MD | CD | MD | CD | |
| CONTROL 1 | NA | NA | NA | NA | 53 | 51 | 57 | 52 | 200 | 175 | 926 | 893 | 28000 | 35000 | 24 | 22 | 72 |
| CONTROL 2 | NA | NA | NA | NA | 51 | 49 | 54 | 50 | 198 | 162 | 930 | 859 | 29000 | 24000 | 22 | 21 | 74 |
| CONTROL AVE | NA | NA | NA | NA | 52 | 50 | 56 | 51 | 199 | 169 | 928 | 876 | 28500 | 29500 | 23 | 22 | 73 |
| 1 MONTH | | | | | 56 | 58 | 60 | 60 | 206 | 175 | 910 | 822 | 23000 | 30000 | 24 | 25 | 85 |
| 2 MONTHS | | | | | 53 | 53 | 59 | 55 | 188 | 178 | 901 | 927 | 34000 | 33000 | 24 | 23 | 72 |
| 3 MONTHS | | | | | 62 | 59 | 64 | 61 | 199 | 183 | 909 | 907 | 27000 | 25000 | 25 | 24 | 73 |
| 4 MONTHS | | | | | 50 | 50 | 56 | 53 | 187 | 157 | 941 | 891 | 31000 | 31000 | 23 | 21 | 64 |
| (% CHANGE) | | | | | | | | | | | | | | | | | |
| 1 MONTH | | | | | 8 | 16 | 8 | 18 | 4 | 4 | -2 | -6 | -19 | 2 | 4 | 16 | 16 |
| 2 MONTHS | | | | | 2 | 6 | 6 | 8 | -6 | 6 | -3 | 6 | 19 | 12 | 4 | 7 | -1 |
| 3 MONTHS | | | | | 19 | 18 | 15 | 20 | 0 | 9 | -2 | 4 | -5 | -15 | 9 | 12 | 0 |
| 4 MONTHS | | | | | -4 | 0 | 1 | 4 | -6 | -7 | 1 | 2 | 9 | 5 | 0 | -2 | -12 |

EPA 9090 with BOTTOM ASH
DURA-FLEX @ 50 degrees centigrade
PHYSICAL PERFORMANCE PROPERTIES

| | STRESS @ YIELD (LB.-IN) | | ELONG @ YIELD (%) | | STRESS @ 100% (LB.-IN) | | STRESS @ 200% (LB.-IN) | | STRESS @ BREAK (LB.-IN) | | ELONG @ BREAK (%) | | SECANT MODULUS (PSI) | | C-TEAR (LB.) | | 2065 PUNC. (LB) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MD | CD | MD | CD | MD | CD | MD | CD | MD | CD | MD | CD | MD | CD | MD | CD | |
| CONTROL 1 | NA | NA | NA | NA | 53 | 51 | 57 | 52 | 200 | 175 | 926 | 893 | 28000 | 35000 | 24 | 22 | 72 |
| CONTROL 2 | NA | NA | NA | NA | 51 | 49 | 54 | 50 | 198 | 162 | 930 | 859 | 29000 | 24000 | 22 | 21 | 74 |
| CONTROL AVE | NA | NA | NA | NA | 52 | 50 | 56 | 51 | 199 | 169 | 928 | 876 | 28500 | 29500 | 23 | 22 | 73 |
| 1 MONTH | | | | | 49 | 50 | 52 | 52 | 172 | 196 | 896 | 933 | 31000 | 26000 | 22 | 21 | 74 |
| 2 MONTHS | | | | | 53 | 54 | 55 | 58 | 187 | 160 | 919 | 852 | 33000 | 30000 | 23 | 22 | 65 |
| 3 MONTHS | | | | | 61 | 58 | 64 | 59 | 203 | 172 | 933 | 891 | 25000 | 23000 | 24 | 22 | 72 |
| 4 MONTHS | | | | | 62 | 59 | 64 | 60 | 189 | 172 | 917 | 904 | 27000 | 31000 | 24 | 23 | 67 |
| (% CHANGE) | | | | | | | | | | | | | | | | | |
| 1 MONTH | | | | | -6 | 0 | -6 | 2 | -14 | 16 | -3 | 7 | 9 | -12 | -4 | -2 | 1 |
| 2 MONTHS | | | | | 2 | 8 | -1 | 14 | -6 | -5 | -1 | -3 | 16 | 2 | 0 | 2 | -11 |
| 3 MONTHS | | | | | 17 | 16 | 15 | 16 | 2 | 2 | 1 | 2 | -12 | -22 | 4 | 2 | -1 |
| 4 MONTHS | | | | | 19 | 18 | 15 | 18 | -5 | 2 | -1 | 3 | -5 | 5 | 4 | 7 | -8 |

EPA 9090 with BOTTOM ASH
DURA-FLEX @ room temperature
POLYMER PERFORMANCE PROPERTIES

| | GAUGE ORIGIN (MIL) | GAUGE AFTER (MIL) | DIMENSIONS BEFORE (CM) | DIMENSIONS AFTER (CM) | HARDNESS BEFORE (DURO D) | HARDNESS AFTER (DURO D) | MASS BEFORE (GM) | MASS AFTER (GM) | DENSITY (GM/CC | VOLATILE LOSS AFTER DESIC. | VOLATILE LOSS AFTER 105 C | VOLATILE LOSS TOTAL VOL. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CONTROL 1 | 47 | 47 | 97.60 | 97.60 | 50 | 50 | 66.0 | 66.0 | 0.925 | 0.07 | 0.00 | 0.07 |
| CONTROL 2 | 49 | 49 | 97.80 | 97.80 | 50 | 50 | 66.2 | 66.2 | 0.927 | 0.10 | 0.00 | 0.10 |
| CONTROL AVE | 48 | 48 | 97.70 | 97.70 | 50 | 50 | 66.1 | 66.1 | 0.926 | 0.09 | 0.00 | 0.09 |
| 1 MONTH | 53 | 53 | 97.25 | 97.45 | 50 | 50 | 73.2 | 73.3 | 0.926 | 0.08 | 0.00 | 0.08 |
| 2 MONTHS | 54 | 53 | 97.50 | 97.50 | 49 | 51 | 73.7 | 73.8 | 0.925 | 0.04 | 0.02 | 0.06 |
| 3 MONTHS | 53 | 53 | 97.65 | 97.65 | 50 | 50 | 72.4 | 72.6 | 0.925 | 0.13 | 0.04 | 0.17 |
| 4 MONTHS | 49 | 49 | 97.40 | 97.60 | 50 | 51 | 66.5 | 66.8 | 0.925 | 0.05 | 0.00 | 0.05 |
| (% CHANGE) | | | | | | | | | | | | |
| 1 MONTH | | 0 | | 0 | | 0 | | 0 | 0 | | | |
| 2 MONTHS | | -2 | | 0 | | 4 | | 0 | 0 | | | |
| 3 MONTHS | | 0 | | 0 | | 0 | | 0 | 0 | | | |
| 4 MONTHS | | 0 | | 0 | | 2 | | 0 | 0 | | | |

EPA 9090 with BOTTOM ASH
DURA-FLEX @ 50 degrees centigrade
POLYMER PERFORMANCE PROPERTIES

| | GAUGE ORIGIN (MIL) | GAUGE AFTER (MIL) | DIMENSIONS BEFORE (CM) | DIMENSIONS AFTER (CM) | HARDNESS BEFORE (DURO D) | HARDNESS AFTER (DURO D) | MASS BEFORE (GM) | MASS AFTER (GM) | DENSITY (GM/CC) | VOLATILE LOSS AFTER DESIC. | VOLATILE LOSS AFTER 105 C | VOLATILE LOSS TOTAL VOL. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CONTROL 1 | 47 | 47 | 97.60 | 97.60 | 50 | 50 | 66.0 | 66.0 | 0.925 | 0.07 | 0.00 | 0.07 |
| CONTROL 2 | 49 | 49 | 97.80 | 97.80 | 50 | 50 | 66.2 | 66.2 | 0.927 | 0.10 | 0.00 | 0.10 |
| CONTROL AVE | 48 | 48 | 97.70 | 97.70 | 50 | 50 | 66.1 | 66.1 | 0.926 | 0.09 | 0.00 | 0.09 |
| 1 MONTH | 48 | 48 | 97.75 | 97.90 | 50 | 50 | 66.3 | 66.5 | 0.925 | 0.06 | 0.00 | 0.06 |
| 2 MONTHS | 54 | 54 | 97.35 | 97.40 | 51 | 48 | 72.3 | 72.2 | 0.926 | 0.05 | 0.03 | 0.08 |
| 3 MONTHS | 52 | 53 | 97.50 | 97.35 | 51 | 50 | 71.5 | 71.7 | 0.925 | 0.19 | 0.07 | 0.26 |
| 4 MONTHS | 52 | 51 | 97.60 | 97.68 | 50 | 49 | 71.7 | 72.2 | 0.924 | 0.05 | 0.00 | 0.05 |
| (% CHANGE) | | | | | | | | | | | | |
| 1 MONTH | | 0 | | 0 | | 0 | | 0 | 0 | | | |
| 2 MONTHS | | 0 | | 0 | | -6 | | 0 | 0 | | | |
| 3 MONTHS | | 2 | | 0 | | -2 | | 0 | 0 | | | |
| 4 MONTHS | | -2 | | 0 | | -2 | | 1 | 0 | | | |

EPA 9090 with FLY ASH
DURA-FLEX @ room temperature
PHYSICAL PERFORMANCE PROPERTIES

| | STRESS @ YIELD (LB.-IN) | | ELONG @ YIELD (%) | | STRESS @ 100% (LB.-IN) | | STRESS @ 200% (LB.-IN) | | STRESS @ BREAK (LB.-IN) | | ELONG @ BREAK (%) | | SECANT MODULUS (PSI) | | C-TEAR (LB.) | | 2065 PUNC. (LB) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MD | CD | MD | CD | MD | CD | MD | CD | MD | CD | MD | CD | MD | CD | MD | CD | |
| CONTROL 1 | NA | NA | NA | NA | 80 | 77 | 92 | 88 | 232 | 234 | 1003 | 1064 | 30000 | 34000 | 30 | 28 | 81 |
| CONTROL 2 | NA | NA | NA | NA | 77 | 81 | 92 | 91 | 240 | 223 | 1052 | 1009 | 33000 | 33000 | 28 | 30 | 87 |
| CONTROL 3 | NA | NA | NA | NA | 72 | 68 | 87 | 81 | 230 | 236 | 1009 | 1089 | 27000 | 32000 | 31 | 30 | 87 |
| CONTROL AVE | NA | NA | NA | NA | 76 | 75 | 90 | 87 | 234 | 231 | 1021 | 1054 | 30000 | 33000 | 30 | 29 | 85 |
| 1 MONTH | | | | | 75 | 74 | 88 | 85 | 238 | 228 | 1006 | 1008 | 33000 | 33000 | 30 | 29 | 76 |
| 2 MONTHS | | | | | 68 | 68 | 71 | 74 | 228 | 250 | 980 | 1112 | 35000 | 41000 | 30 | 29 | 79 |
| 3 MONTHS | | | | | 80 | 75 | 83 | 76 | 258 | 214 | 1073 | 957 | 31000 | 31000 | 29 | 28 | 82 |
| 4 MONTHS | | | | | 75 | 74 | 77 | 77 | 253 | 226 | 1068 | 990 | 26000 | 24000 | 30 | 29 | 85 |
| (% CHANGE) | | | | | | | | | | | | | | | | | |
| 1 MONTH | | | | | -2 | -2 | -3 | -2 | 2 | -1 | -2 | -4 | 10 | 0 | 1 | -1 | -11 |
| 2 MONTHS | | | | | -11 | -10 | -21 | -15 | -3 | 8 | -4 | 6 | 17 | 24 | 1 | -1 | -7 |
| 3 MONTHS | | | | | 5 | 0 | -8 | -12 | 10 | -7 | 5 | -9 | 3 | -6 | -2 | -5 | -4 |
| 4 MONTHS | | | | | -2 | -2 | -15 | -11 | 8 | -2 | 5 | -6 | -13 | -27 | 1 | -1 | 0 |

EPA 9090 with FLY ASH
DURA-FLEX @ 50 degrees centigrade
PHYSICAL PERFORMANCE PROPERTIES

| | STRESS @ YIELD (LB.-IN) | | ELONG @ YIELD (%) | | STRESS @ 100% (LB.-IN) | | STRESS @ 200% (LB.-IN) | | STRESS @ BREAK (LB.-IN) | | ELONG @ BREAK (%) | | SECANT MODULUS (PSI) | | C-TEAR (LB.) | | 2065 PUNC. (LB) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MD | CD | MD | CD | MD | CD | MD | CD | MD | CD | MD | CD | MD | CD | MD | CD | |
| CONTROL 1 | NA | NA | NA | NA | 80 | 77 | 92 | 88 | 232 | 234 | 1003 | 1064 | 30000 | 34000 | 30 | 28 | 81 |
| CONTROL 2 | NA | NA | NA | NA | 77 | 81 | 92 | 91 | 240 | 223 | 1052 | 1009 | 33000 | 33000 | 28 | 30 | 87 |
| CONTROL 3 | NA | NA | NA | NA | 72 | 68 | 87 | 81 | 230 | 236 | 1009 | 1089 | 27000 | 32000 | 31 | 30 | 87 |
| CONTROL AVE | NA | NA | NA | NA | 76 | 75 | 90 | 87 | 234 | 231 | 1021 | 1054 | 30000 | 33000 | 30 | 29 | 85 |
| 1 MONTH | | | | | 70 | 73 | 86 | 86 | 246 | 230 | 1044 | 1003 | 28000 | 29000 | 31 | 29 | 81 |
| 2 MONTHS | | | | | 73 | 76 | 77 | 79 | 239 | 241 | 1020 | 1031 | 35000 | 38000 | 31 | 29 | 79 |
| 3 MONTHS | | | | | 80 | 79 | 82 | 84 | 239 | 245 | 1006 | 1056 | 30000 | 35000 | 30 | 29 | 78 |
| 4 MONTHS | | | | | 75 | 71 | 79 | 74 | 250 | 241 | 1026 | 1065 | 30000 | 25000 | 30 | 30 | 78 |
| (% CHANGE) | | | | | | | | | | | | | | | | | |
| 1 MONTH | | | | | -8 | -3 | -5 | -1 | 5 | 0 | 2 | -5 | -7 | -12 | 4 | -1 | -5 |
| 2 MONTHS | | | | | -4 | 1 | -15 | -9 | 2 | 4 | 0 | -2 | 17 | 15 | 4 | -1 | -7 |
| 3 MONTHS | | | | | 5 | 5 | -9 | -3 | 2 | 6 | -2 | 0 | 0 | 6 | 1 | -1 | -8 |
| 4 MONTHS | | | | | -2 | -6 | -13 | -15 | 7 | 4 | 0 | 1 | 0 | -24 | 1 | 2 | -8 |

EPA 9090 with FLY ASH
DURA-FLEX @ room temperature
POLYMER PERFORMANCE PROPERTIES

| | GAUGE ORIGIN (MIL) | GAUGE AFTER (MIL) | DIMENSIONS BEFORE (CM) | DIMENSIONS AFTER (CM) | HARDNESS BEFORE (DURO D) | HARDNESS AFTER (DURO D) | MASS BEFORE (GM) | MASS AFTER (GM) | DENSITY (GM/CC) | VOLATILE LOSS AFTER DESIC. | VOLATILE LOSS AFTER 105 C | VOLATILE LOSS TOTAL VOL. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CONTROL 1 | 61 | 61 | 99.26 | 99.26 | 54 | 54 | 85.8 | 85.8 | 0.929 | 0.07 | 0.00 | 0.07 |
| CONTROL 2 | 61 | 61 | 99.13 | 99.13 | 54 | 54 | 85.5 | 85.5 | 0.930 | 0.04 | 0.02 | 0.06 |
| CONTROL 3 | 62 | 62 | 99.40 | 99.40 | 53 | 53 | 86.4 | 86.4 | 0.929 | 0.10 | 0.00 | 0.10 |
| CONTROL AVE | 61 | 61 | 99.26 | 99.26 | 54 | 54 | 85.9 | 85.9 | 0.929 | 0.07 | 0.01 | 0.08 |
| 1 MONTH | 63 | 61 | 99.50 | 99.45 | 53 | 51 | 89.3 | 90.0 | 0.929 | 0.05 | 0.06 | 0.11 |
| 2 MONTHS | 62 | 60 | 100.11 | 100.15 | 54 | 53 | 87.8 | 88.4 | 0.929 | 0.04 | 0.01 | 0.05 |
| 3 MONTHS | 62 | 59 | 99.30 | 99.20 | 53 | 53 | 85.3 | 85.7 | 0.930 | 0.02 | 0.09 | 0.11 |
| 4 MONTHS | 63 | 62 | 99.2 | 99.1 | 53 | 53 | 86.5 | 87.6 | 0.931 | 0.06 | 0.02 | 0.08 |
| (% CHANGE) | | | | | | | | | | | | |
| 1 MONTH | | -3 | | 0 | | -4 | | 1 | 0 | | | |
| 2 MONTHS | | -3 | | 0 | | -2 | | 1 | 0 | | | |
| 3 MONTHS | | -5 | | 0 | | 0 | | 0 | 0 | | | |
| 4 MONTHS | | -2 | | 0 | | 0 | | 1 | 0 | | | |

EPA 9090 with FLY ASH
DURA-FLEX @ 50 degrees centigrade
POLYMER PERFORMANCE PROPERTIES

| | GAUGE ORIGIN (MIL) | GAUGE AFTER (MIL) | DIMENSIONS BEFORE (CM) | DIMENSIONS AFTER (CM) | HARDNESS BEFORE (DURO D) | HARDNESS AFTER (DURO D) | MASS BEFORE (GM) | MASS AFTER (GM) | DENSITY (GM/CC) | VOLATILE LOSS AFTER DESIC. | VOLATILE LOSS AFTER 105 C | VOLATILE LOSS TOTAL VOL. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CONTROL 1 | 61 | 61 | 99.26 | 99.26 | 54 | 54 | 85.8 | 85.8 | 0.929 | 0.07 | 0.00 | 0.07 |
| CONTROL 2 | 61 | 61 | 99.13 | 99.13 | 54 | 54 | 85.5 | 85.5 | 0.930 | 0.04 | 0.02 | 0.06 |
| CONTROL 3 | 62 | 62 | 99.40 | 99.40 | 53 | 53 | 86.4 | 86.4 | 0.929 | 0.10 | 0.00 | 0.10 |
| CONTROL AVE | 61 | 61 | 99.26 | 99.26 | 54 | 54 | 85.9 | 85.9 | 0.929 | 0.07 | 0.01 | 0.08 |
| 1 MONTH | 66 | 62 | 99.06 | 99.15 | 53 | 53 | 88.8 | 89.3 | 0.930 | 0.07 | 0.06 | 0.13 |
| 2 MONTHS | 64 | 62 | 99.19 | 99.20 | 53 | 52 | 89.0 | 89.5 | 0.929 | 0.07 | 0.00 | 0.07 |
| 3 MONTHS | 61 | 61 | 99.13 | 98.90 | 54 | 52 | 89.1 | 89.6 | 0.930 | 0.12 | 0.04 | 0.16 |
| 4 MONTHS | 63 | 61 | 100.6 | 99.65 | 53 | 52 | 87.0 | 87.4 | 0.931 | 0.00 | 0.07 | 0.07 |
| (% CHANGE) | | | | | | | | | | | | |
| 1 MONTH | | -6 | | 0 | | 0 | | 1 | 0 | | | |
| 2 MONTHS | | -3 | | 0 | | -2 | | 1 | 0 | | | |
| 3 MONTHS | | 0 | | 0 | | -4 | | 1 | 0 | | | |
| 4 MONTHS | | -3 | | -1 | | -2 | | 0 | 0 | | | |

# F.4
# Appendix H Excerpt – Piping and Permeability

# Appendix H
# Piping and Permeability Calculations

## Table of Contents


- Purpose/Methodology/Assumptions/Results/References
- Calculations

## Purpose/Methodology/Assumptions/Results/References

744 Heartland Trail (53717-8923) P. O. Box 8923 (53708-8923) Madison, WI (608) 831-4444 FAX: (608) 831-3334 VOICE: (608) 831-1989

| PROJECT/PROPOSAL NAME | PREPARED By: | PREPARED Date: | CHECKED By: | CHECKED Date: | PROJECT/PROPOSAL NO. |
|---|---|---|---|---|---|
| Dairyland Power Cooperative | MJA | 9/18/00 | BJK | 10/10/00 | 3081.40 |

# PIPING AND PERMEABILITY CALCULATIONS

## Purpose

The purpose of the piping and permeability calculations is to demonstrate proper soil filter design by satisfying the following criteria:

1. **Piping**: The pore space in the soil filter that is in contact with the material being retained must be small enough to limit particles from being washed in or through it. Likewise, the perforation size of the collection system pipe must be designed to limit pipe bedding material from entering the pipe.
2. **Permeability**: The pore space in the soil filter must be large enough to provide sufficient permeability in order to permit seepage to escape freely.

## Methodology

The piping and permeability calculations have been performed using the three piping relationships, the permeability relationship, and the pipe perforation piping relationship provided in the Naval Facilities Engineering Command (NAVFAC) Design Manual, Figure 4, pg. 7.1-273 (U.S. Navy, 1986). These relationships compare the particle sizes of given materials to one another.

**To avoid movement of particles (piping criteria):**

$$\frac{D15_F}{D85_B} < 5$$

$$\frac{D50_F}{D50_B} < 25$$

$$\frac{D15_F}{D15_B} < 20$$

Note: For very uniform base material ($C_U$<1.5): $D15_F/D85_B$ may be increased to 6.
For broadly graded base material ($C_U$>4): $D15_F/D15_B$ may be increased to 40.

**To avoid headloss in filter (permeability criteria):**

$$\frac{D15_F}{D15_B} > 4$$

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**To avoid loss of filter material into collection pipe perforations:**

$$\frac{D85_F}{\text{Hole Diameter}} > 1.2 \quad \text{or} \quad \frac{D85_F}{\text{SlotWidth}} > 1.4$$

Notes: D15 = Particle size at which 15 percent of the given material passes
D50 = Particle size at which 50 percent of the given material passes
D85 = Particle size at which 85 percent of the given material passes
F = Filter Material
B = Base Material (material to be retained)

When these relationships are satisfied, effective filter designs are established.

## Assumptions

### Filter Applications

The graded filter design was analyzed by evaluating grain-size distributions for the leachate drainage blanket and the pipe bedding material. Pipe perforation size was also used as part of this calculation. Two filter configurations were analyzed:

- Leachate Drainage Blanket (Base)/Pipe Bedding Material (Filter)
- Pipe Bedding Material (Filter)/Pipe Perforation Size

### Soil Properties

Detailed grain-size distribution information for existing material is not available; therefore, typical grain size distributions based on the proposed specification have been used in this analysis for the leachate drainage blanket and the pipe bedding material. Grain-size distribution curves for these materials are included in this section. Average values, between the high and low curves, of D85, D50, and D15 for the drainage blanket and the pipe bedding material have been used for this analysis.

## Results

The results of the analysis indicate that the leachate drainage blanket and the pipe bedding material will meet the requirements for a graded filter design. The calculations indicate that the maximum hole diameter or slot size to be used in the collection pipes is 1/2 inch, therefore the proposed 3/8 inch holes shall be adequate.

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Prior to construction, the actual granular materials used for the graded filter will be tested for grain size distribution, and the ratios will be compared to the given criteria to document that the materials meet the requirements of a graded filter design.

## References

U.S. Navy. 1982 Soil Mechanics. Naval Facilities Engineering Command (NAVFAC) Design Manual DM-7.1. Washington D.C.

# Calculations

# COMPUTATION SHEET



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## *Piping and Permeability Calculation*

### *Input*

**Base (Drainage Blanket)**

| | |
|---|---|
| $D15_B$ | 0.2 |
| $D50_B$ | 0.6 |
| $D85_B$ | 2.4 |

**Filter (Bedding Material)**

| | |
|---|---|
| $D15_F$ | 2.7 |
| $D50_F$ | 8.4 |
| $D85_F$ | 18.6 |

**Collection Pipe**

Pipe Hole Diameter 1/2 inch or Slot Width 1/2 inch

### *Results*

**Permeability Results**

| | Actual | Required |
|---|---|---|
| $D15_F / D15_B$ | 12.7 | > 4 |

**Perforation Size Results**

| | Actual | Required |
|---|---|---|
| $D85_F / _{HOLE}$ | 1.5 | > 1.2 |
| or | | |
| $D85_F / _{SLOT}$ | 1.5 | > 1.4 |

**Piping Results**

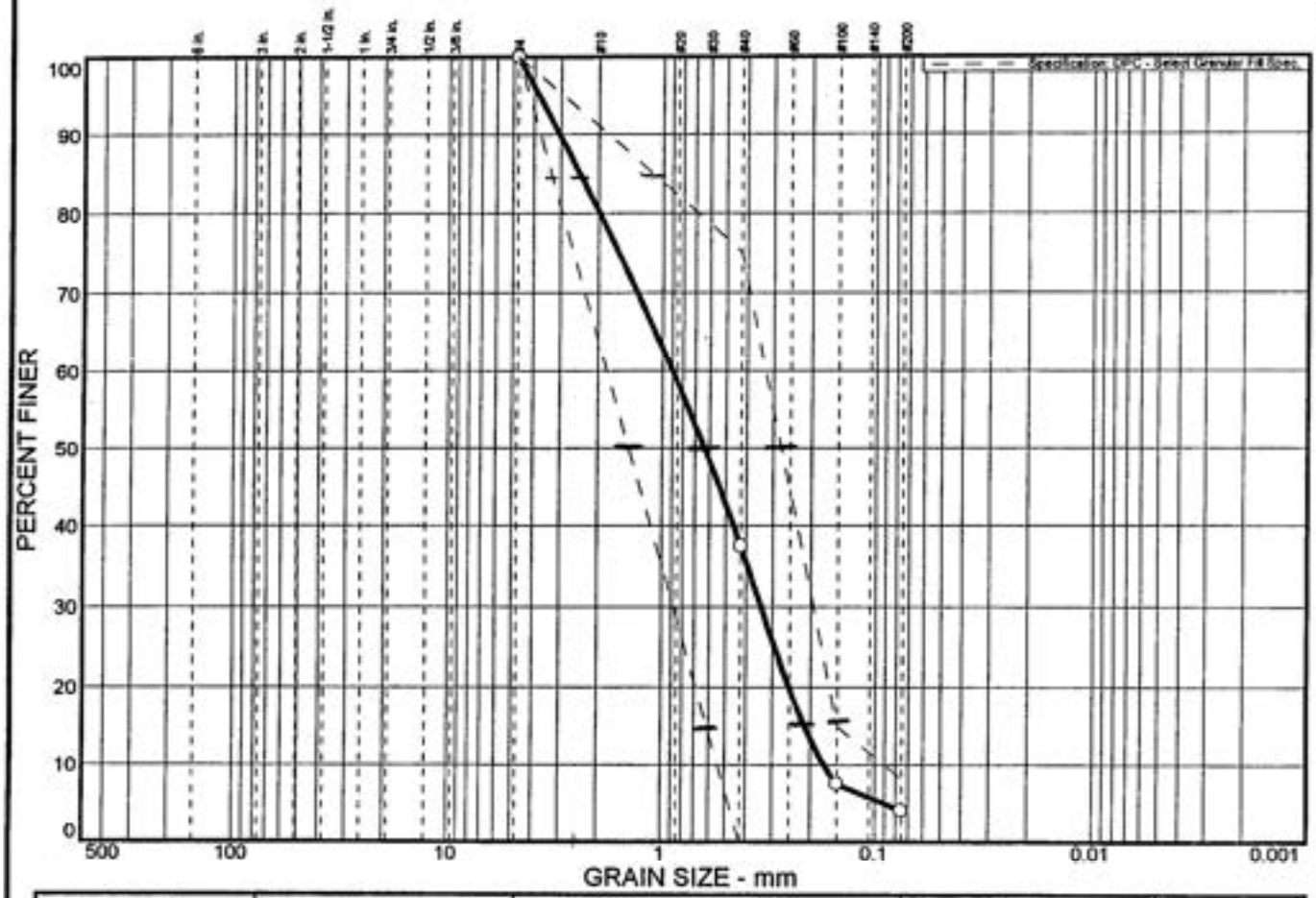
| | Actual | Required |
|---|---|---|
| $D15_F / D85_B$ | 1.1 | < 5 |
| $D50_F / D50_B$ | 13.3 | < 25 |
| $D15_F / D15_B$ | 12.7 | < 20 |

### *NOTES*

1. All units are in millimeters unless specified.
2. For very uniform base material (Cu<1.5): $D15_F/D85_B$ may be increased to 6.
3. For broadly graded base material (Cu>4): $D15_F/D15_B$ may be increased to 40 (Piping equation only).
4. To avoid segregation, filter material should contain no sizes larger than 3 inches.
5. To avoid internal movement of fines, filter material should have no more than 5% passing No. 200 sieve.

(NAVFAC, 1986)

# GRAIN SIZE DISTRIBUTION TEST REPORT




| % + 3" | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|
| 0.0 | 0.0 | 96.0 | 4.0 | |

| SIEVE SIZE | PERCENT FINER | SPEC.* PERCENT | PASS? (X=NO) |
|---|---|---|---|
| #4 | 100.0 | 100 - 100 | |
| #40 | 37.5 | 0 - 75 | |
| #100 | 7.5 | 0 - 15 | |
| #200 | 4.0 | 0 - 8 | |

* DPC - Select Granular Fill Spec.

**Soil Description**

**Atterberg Limits**

PL= LL= PI=

**Coefficients**

$D_{85}$= 2.44 $D_{60}$= 0.896 $D_{50}$= 0.632
$D_{30}$= 0.341 $D_{15}$= 0.212 $D_{10}$= 0.172
$C_u$= 5.20 $C_c$= 0.75

**Classification**

USCS= SP AASHTO=

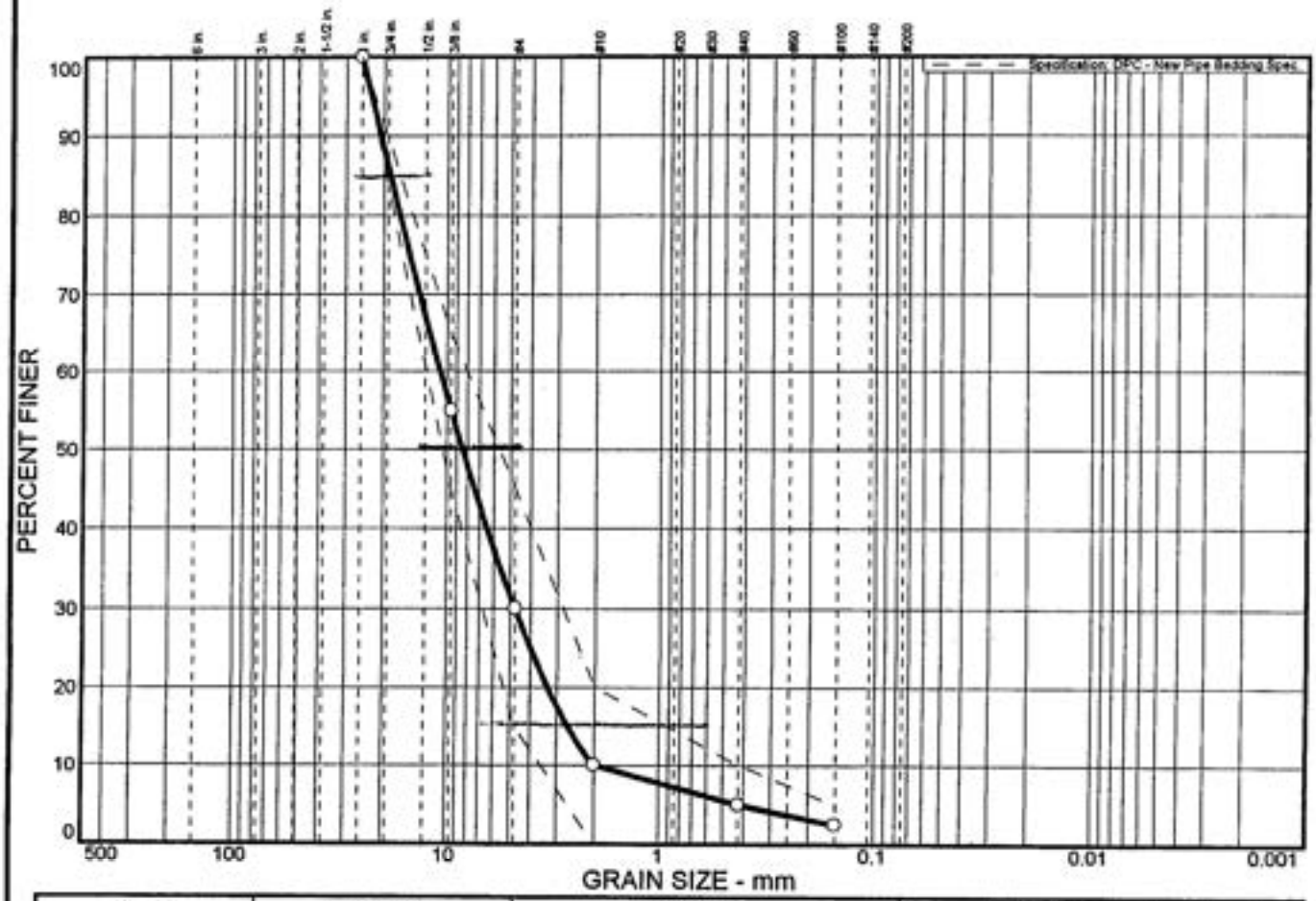
**Remarks**

**Sample No.:** Average Sample **Source of Sample:** Select Granular Fill **Date:** 9-18-00
**Location:** **Elev./Depth:**

**RMT, Inc.**

**Client:**
**Project:** DPC
**Project No:** 3081.40 **Figure:**

# GRAIN SIZE DISTRIBUTION TEST REPORT




| % + 3" | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|
| 0.0 | 70.0 | 30.0 | | |

| SIEVE SIZE | PERCENT FINER | SPEC.* PERCENT | PASS? (X=NO) |
|---|---|---|---|
| 1.0 in. | 100.0 | 100 - 100 | |
| .375 in. | 55.0 | 45 - 65 | |
| #4 | 30.0 | 15 - 45 | |
| #10 | 10.0 | 0 - 20 | |
| #40 | 5.0 | 0 - 10 | |
| #100 | 2.5 | 0 - 5 | |

* DPC - New Pipe Bedding Spec.

**Soil Description**

**Atterberg Limits**

PL= LL= PI=

**Coefficients**

$D_{85}$= 18.6 $D_{60}$= 10.7 $D_{50}$= 8.41
$D_{30}$= 4.75 $D_{15}$= 2.67 $D_{10}$= 2.00
$C_u$= 5.37 $C_c$= 1.05

**Classification**

USCS= AASHTO=

**Remarks**

**Sample No.:** Average Sample #2 **Source of Sample:** Pipe Bedding **Date:** 9-19-00
**Location:** **Elev./Depth:**

**RMT, Inc.**

**Client:**
**Project:** DPC
**Project No:** 3081.40 **Figure:**

# F.5
# Appendix F Excerpt – Saturated Head Over Liner Calculation

# Saturated Depth on Landfill Liner

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# MAXIMUM SATURATED DEPTH ON LANDFILL LINER (McENROE METHOD)

## Purpose:

To estimate the maximum saturated depth (i.e., leachate head) on the base liner of the landfill using the McEnroe Method.

## Methodology:

NR 504.06(5)(a) of the Wisconsin Administrative Code limits the average leachate head over the liner to 12 inches or less. Factors affecting this saturated depth are the percolation rate into the drainage layer, the hydraulic conductivity of the drainage layer, the leachate flow distance from the upstream boundary to the leachate collection pipe, and the slope of the landfill liner.

The McEnroe Method uses a set of formulas for estimating the maximum saturated depth over a sloping liner. These equations were developed by Bruce M. McEnroe and published by ASCE in the Journal of Environmental Engineering, March/April 1993. These equations modify the method originally developed by McEnroe in 1989. The three equations are presented below:

For $R<1/4$,

$$Y_{max} = (R-RS+R^2S^2)^{1/2}\ \{[(1-A-2R)(1+A-2RS)]/[(1+A-2R)(1-A-2RS)]\}^{1/2A}$$

For $R=1/4$,

$$Y_{max} = R(1-2RS)/(1-2R)\ \exp\{2R(S-1)/[(1-2RS)(1-2R)]\}$$

For $R>1/4$,

$$Y_{max} = (R-RS+R^2S^2)^{1/2}\ \exp\{(1/B)\tan^{-1}[(2RS-1)/B]-(1/B)\tan^{-1}[(2R-1)/B]\}$$

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where:

$R = r/(K\sin^2 \alpha)$
$r$ = percolation rate per unit surface area ($cm^3/sec/cm^2$)
$K$ = saturated hydraulic conductivity of the leachate drainage layer (cm/sec)
$\alpha$ = slope angle, measured from horizontal
$S = \tan \alpha$ = slope of liner (ft/ft)
$A = (1-4R)^{1/2}$
$B = (4R-1)^{1/2}$
$L$ = drainage distance, measured horizontally (ft)
$y_{max} = Y_{max}(L \tan \alpha)$ = maximum saturated depth (ft)

A computer spreadsheet utilizing the McEnroe Method was used to calculate the maximum leachate head on the liner for the proposed liner and leachate collection system configurations.

## Assumptions:

1. The minimum liner slope, located on the base of the landfill and measured perpendicular to the leachate collection pipes, is 4 percent. The maximum flow distance associated with this minimum slope is approximately 145 feet. This occurs at the eastern end of the liner base area.

2. The maximum leachate flow distance across the base of the landfill is approximately 190 feet. This occurs at the western end of the liner base area, with a slope of 6 percent measured perpendicular to the leachate collection pipe.

3. In accordance with NR 504.06(5)(t), the drainage layer is required to have a minimum hydraulic conductivity of $1 \times 10^{-2}$ cm/s.

4. Leachate generation (impingement) rates presented in NR 512.12(3) of the Wisconsin Administrative Code (WAC) were used for both open and post-closure conditions. The open conditions impingement rate is 6 inches per year, or 0.5 inches per month. The post-closure impingement rate is 1 inch per year, or 0.083 inches per month.

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## Results:

Using the McEnroe Method, the maximum leachate head on the liner during landfill operations was determined to be approximately 2 inches. The post-closure maximum leachate head on the liner was determined to be 0.3 inches. Both of these values are much less than the maximum 12 inches required by NR 504.06(5) of the Wisconsin Administrative Code. The supporting computer spreadsheet calculations are attached.

## References:

McEnroe, Bruce M. "Steady Drainage of Landfill Covers and Bottom Liners," Journal of Environmental Engineering. ASCE, Vol. 115, No. 6, December 1989, pg. 1114 - 1122.

McEnroe, Bruce M. "Maximum Saturated Depth Over Landfill Liner," Journal of Environmental Engineering. ASCE, Vol. 119, No. 2, March/April 1993, pg. 262-270.

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## MAXIMUM SATURATED DEPTH ON LANDFILL LINER (McENROE METHOD)

OPEN CONDITIONS

| | | | |
|---|---|---|---|
| r = | 0.5 | in/month | (from NR 512.12(3)) |
| r = | 4.83E-07 | cm/sec | (calculated) |
| K = | 0.01 | cm/sec | |
| S = | 4 | % | longest flow distance at flattest |
| L = | 145 | ft | base slope (perpendicular to pipe) |
| alpha = | 0.0399787 | radians | |
| alpha = | 2.29 | degrees | |
| S = | 0.04 | ft/ft | |
| R = | 0.0303 | | |

For R < 1/4

A = 0.9375

$Y_{max}$ = 0.03

$y_{max}$ = 0.16 ft = 1.9 in < 12 in

For R = 1/4

$Y_{max}$ = NOT APPLICABLE

$y_{max}$ = N/A ft = N/A in

For R >1/4

B = NOT APPLICABLE

$Y_{max}$ = NOT APPLICABLE

$y_{max}$ = N/A ft = N/A in

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## MAXIMUM SATURATED DEPTH ON LANDFILL LINER (McENROE METHOD)

OPEN CONDITIONS

| | | | |
|---|---|---|---|
| r = | 0.5 | in/month | (from NR 512.12(3)) |
| r = | 4.83E-07 | cm/sec | (calculated) |
| K = | 0.01 | cm/sec | |
| S = | 6 | % | |
| L = | 190 | ft | ← maximum flow distance to pipe along base (measured perpendicular to pipe) |

| | | |
|---|---|---|
| alpha = | 0.0599282 | radians |
| alpha = | 3.43 | degrees |
| S = | 0.06 | ft/ft |
| R = | 0.0135 | |

For R < 1/4

A = 0.9727

$Y_{max}$ = 0.01

$y_{max}$ = 0.15 ft = 1.8 in < 12 in

For R = 1/4

$Y_{max}$ = NOT APPLICABLE

$y_{max}$ = N/A ft = N/A in

For R >1/4

B = NOT APPLICABLE

$Y_{max}$ = NOT APPLICABLE

$y_{max}$ = N/A ft = N/A in

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## MAXIMUM SATURATED DEPTH ON LANDFILL LINER (McENROE METHOD)

POST-CLOSURE CONDITIONS

| | | | |
|---|---|---|---|
| r = | 0.083 | in/month | (from NR 512.12(3)) |
| r = | 8.02E-08 | cm/sec | (calculated) |
| K = | 0.01 | cm/sec | |
| S = | 4 | % | |
| L = | 145 | ft | |

| | | |
|---|---|---|
| alpha = | 0.0399787 | radians |
| alpha = | 2.29 | degrees |
| S = | 0.04 | ft/ft |
| R = | 0.0050 | |

For R < 1/4

A = 0.9899

$Y_{max}$ = 0.00

$y_{max}$ = 0.03 ft = 0.3 in < 12 in

For R = 1/4

$Y_{max}$ = NOT APPLICABLE

$y_{max}$ = N/A ft = N/A in

For R >1/4

B = NOT APPLICABLE

$Y_{max}$ = NOT APPLICABLE

$y_{max}$ = N/A ft = N/A in

# F.6
# Appendix G Excerpt – Pipe Strength Calculations

# Appendix G
# Pipe Strength Calculations

## Table of Contents


- Pipe Strength Calculations
  - Purpose/Methodology/Assumptions/Results/References
  - Calculations

# Pipe Strength Calculations

## Purpose/Methodology/Assumptions/Results/References

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## Purpose

The purpose of the pipe strength calculations is to demonstrate that the proposed piping for the Phase IV disposal facility will withstand the potential worst-case loading conditions, and provide adequate factors of safety for long-term performance.

## Methodology

The pipe strength analysis consists of evaluating the pipes' abilities to withstand the following:

- Excessive ring deflection
- Wall crushing (ring compression)
- Longitudinal beam deflection

For flexible pipe (e.g., PVC and HDPE), ring deflection has historically been calculated using the Modified Iowa Formula. This formula uses pipe properties, bedding conditions, and anticipated pipe loading conditions to determine pipe deflection. Recent information from Dr. Watkins of Utah State University, the developer of the Modified Iowa Formula (Harrison and Watkins, 1996) and others, however, indicates that for pipes bedded in aggregate, the Modified Iowa Formula overestimates ring deflection for flexible pipes in stiff embankments and should not be used as a limiting design criteria in landfill applications. The Modified Iowa formula is not representative of the conditions to which a landfill collection pipe is exposed for the following reasons:

- The modulus of soil reaction, E', is employed as a spring constant, whereas the soil (bedding stone) is not an elastic material (not spring-like).
- After deep burial, such as the first lift of waste, forces requiring a spring-like reaction from the sidefill soil no longer exist (i.e., the loads on the pipe will be distributed and not concentrated over the pipe like a wheel load).
- The model does not consider the behavior of the sidefill in the vertical direction (it has been reported by Watkins that the pipe cannot, and will not, deflect more than the sidefill around the pipe).

Watkins concluded that the ring compression formula is the correct fundamental design approach and should be used while also checking for other performance limits (primarily sidefill deflection).

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For this analysis, the ring compression formula recommended by Watkins has been used to check the adequacy of the piping bedded in aggregate in the disposal facility. Ring deflection has been conservatively estimated by calculating the deflection of the bedding soil on the sides of the pipe. For pipes bedded in clay (sidewall penetrations), the Modified Iowa formula was utilized.

Longitudinal strain is caused by inconsistent support by the pipe bedding (Harrison and Watkins, 1996). This condition is not applicable in landfill applications such as the disposal facility since the landfill base will be constructed on a firm foundation with pipes continuously bedded. Therefore, longitudinal strain was not calculated.

## Equations

Wall Crushing (Ring Compression):

$$S_A = \sigma(SDR)/2, \qquad \text{(Harrison and Watkins, 1996)}$$

where,

$S_A$ = the magnitude of the compressive force experienced by the pipe wall (psi);

$\sigma$ = the maximum unit pressure expected to act on the top of the pipe (psi);

SDR = standard dimension ratio.

$S_A$ is then compared to the design long-term compressive strength of the material (approximately 800 psi for HDPE which has a factor of safety of 2 or greater built into it [Plexco/Spirolite] and approximately 4,000 psi for PVC).

Ring Deflection (sidefill deflection):

$$X = \varepsilon = \sigma \text{ (pipe diameter)}/E,$$

where:

X = Deflection; conservatively assumed to equal $\varepsilon$ (the allowable ring deflection for PVC and HDPE pipes is 7.5 percent);

$\varepsilon$ = vertical compression of sidefill;

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E = modulus of elasticity of bedding stone - Constrained Modulus (note: this value differs from the modulus of soil reaction E' used in the Modified Iowa formula). Assume E = 20,000 psi for uniform gravel at 90% relative density and subject to initial loading (Lambe and Wittmann, 1969);

$\sigma$ = the maximum unit pressure expected to act on the top of the pipe (psi).

## Assumptions

### Piping Applications

For the disposal facility, there are three key pipes for pipe strength consideration at this time. These pipes include the following:

- 6-inch SDR 17 HDPE leachate collection pipe
- 8-inch SDR 17 HDPE secondary containment pipe
- 10-inch SDR 17 HDPE secondary containment pipe
- 3-inch SCH 120 PVC leachate head well pipe

Note that all piping situations are open-channel flow conditions without pressure (i.e., pipes do not run full). Further, these pipes will be constructed with a coarse stone aggregate bedding. An 8-inch and 10-inch leachate conveyance pipe were evaluated to allow for flexibility concerning the size of the outer pipe, which will act as secondary containment for a 6-inch leachate conveyance pipe.

### Loading Conditions

The pipes' structural stabilities were analyzed for severe loading conditions. The severe loading conditions were based on the following:

- The probable maximum equipment load on the pipe for an appropriate minimum soil cover depth during construction.
- The probable prismatic static load on the pipe following closure. This loading condition is considered conservative for deep burials based on a telephone conversation with Dr. Watkins on March 18, 1998.

Vehicle specifications were determined from the Caterpillar Performance Handbook, Edition 20. To be conservative, waste and soil unit weights were 80 lbs/ft$^3$ and 120 lbs/ft$^3$, respectively, based on the soil characteristics. The maximum waste height over the piping networks is approximately 140 feet.

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In all cases, the static load on the pipe following landfill closure is the higher of the two loading conditions on the pipes; therefore, the ring compression and deflection calculation are based on these static loads.

**Pipe Compressive Strength**

An allowable design long-term compressive strength of 800 psi was assumed based on recommendations from Plexco/Spirolite for HDPE and 4,000 psi for PVC. The maximum allowable deflection is 7.5 percent, from the Uni-Bell Handbook (see attached references at the end of the pipe strength calculations).

For flexible pipe materials (e.g., PVC and HDPE), under conditions of constant strain (deflection), the rate of relaxation of the pipe is greater than the rate of strength regression. This means that the pipe will react relatively quickly to a compressive load by relaxing. As the pipe relaxes, the load is transferred to the surrounding bedding material (soil arch). As the load is transferred to the soil arch, the stress in the pipe will be reduced. Under these conditions, the pipe is exposed to a state of constant strain, not constant stress. If additional loads are then placed on the pipes, these additional loads will be resisted by the pipe's original compressive strength. The pipe will again relax, and the load will be taken up by the soil arch. Therefore, using the pipe's original compressive strength for this analysis is considered the correct approach.

It is noted that the compressive strength values used in this analysis are based on manufacturer's reference data from testing in which the pipe is placed in tension. Under landfill conditions, the pipe will be placed in compression. Strength for materials placed in compression are expected to be higher than for materials placed in tension. This, therefore, provides additional conservatism to this analysis.

**Temperature Effects**

Tests by Dr. Watkins have shown that polyethylene softens slightly at 140°F. The result is that the pipe relaxes faster and, as a result, transfers the load to the soil arch faster. For the same reasons discussed above, the pipe will be in a state of constant strain, not constant stress. Therefore, temperature is not a critical performance limit under typical landfill conditions.

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|---|---|---|---|---|---|
| Dairyland Power Cooperative | BAA | 8/00 | MJA | 10/00 | 3081.40 |

## Pipe Creep

Pipe creep occurs under conditions of constant stress, not conditions of constant strain. Since a condition of constant stress does not occur in landfill pipe applications, creep is not a performance limit.

## Results

The results of the pipe strength calculations show that the pipes evaluated will be able to withstand the load placed on them. These pipes were analyzed at the locations where the dead loads would be the greatest. The associated factor of safety against wall crushing exceeded the minimum design value of 4.0. The allowable deflection (7.5%) was not exceeded based on the anticipated deflection of the sidefill soil. Based on these calculations, the proposed pipe designs are adequate for the anticipated loading conditions.

| PIPE NUMBER | PIPE DESCRIPTION | RING COMPRESSION FORCE (psi)(1) | ESTIMATED DEFLECTION (sidefill soil compression)(2) |
|---|---|---|---|
| 1 | 6" SDR 17 HDPE LEACHATE COLLECTION PIPE | 703 | 0.41% |
| 2 | 8" SDR 17 HDPE SECONDARY CONTAINMENT PIPE (IN AGGREGATE) | 284 | 0.17% |
| 3 | 10" SDR 17 HDPE SECONDARY CONTAINMENT PIPE (IN AGGREGATE) | 283 | 0.17% |
| 3A | 10" SDR 17 HDPE SECONDARY CONTAINMENT PIPE (IN CLAY) | N/A | 5.76% |
| 4 | 3" SCH 120 PVC LEACHATE HEAD WELL PIPE | 403 | 2.85% |

(1) The allowable design long-term ring compression force is equal to 800 psi for HDPE and 4,000 psi for PVC.
(2) The allowable design estimated defection is equal to 7.5 percent.

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|---|---|---|---|---|---|
| Dairyland Power Cooperative | BAA | 8/00 | MJA | 10/00 | 3081.40 |

## References

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Utah State University. 1996. Procedure for structural design of HDPE pipe, DR-11, buried in waste landfills. Reynold King Watkins, Professor Emeritus, Department of Civil and Environmental Engineering, Logan, Utah. February 19, 1996.

# Calculations

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|---|---|---|---|---|---|
| DPC Phase IV | By: BAA | Aug-00 | By:MJA | Date: 10/00 | 3081.40 |

# PIPE STRENGTH CALCULATIONS

## Piping Applications:

| Pipe # | Description | Dia. (in.) nomina | actual |
|---|---|---|---|
| 1 | SDR 17 HDPE Leachate Collection Pipe | 6 | 6.625 |
| 2 | SDR 17 HDPE Leachate Conveyance Pipe | 8 | 8.625 |
| 3 | SDR 17 HDPELeachate Conveyance Pipe | 10 | 10.75 |
| 4 | Sch.120 PVC Leachate Headwell Pipe | 3 | 3.5 |
| 5 | SDR 11 HDPE Leach.Conv. Pipe (in Clay) | 10 | 10.75 |
| 6 | | 0 | 0 |
| 7 | | 0 | 0 |

Minimum soil cover over pipes for operation of wheeled vehicles (in.): 36
Minimum soil cover over pipes for operation of tracked vehicles (in.): 24

## Calculate Equipment Loads:

From Uni-Bell Handbook of PVC Pipe Design and Construction (1982)

$W_{sc} = C_s (P F'/ L)$ <= Concentrated Load

Where: $W_{sc}$ = The load on the pipe, lb/unit length

P = The concentrated load, lb

F' = The impact factor <= 1.5 (From Uni-Bell Handbook)

L = The effective length of conduit (3' or less), ft

$C_s$ = The load coefficient which is a function of $B_c$/2H and L/2H,

Where:

H = The height of the fill from the top of the pipe to the ground surface, ft

$B_c$ = The diameter of the pipe, ft

and:

$W_{sd} = C_s P F' B_c$ <= Distributed Load

Where: $W_{sd}$ = The load on the pipe, lb/unit length

P = The intensity of the distributed load, lb/ft$^2$

F' = The impact factor <= 1.5 (From Uni-Bell Handbook)

$B_c$ = The diameter of the pipe, ft

$C_s$ = The load coefficient which is a function of D/2H and M/2H,

Where D and M are the width and length, respectfully, of the area over which the distributed load acts, ft

# COMPUTATION SHEET



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**Using the formulas, determine the maximum equipment loads for the pipe diameters to be used in the landfill design**

**Consider the following equipment:**

CAT 637E Scraper
Operating weight (loaded) = 195,000 lb
50/50 weight distribution
Number of Wheels = 4
Weight per wheel = 48,750 lb = P

CAT 826C Landfill Compactor
Operating weight (loaded) = 69,700 lb
50/50 weight distribution
Number of Wheels = 4
Weight per wheel = 17,425 lb = P

CAT D4000 Articulated Dumptruck
Operating weight (loaded) = 141,700 lb
34/33/33 weight distribution (3 axels)
Number of Wheels = 6
Weight per wheel = 23,617 lb = P

**=> For wheeled vehicles the CAT 637E Scraper load is the largest, thus use 48750 lb. to determine Wsc**

CAT D9N Dozer
Operating weight (loaded) = 94,000 lb
Track width = 2 ft. Track length = 11.4 ft.
Ground Contact Area = 6,566 $in^2$
Weight per track = 47,000 lb
Force per unit area = 14 psi

**=> For distributed loads use 14 psi to determine Wsd**

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|---|---|---|---|---|---|
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**6.625" Diameter Pipe**

O.D. = 6.625 in.

Min. Soil Cover (wheeled) = 36 in.

Bc/2H = 0.1 L/2H = 0.5

From Table, Cs = 0.079

Wsc = 160 lbs/in

Min. Soil Cover (tracked) = 24 in.

D/2H = 0.5 M/2H = 2.9

From Table, Cs = 0.54

Wsd = 75 lb/in

**Use 160 lb/in**

**8.625" Diameter Pipe**

O.D. = 8.625 in.

Min. Soil Cover (wheeled) = 36 in.

Bc/2H = 0.1 L/2H = 0.5

From Table, Cs = 0.079

Wsc = 160 lbs/in

Min. Soil Cover (tracked) = 24 in.

D/2H = 0.5 M/2H = 2.9

From Table, Cs = 0.54

Wsd = 98 lb/in

**Use 160 lb/in**

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| PROJECT/PROPOSAL NAME | PREPARED | | CHECKED | | PROJECT/PROPOSAL NO. |
|---|---|---|---|---|---|
| DPC Phase IV | By: BAA | Aug-00 | By:MJA | Date: 10/00 | 3081.40 |

**10.75" Diameter Pipe**

O.D. = 10.75 in.

Min. Soil Cover (wheeled) = 36 in.

Bc/2H = 0.1 L/2H = 0.5

From Table, Cs = 0.079

Wsc = 160 lbs/in

Min. Soil Cover (tracked) = 24 in.

D/2H = 0.5 M/2H = 2.9

From Table, Cs = 0.54

Wsd = 122 lb/in

**Use 160 lb/in**

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| PROJECT/PROPOSAL NAME | PREPARED | | CHECKED | | PROJECT/PROPOSAL NO. |
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**3.5" Diameter Pipe**

O.D. = 3.5 in.

Min. Soil Cover (wheeled) = 36 in.

Bc/2H = 0.1 L/2H = 0.5

From Table, Cs = 0.079

Wsc = 160 lbs/in

Min. Soil Cover (tracked) = 24 in.

D/2H = 0.5 M/2H = 2.9

From Table, Cs = 0.54

Wsd = 40 lb/in

**Use 160 lb/in**

# COMPUTATION SHEET



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|---|---|---|---|---|---|
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**Calculate Soil and Waste Loads (Dead Loads):**

| Soil Type | unit wt (pcf) |
|---|---|
| Soil | 120 |
| Waste | 80 |
| | |
| | |
| | |
| | |
| | |

| Pipe # | Soil ht. (ft) | Waste ht. (ft) | 0 ht. (ft) | 0 ht. (ft) | 0 ht. (ft) | 0 ht. (ft) | 0 ht. (ft) | Pipe Diam (in) | Load psi | Load lb/in |
|---|---|---|---|---|---|---|---|---|---|---|
| Operational | | | | | | | | | | |
| 1 | 3 | 0 | | | | | | 6.625 | 2.5 | 17 |
| 2 | 4 | 0 | | | | | | 8.625 | 3.3 | 29 |
| 3 | 4 | 0 | | | | | | 10.750 | 3.3 | 36 |
| 4 | 2 | 0 | | | | | | 3.500 | 1.7 | 6 |
| 5 | 4 | 0 | | | | | | 10.750 | 3.3 | 36 |
| 6 | | | | | | | | | | |
| | | | | | | | | | | |
| Closure | | | | | | | | | | |
| 1 | 6 | 140 | | | | | | 6.625 | 83 | 548 |
| 2 | 40 | 0 | | | | | | 8.625 | 33 | 288 |
| 3 | 40 | 0 | | | | | | 10.750 | 33 | 358 |
| 4 | 4.5 | 110 | | | | | | 3.500 | 65 | 227 |
| 5 | 5 | 68 | | | | | | 10.750 | 42 | 451 |
| 6 | | | | | | | | | | |
| | | | | | | | | | | |

**Worst Case Loading**

| Pipe Description | Pipe Diam (in) | Operational Load (lb/in) | Closure Load (lb/in) | Worst Case Load (lb/in) |
|---|---|---|---|---|
| SDR 17 HDPE Leachate Collection Pipe | 6.625 | 177 | 548 | 548 |
| SDR 17 HDPE Leachate Conveyance Pipe | 8.625 | 189 | 288 | 288 |
| SDR 17 HDPELeachate Conveyance Pipe | 10.750 | 196 | 358 | 358 |
| Sch.120 PVC Leachate Headwell Pipe | 3.500 | 166 | 227 | 227 |
| SDR 11 HDPE Leach.Conv. Pipe (in Clay) | 10.750 | 196 | 451 | 451 |
| 0 | #N/A | 0 | 0 | 0 |
| 0 | #N/A | 0 | 0 | 0 |

TABLE 1 Influence Coefficients, Cs for Concentrated and Distributed Loads Vertically Centered Over Conduit (Solution of Holl's and Newmark's integration of Boussinesq Equasion)

| D/2H or | M/2H or L/2H | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $B_c$/2H | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 | 1.0 | 1.2 | 1.5 | 2.0 | 5.0 |
| 0.1 | 0.019 | 0.037 | 0.053 | 0.067 | 0.079 | 0.089 | 0.097 | 0.103 | 0.108 | 0.112 | 0.117 | 0.121 | 0.124 | 0.128 |
| 0.2 | 0.037 | 0.072 | 0.103 | 0.131 | 0.155 | 0.174 | 0.189 | 0.202 | 0.211 | 0.219 | 0.229 | 0.238 | 0.244 | 0.248 |
| 0.3 | 0.053 | 0.103 | 0.149 | 0.190 | 0.224 | 0.252 | 0.274 | 0.292 | 0.306 | 0.318 | 0.333 | 0.345 | 0.355 | 0.360 |
| 0.4 | 0.067 | 0.131 | 0.190 | 0.241 | 0.284 | 0.320 | 0.349 | 0.373 | 0.391 | 0.405 | 0.425 | 0.440 | 0.454 | 0.460 |
| 0.5 | 0.079 | 0.155 | 0.224 | 0.284 | 0.336 | 0.379 | 0.414 | 0.441 | 0.463 | 0.481 | 0.505 | 0.525 | 0.540 | 0.548 |
| 0.6 | 0.089 | 0.174 | 0.252 | 0.320 | 0.379 | 0.428 | 0.467 | 0.499 | 0.524 | 0.544 | 0.572 | 0.596 | 0.613 | 0.624 |
| 0.7 | 0.097 | 0.189 | 0.274 | 0.349 | 0.414 | 0.467 | 0.511 | 0.546 | 0.584 | 0.597 | 0.628 | 0.650 | 0.674 | 0.688 |
| 0.8 | 0.103 | 0.202 | 0.292 | 0.373 | 0.441 | 0.499 | 0.546 | 0.584 | 0.615 | 0.639 | 0.674 | 0.703 | 0.725 | 0.740 |
| 0.9 | 0.108 | 0.211 | 0.306 | 0.391 | 0.463 | 0.524 | 0.574 | 0.615 | 0.647 | 0.673 | 0.711 | 0.742 | 0.766 | 0.784 |
| 1.0 | 0.112 | 0.219 | 0.318 | 0.405 | 0.481 | 0.544 | 0.597 | 0.639 | 0.673 | 0.701 | 0.740 | 0.774 | 0.800 | 0.816 |
| 1.2 | 0.117 | 0.229 | 0.333 | 0.425 | 0.505 | 0.572 | 0.628 | 0.674 | 0.711 | 0.740 | 0.783 | 0.820 | 0.849 | 0.868 |
| 1.5 | 0.121 | 0.238 | 0.345 | 0.440 | 0.525 | 0.596 | 0.650 | 0.703 | 0.742 | 0.774 | 0.820 | 0.861 | 0.894 | 0.916 |
| 2.0 | 0.124 | 0.244 | 0.355 | 0.454 | 0.540 | 0.613 | 0.674 | 0.725 | 0.766 | 0.800 | 0.849 | 0.894 | 0.930 | 0.956 |

Ref: Uni-bell Handbook of PVC Pipe

HDPE PIPE DESIGN BY RING COMPRESSION AND DEFLECTION

PROJECT NAME DPC
PROJECT NO. : 3081.40
USER NAME : MJA
DATE : 8/20/2000

FILE:p:\data\projects\3081\40\pipe\lcpipe1.xls
HDPE CALCLULATION ONLY

6" SDR 17 HDPE Leachate Collection Pipe

<<< VARIABLES >>>

| | |
|---|---|
| STANDARD DIMENSION RATIO | 17.0 |
| OUTSIDE DIAMETER (inches) | 6.625 |
| PIPE LOADING (lbs/in) | 548 |
| PIPE LOADING (psi) | 83 |
| BEDDING CONSTRAINED MODULUS (psi) | 20000 |

<<< CONSTANTS >>>

| | |
|---|---|
| PIPE COMPRESSIVE STRENGTH, FS ≥2.0 (psi) | 800 |

<<< CALCULATED VALUES >>>

| | |
|---|---|
| RING COMPRESSIVE FORCE (psi) | 703 |
| IS RING COMPRESSIVE FORCE GREATER THAN PIPE COMPRESSIVE STRENGTH? | No |
| DEFLECTION:SIDEFILL COMP. (in) | 0.027 |
| % DEFLECTION | 0.41% |

HDPE PIPE DESIGN BY RING COMPRESSION AND DEFLECTION

PROJECT NAME DPC
PROJECT NO. : 3081.40
USER NAME : MJA
DATE : 8/20/2000

FILE:p:\data\projects\3081\40\pipe\cpipe2.xls
HDPE CALCLULATION ONLY

8" SDR 17 HDPE Leachate Conveyance Pipe

<<< VARIABLES >>>

| | |
|---|---|
| STANDARD DIMENSION RATIO | 17.0 |
| OUTSIDE DIAMETER (inches) | 8.625 |
| PIPE LOADING (lbs/in) | 288 |
| PIPE LOADING (psi) | 33 |
| BEDDING CONSTRAINED MODULUS (psi) | 20000 |

<<< CONSTANTS >>>

| | |
|---|---|
| PIPE COMPRESSIVE STRENGTH, FS ≥2.0 (psi) | 800 |

<<< CALCULATED VALUES >>>

| | |
|---|---|
| RING COMPRESSIVE FORCE (psi) | 284 |
| IS RING COMPRESSIVE FORCE GREATER THAN PIPE COMPRESSIVE STRENGTH? | No |
| DEFLECTION:SIDEFILL COMP. (in) | 0.014 |
| % DEFLECTION | 0.17% |

HDPE PIPE DESIGN BY RING COMPRESSION AND DEFLECTION

PROJECT NAME DPC
PROJECT NO. : 3081.40
USER NAME : MJA
DATE : 8/20/2000

FILE:p:\data\projects\3081\40\pipe\lcpipe3.xls
HDPE CALCLULATION ONLY

10" SDR 17 HDPE Leachate Conveyance Pipe

<<< VARIABLES >>>

| | |
|---|---|
| STANDARD DIMENSION RATIO | 17.0 |
| OUTSIDE DIAMETER (inches) | 10.750 |
| PIPE LOADING (lbs/in) | 358 |
| PIPE LOADING (psi) | 33 |
| BEDDING CONSTRAINED MODULUS (psi) | 20000 |

<<< CONSTANTS >>>

| | |
|---|---|
| PIPE COMPRESSIVE STRENGTH, FS ≥2.0 (psi) | 800 |

<<< CALCULATED VALUES >>>

| | |
|---|---|
| RING COMPRESSIVE FORCE (psi) | 283 |
| IS RING COMPRESSIVE FORCE GREATER THAN PIPE COMPRESSIVE STRENGTH? | No |
| DEFLECTION:SIDEFILL COMP. (in) | 0.018 |
| % DEFLECTION | 0.17% |

***** MODIFIED IOWA FORMULA FOR PVC PIPE DESIGN BY RING DEFLECTION *****

| | |
|---|---|
| PROJECT | : DPC |
| PROJECT NO. | : 3081.40 |
| USER NAME | : MJA |
| DATE | : 02-Oct-00 |

FILE:H:\DATA\COMMON\TEMPLATE\SC-11\IOWAPVC.XLS
PVC CALCULATION ONLY
PIPE DESCRIPION: 3" DIA. SCHEDULE 80 PVC HEADWELL PIPE

<<< VARIABLES >>>

| | |
|---|---|
| STANDARD DIMENSION RATIO | 12.4 |
| OUTSIDE DIAMETER (inches) | 3.500 |
| MIN. WALL THICKNESS (inches) | 0.300 |
| WEIGHT / LINEAL INCH (lbs/in) | 227 |
| SOIL MODULUS (psi) | 2000 |

<<< CONSTANTS >>>

| | |
|---|---|
| BEDDING FACTOR | 0.10 |
| DEFLECTION LAG FACTOR | 1.5 |
| FLEXURAL MODULUS (psi) | 400,000 |

<<< CALCULATED VALUES >>>

| | |
|---|---|
| MOMENT OF INERTIA (inch^3) | 0.002 |
| MEAN RADII (inches) | 1.600 |
| PIPE STIFFNESS (psi) | 1,475 |
| DEFLECTION (inches) | 0.100 |
| % DEFLECTION | 2.85% |

$\left(\frac{227\#}{in}\right) \div (3.5in) = 64.8\ psi$

Wall Crushing
$\sigma_A = \sigma(SDR)/2 = (65\ psi)(12.4)/2 = 403\ psi$ ✓

***** MODIFIED IOWA FORMULA FOR HDPE PIPE DESIGN BY RING DEFLECTION *****

PROJECT NAME: DPC
PROJECT NO. : 07-Jun-08
USER NAME : BJK
DATE : 05-Oct-00

FILE:H\DATA\COMMON\TEMPLATE\SC-11\IOWAHDPE.XLS
HDPE CALCLULATION ONLY
PIPE DESCRIPION: 8" SDR 17 HDPE Leachate Conveyance Pipe

<<< VARIABLES >>>

| | |
|---|---|
| STANDARD DIMENSION RATIO | 11.0 |
| OUTSIDE DIAMETER (inches) | 10.750 |
| WEIGHT / LINEAL INCH (lbs/in) | 451 |
| SOIL MODULUS (psi) | 400 |

<<< CONSTANTS >>>

| | |
|---|---|
| BEDDING FACTOR | 0.10 |
| DEFLECTION LAG FACTOR | 1.5 |
| FLEXURAL MODULUS (psi) | 105,000 |

<<< CALCULATED VALUES >>>

| | |
|---|---|
| AVERAGE WALL THICKNESS (inches) | 1.036 |
| MOMENT OF INERTIA (inch^3) | 0.093 |
| MEAN RADII (inches) | 4.857 |
| PIPE STIFFNESS (psi) | 570 |
| DEFLECTION (inches) | 0.619 |
| % DEFLECTION | 5.76% |
| % TANGENTIAL STRAIN | 2.22% |
| TANGENTIAL STRAIN ALLOWABLE | 4.20% |
| FACTOR OF SAFETY (STRAIN) | 1.89 |

# COMPUTATION SHEET

RMT INC.
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SHEET _____ OF _____

| PROJECT / PROPOSAL NAME | PREPARED By: | Date: | CHECKED By: | Date: | PROJECT / PROPOSAL NO. |
|---|---|---|---|---|---|
| DPC | BJF | 10/00 | MJA | 10/00 | 3081.40 |

Figure 3

BUREAU OF RECLAMATION VALUES OF E' FOR IOWA FORMULA
(For Initial Flexible Pipe Deflection) (REFERENCE PLEXCO)

| Soil type-pipe bedding material (Unified Classification System 1/) | E' for degree of compaction of bedding (lb/in²) 4/ Dumped | Slight <85% Proctor <40% rel. den. | Moderate 85-95% Proctor 40-70% rel. den. | High >95% Proctor >70% rel. den. |
|---|---|---|---|---|
| Fine-grained Soils (LL > 50) 2/ Soils with medium to high plasticity CH, MH, CH-MH | No data available; consult a competent Soils Engineer; Otherwise use E' = 0 | | | |
| Fine-grained Soils (LL < 50) Soils with medium to no plasticity CL, ML, ML-CL, with less than 25 percent coarse-grained particles | 50 | 200 | 400 | 1,000 |
| Fine-grained Soils (LL < 50) Soils with medium to no plasticity CL, ML, ML-CL, with more than 25 percent coarse-grained particles; Coarse-grained Soils with Fines GM, GC, SM, SC 3/ contains more than 12 percent fines | 100 | 400 | 1,000 | 2,000 |
| Coarse-grained Soils with Little or No Fines GW, GP, SW, SP 3/ contains less than 12 percent fines | 200 | 1,000 | 2,000 | 3,000 |
| Crushed Rock | 1,000 | 3,000 | | |

1/ ASTM Designation D-2487, USBR Designation E-3.

2/ LL = Liquid limit.

3/ Or any borderline soil beginning with one of these symbols (i.e., GM-GC, GC-SC.).

4/ 1 lb/in² = 0.07 kg/cm².

FIGURE 2
Variation In Soil Stress With Cover Depth Below H-20 Wheel Load

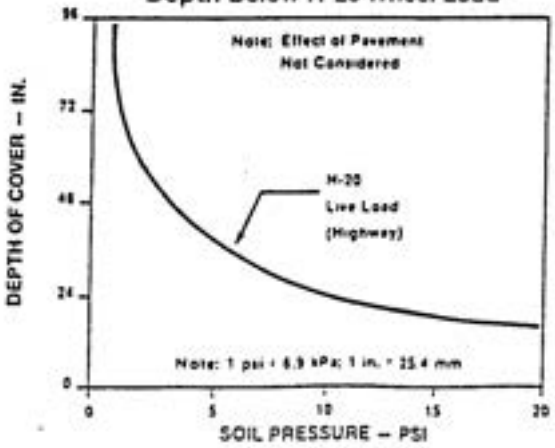
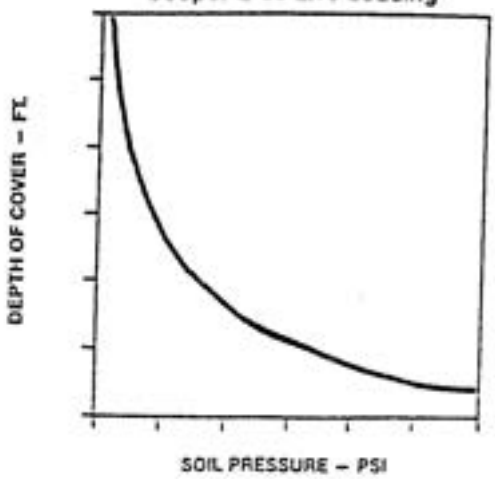



FIGURE 3
Cooper E-80 Live Loading



# F.7
# Appendix J Excerpt – Global Stability

# Global Slope Stability

# Purpose/Approach/Methodologies/Assumptions/ Results/References

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| PROJECT/PROPOSAL NAME | PREPARED By: | Date: | CHECKED By: | Date: | PROJECT/PROPOSAL NO. |
|---|---|---|---|---|---|
| Dairyland Power Cooperative | JDH<br>Rev. BJK | 9/97<br>9/00 | PDC | 9/97 | 3081.40 |

# GLOBAL SLOPE STABILITY

## Purpose

To evaluate the global slope stability of the liner and final slopes.

## Approach

The global stability analysis was performed by evaluating the following worst-case slope conditions:

### Liner Slope

The worst-case slope of the liner consists of an 83-foot-high 3H:1V slope with a 2-foot-thick low-permeability soil layer, a GCL, a geomembrane, and a 1-foot-thick granular drainage layer (approximately Coordinate N172500, E147700, west slope [see Figure J-1]).

### Final Cover Slope

The worst-case slope of the final cover consists of a 36-foot-high, 4H:1V slope (approximately Coordinate N172000, E1477000, west slope [see Figure J-2]). Conditions are modeled for ash waste.

## Methodologies

- The analyses have been performed using the computer program XSTABL, which was developed at Purdue University and subsequently modified by Interactive Software Designs, Inc., of Moscow, Idaho (1994). XSTABL is used to perform the iterative task of identifying the worst-case failure scenario for each case using the Modified Bishops Method. XSTABL uses a two-dimensional static equilibrium method to determine a factor of safety against failure.
- The failure mode considered for the stability analysis was the circular or rotational failure of the waste, subgrade, natural formations, and compacted embankments (*i.e.*, perimeter berm, liner, and cover).
- The circular trial failure surface generator performs a search for the critical failure surface based on failure initiation and termination points established by the user, and is often used when no well-defined weak zone exists in the profile being evaluated. This failure mode is used in evaluating the stability of the liner and final slopes.
- The worst-case (lowest factor of safety) is identified by varying the limits of the failure generation locations. In cases where both types of failure are used to analyze the stability, the failure mode resulting in the most critical (lowest) factor of safety is presented in the results.

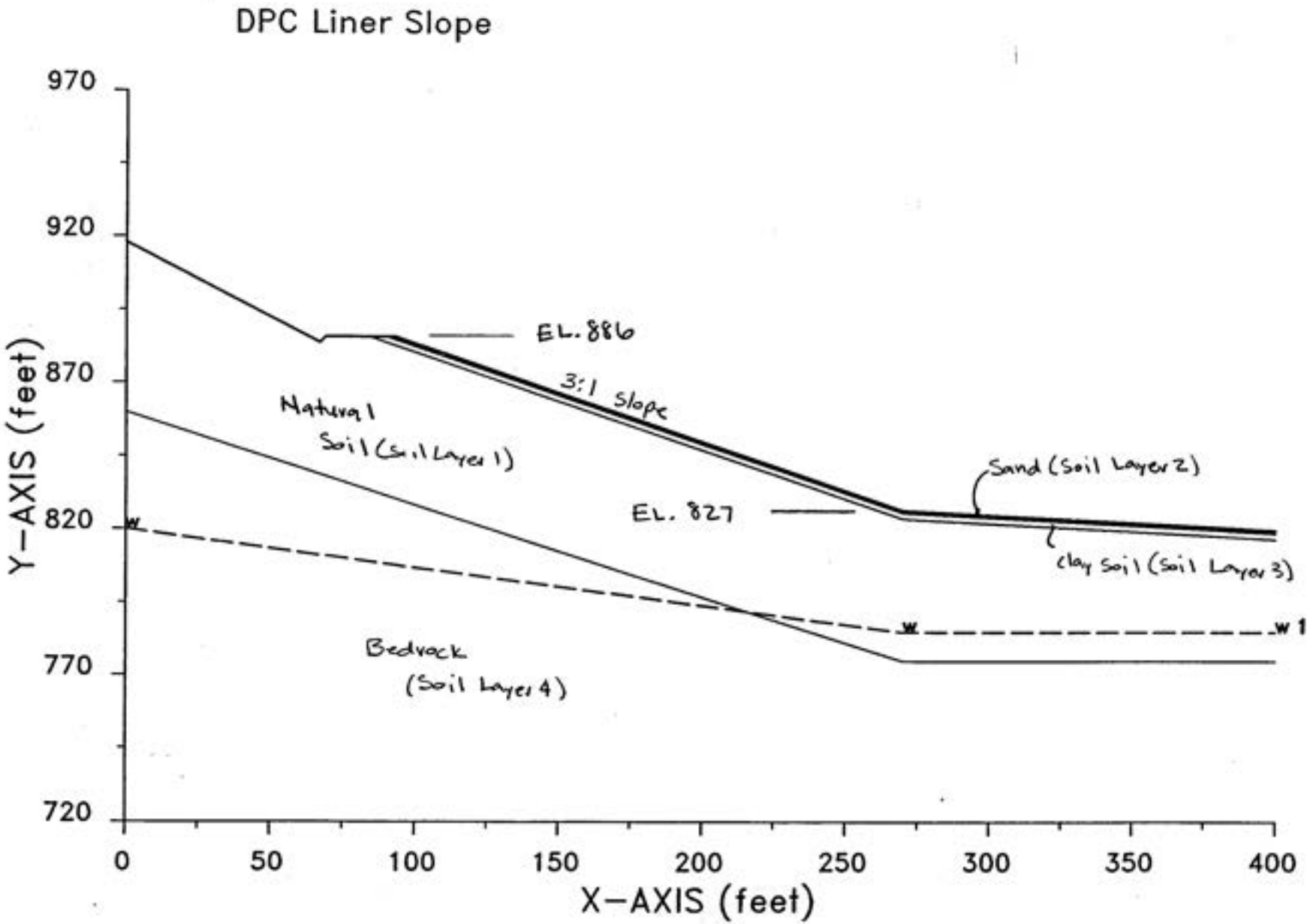



FIGURE J-1
DPC 3081.28

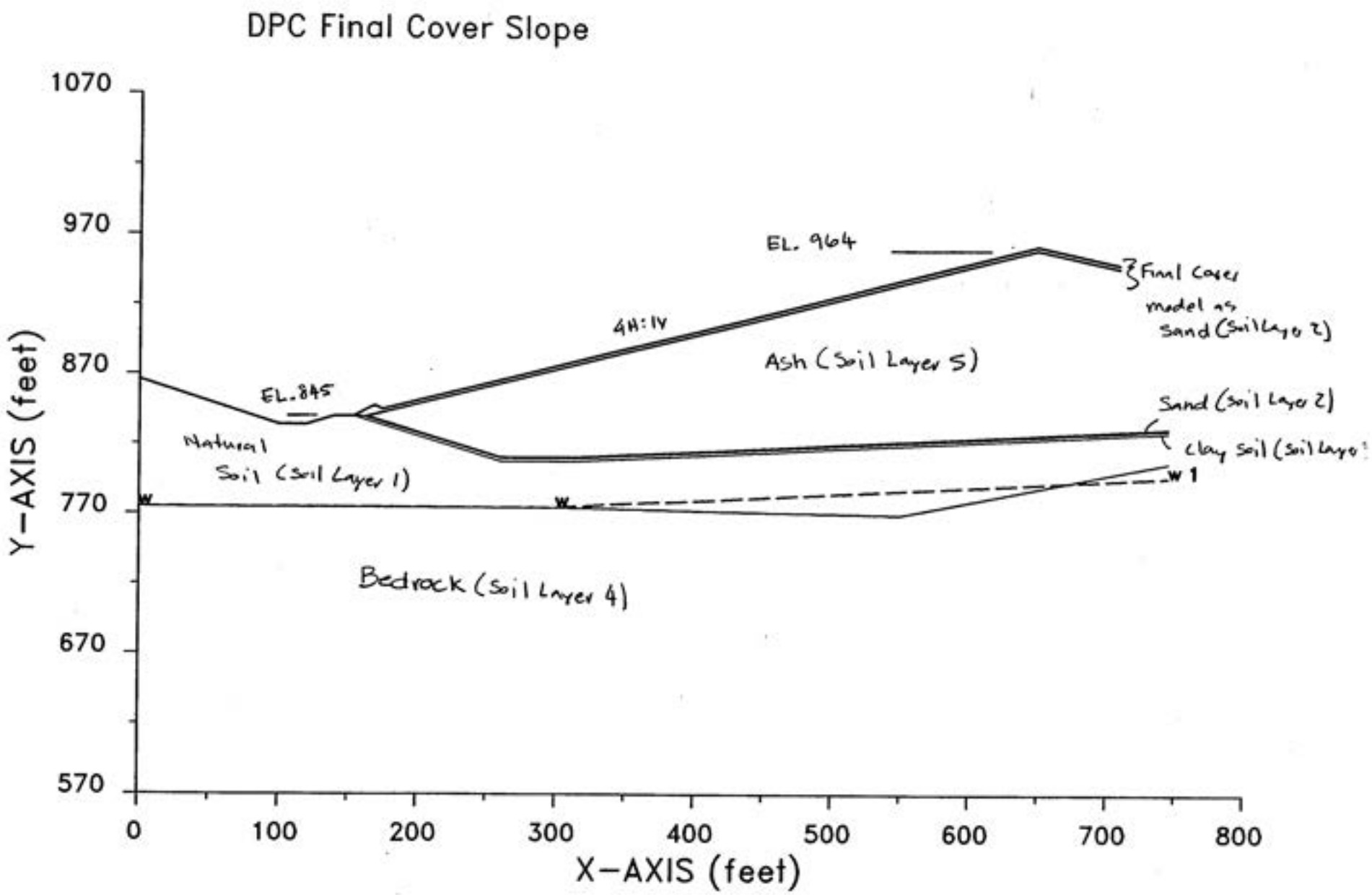



FIGURE J-2
DPC 3081.28

744 Heartland Trail (53717-8923) P. O. Box 8923 (53708-8923) Madison, WI (608) 831-4444 FAX: (608) 831-3334 VOICE: (608) 831-1989

| PROJECT/PROPOSAL NAME | PREPARED By: | Date: | CHECKED By: | Date: | PROJECT/PROPOSAL NO. |
|---|---|---|---|---|---|
| Dairyland Power Cooperative | JDH<br>Rev. BJK | 9/97<br>9/00 | PDC | 9/97 | 3081.40 |

## Assumptions

- Profile - The cross sections selected to be analyzed are representative of worst-case profiles with regard to slope stability. The longest and highest slopes were selected for modeling. The geologic setting and subgrade information was based on the information found on the geologic cross sections contained in this report.
- To simplify the analysis, the final cover is modeled as a single layer of soil, using sand soil characteristics. This assumption is minor due to the small thickness of the final cover relative to the thickness of waste.
- Groundwater - The water table is estimated to be at varying elevations of 775 to 799 feet through the cross section based on the groundwater elevation maps found in this report.
- A factor of safety of at least 1.3 is acceptable against global slope failures.
- The shear strength of the ash is based on published results of fly ash materials (Oweis, 1990). The results of these tests are as follows:

| MATERIAL | MC (%) | $\gamma_d$ (pcf) | c (psf) | $\phi$ (degrees) |
|---|---|---|---|---|
| DPC ash waste | 40 | 50 | 130 | 20 |

Notes:
MC = moisture content.
$\gamma_d$ = dry unit weight.
c = cohesion (psf).
$\phi$ = friction angle.

- Soil Parameters - Unit weight, friction angles, and cohesive strength parameters were estimated based on information gathered from boring logs contained in Appendix C of Addendum 3 for the Initial Site Report (RMT, 1995) and on geologic cross sections. Parameters were chosen based on their correlation with pocket penetration numbers and Plasticity Indices. Published values and engineering judgment were also considered to conservatively estimate the clay, soil, and waste characteristics, as presented in the following table:

| MATERIAL | $\gamma$ (pcf) | $\gamma$ Sat (pcf) | $\phi$ (degrees) | c (psf) |
|---|---|---|---|---|
| Natural soil | 120 | 120 | 20 | 200 |
| Sand | 110 | 110 | 30 | 0 |
| Clay soil | 125 | 125 | 25 | 400 |
| Bedrock | 145 | 145 | 45 | 10000 |
| Ash waste | 80 | 80 | 20 | 130 |

744 Heartland Trail (53717-8923) P. O. Box 8923 (53708-8923) Madison, WI (608) 831-4444 FAX: (608) 831-3334 VOICE: (608) 831-1989

| PROJECT/PROPOSAL NAME | PREPARED By: | PREPARED Date: | CHECKED By: | CHECKED Date: | PROJECT/PROPOSAL NO. |
|---|---|---|---|---|---|
| Dairyland Power Cooperative | JDH<br>Rev. BJK | 9/97<br>9/00 | PDC | 9/97 | 3081.40 |

## Results

- The results of the slope stability analysis are summarized below.

**Factors of Safety Against Circular Failure**

| | FACTOR OF SAFETY |
|---|---|
| Liner slope | 1.6 |
| Final cover slope | 1.8 |

- Based on the assumed soil strength parameters and slope conditions, the slopes of the liner and final cover will be stable under the specified modeled conditions.

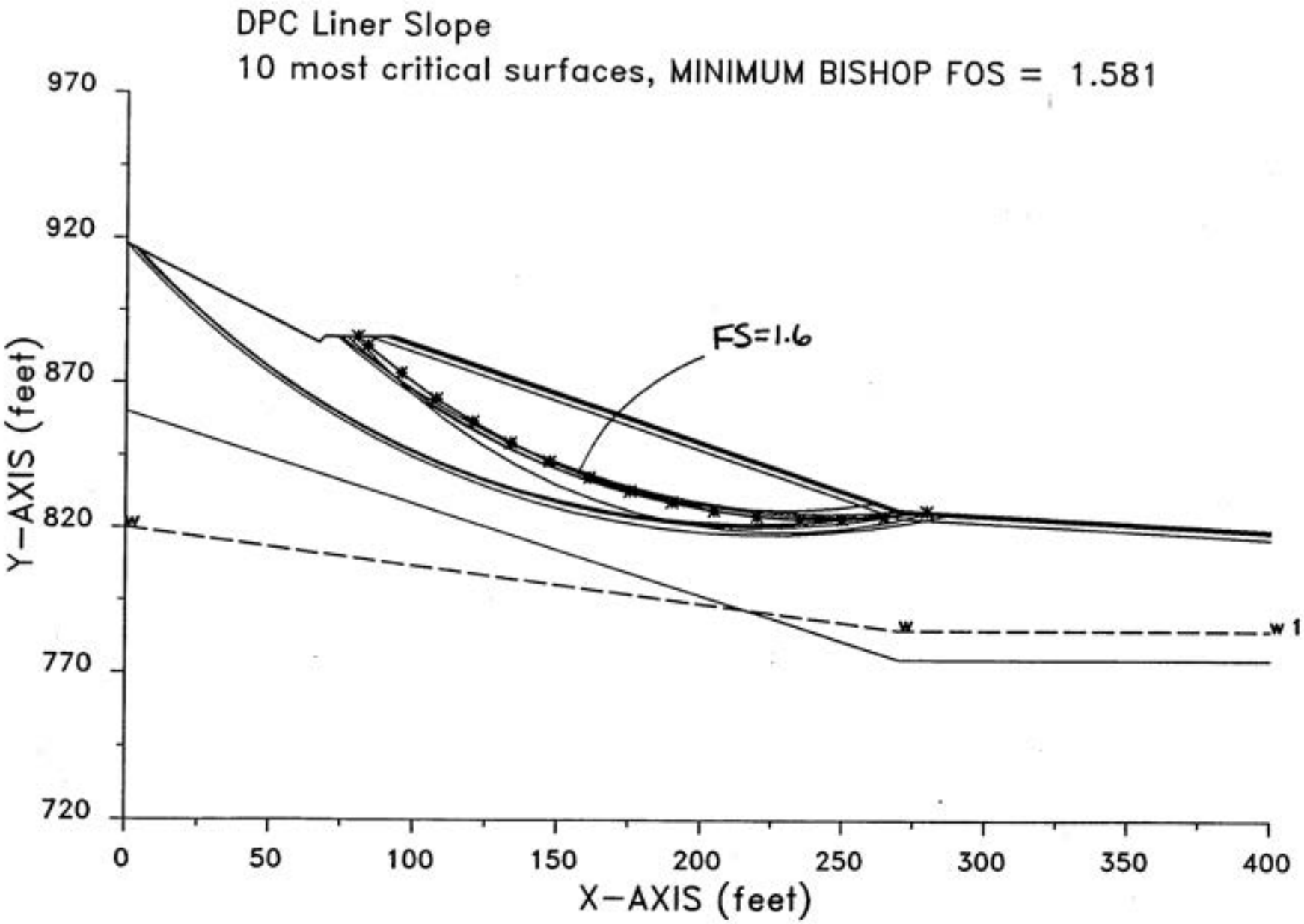
## References

Oweis, I. S. and R.P. Khera. 1990. Geotechnology of waste management. Butterworths, London.

RMT, Inc. 4/1995. Initial site report for Dairyland Power Cooperative.

Interactive Software Designs. 1994. XSTABL Slope Stability Computer Program. Moscow, Idaho.

# XSTABL Outputs


DPC Liner Slope
10 most critical surfaces, MINIMUM BISHOP FOS = 1.581
FS=1.6
w
w 1
970
920
870
820
770
720
Y-AXIS (feet)
0
50
100
150
200
250
300
350
400
X-AXIS (feet)

XSTABL File: LIN

```
*****************************************
*              X S T A B L              *
*                                       *
*       Slope Stability Analysis        *
*              using the                *
*           Method of Slices            *
*                                       *
*        Copyright (C) 1992 - 96        *
*   Interactive Software Designs, Inc.  *
*       Moscow, ID 83843, U.S.A.        *
*                                       *
*         All Rights Reserved           *
*                                       *
*  Ver. 5.200                96 - 1460  *
*****************************************
```

Problem Description : DPC Liner Slope

✓ JDA
8/97

---
SEGMENT BOUNDARY COORDINATES
---

7 SURFACE boundary segments

| Segment No. | x-left (ft) | y-left (ft) | x-right (ft) | y-right (ft) | Soil Unit Below Segment |
|---|---|---|---|---|---|
| 1 | .0 | 918.0 | 67.0 | 884.0 | 1 |
| 2 | 67.0 | 884.0 | 69.0 | 886.0 | 1 |
| 3 | 69.0 | 886.0 | 84.0 | 886.0 | 1 |
| 4 | 84.0 | 886.0 | 90.0 | 886.0 | 3 |
| 5 | 90.0 | 886.0 | 93.0 | 886.0 | 2 |
| 6 | 93.0 | 886.0 | 270.0 | 827.0 | 2 |
| 7 | 270.0 | 827.0 | 400.0 | 820.0 | 2 |

6 SUBSURFACE boundary segments

| Segment No. | x-left (ft) | y-left (ft) | x-right (ft) | y-right (ft) | Soil Unit Below Segment |
|---|---|---|---|---|---|
| 1 | 90.0 | 886.0 | 270.0 | 826.0 | 3 |
| 2 | 270.0 | 826.0 | 400.0 | 819.0 | 3 |
| 3 | 84.0 | 886.0 | 270.0 | 824.0 | 1 |
| 4 | 270.0 | 824.0 | 400.0 | 817.0 | 1 |
| 5 | .0 | 860.0 | 270.0 | 775.0 | 4 |
| 6 | 270.0 | 775.0 | 400.0 | 775.0 | 4 |

---
ISOTROPIC Soil Parameters
---

4 Soil unit(s) specified

| Soil Unit No. | Unit Weight Moist (pcf) | Unit Weight Sat. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Pore Pressure Parameter Ru | Pore Pressure Constant (psf) | Water Surface No. | |
|---|---|---|---|---|---|---|---|---|
| 1 | 120.0 | 120.0 | 200.0 | 20.00 | .000 | .0 | 1 | - Natural Soil |
| 2 | 110.0 | 110.0 | .0 | 30.00 | .000 | .0 | 1 | - Sand |
| 3 | 125.0 | 125.0 | 400.0 | 25.00 | .000 | .0 | 1 | - Clay Soil |
| 4 | 145.0 | 145.0 | 10000.0 | 45.00 | .000 | .0 | 1 | - Bedrock |

1 Water surface(s) have been specified

Unit weight of water = 62.40 (pcf)

Water Surface No. 1 specified by 3 coordinate points

**********
PHREATIC SURFACE,
**********

| Point No. | x-water (ft) | y-water (ft) |
|---|---|---|
| 1 | .00 | 820.00 |
| 2 | 270.00 | 785.00 |
| 3 | 400.00 | 785.00 |

A critical failure surface searching method, using a random technique for generating CIRCULAR surfaces has been specified.

400 trial surfaces will be generated and analyzed.

20 Surfaces initiate from each of 20 points equally spaced along the ground surface between x = 250.0 ft
and x = 290.0 ft

Each surface terminates between x = .0 ft
and x = 90.0 ft

Unless further limitations were imposed, the minimum elevation at which a surface extends is y = .0 ft

15.0 ft line segments define each trial failure surface.

---
ANGULAR RESTRICTIONS
---

The first segment of each failure surface will be inclined
within the angular range defined by :

Lower angular limit := -45.0 degrees
Upper angular limit := (slope angle - 5.0) degrees

Factors of safety have been calculated by the :

* * * * * SIMPLIFIED BISHOP METHOD * * * * *

The most critical circular failure surface
is specified by 16 coordinate points

| Point No. | x-surf (ft) | y-surf (ft) |
|---|---|---|
| 1 | 279.47 | 826.49 |
| 2 | 264.59 | 824.66 |
| 3 | 249.61 | 823.77 |
| 4 | 234.61 | 823.79 |
| 5 | 219.64 | 824.75 |
| 6 | 204.76 | 826.63 |
| 7 | 190.02 | 829.43 |
| 8 | 175.49 | 833.14 |
| 9 | 161.21 | 837.74 |
| 10 | 147.25 | 843.21 |
| 11 | 133.65 | 849.54 |
| 12 | 120.46 | 856.70 |
| 13 | 107.75 | 864.66 |
| 14 | 95.55 | 873.39 |
| 15 | 83.92 | 882.86 |
| 16 | 80.52 | 886.00 |

**** Simplified BISHOP FOS = 1.581 ****

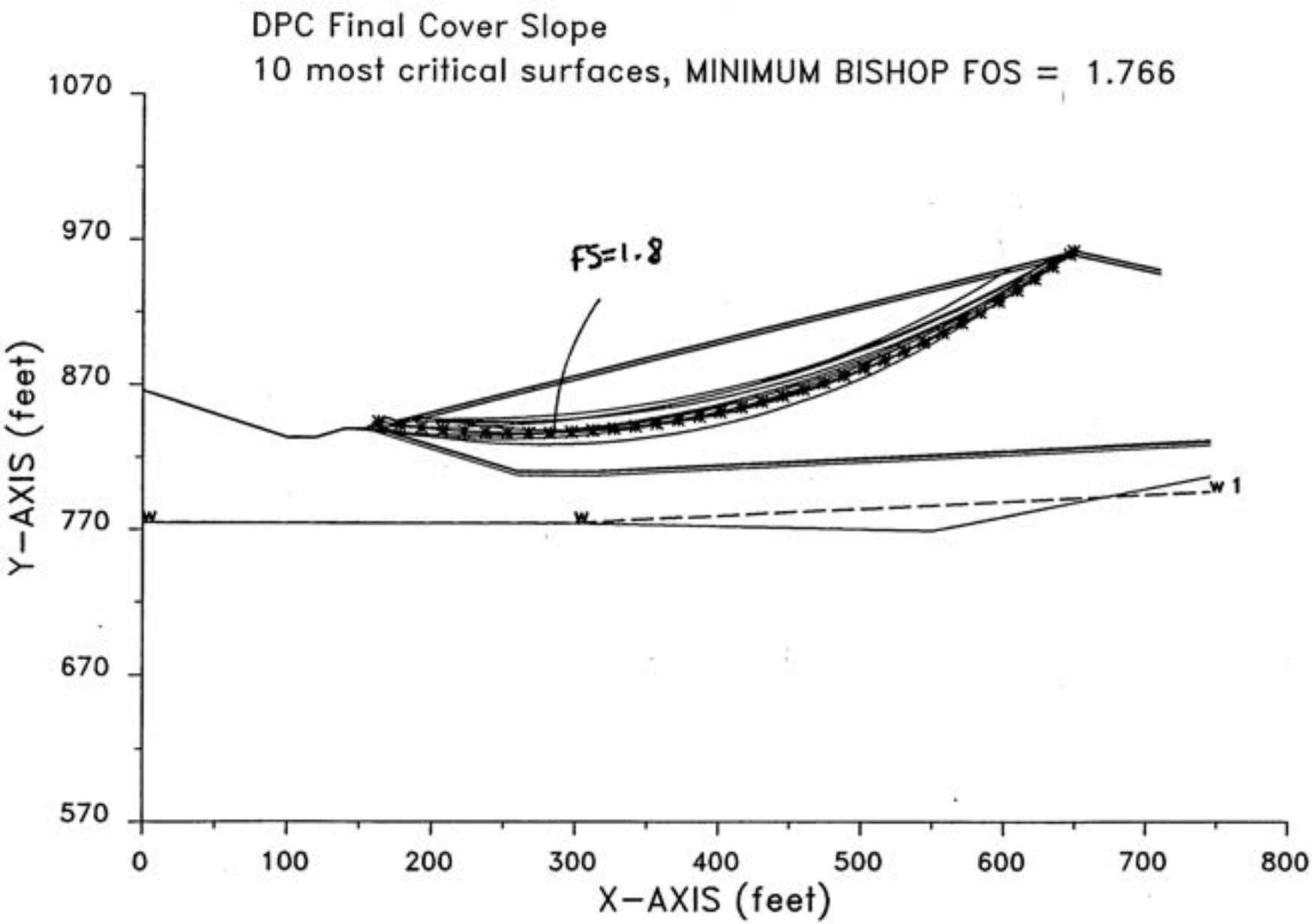
The following is a summary of the TEN most critical surfaces

Problem Description : DPC Liner Slope

| | FOS (BISHOP) | Circle Center x-coord (ft) | Circle Center y-coord (ft) | Radius (ft) | Initial x-coord (ft) | Terminal x-coord (ft) | Resisting Moment (ft-lb) |
|---|---|---|---|---|---|---|---|
| 1. | 1.581 | 242.58 | 1065.87 | 242.21 | 279.47 | 80.52 | 4.571E+07 |
| 2. | 1.583 | 240.37 | 1080.10 | 256.18 | 277.37 | 73.34 | 5.172E+07 |
| 3. | 1.588 | 217.22 | 1112.22 | 290.31 | 271.05 | 2.88 | 9.804E+07 |
| 4. | 1.588 | 222.43 | 1115.96 | 297.80 | 290.00 | .10 | 1.125E+08 |
| 5. | 1.589 | 245.92 | 1099.38 | 273.91 | 273.16 | 74.27 | 5.033E+07 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 6. | 1.590 | 228.19 | 1018.10 | 199.02 | 281.58 | 79.45 | 4.717E+07 |
| 7. | 1.590 | 246.76 | 1096.56 | 272.04 | 279.47 | 74.66 | 5.171E+07 |
| 8. | 1.590 | 219.48 | 1112.23 | 291.43 | 277.37 | 4.12 | 1.004E+08 |
| 9. | 1.592 | 215.31 | 1104.38 | 282.98 | 271.05 | 4.55 | 9.690E+07 |
| 10. | 1.592 | 227.51 | 1048.57 | 221.91 | 262.63 | 76.64 | 4.135E+07 |

* * * END OF FILE * * *


DPC Final Cover Slope
10 most critical surfaces, MINIMUM BISHOP FOS = 1.766
FS=1.8
w
w
w 1
1070
970
870
770
670
570
Y-AXIS (feet)
0
100
200
300
400
500
600
700
800
X-AXIS (feet)

XSTABL File: COVER 8-26-97 8:38

```
*****************************************
*              X S T A B L              *
*                                       *
*        Slope Stability Analysis       *
*               using the               *
*            Method of Slices           *
*                                       *
*        Copyright (C) 1992 - 96        *
*   Interactive Software Designs, Inc.  *
*        Moscow, ID 83843, U.S.A.       *
*                                       *
*          All Rights Reserved          *
*                                       *
* Ver. 5.200                96 - 1460   *
*****************************************
```

Problem Description : DPC Final Cover Slope

---

SEGMENT BOUNDARY COORDINATES

---

✓JOH 8/97

9 SURFACE boundary segments

| Segment No. | x-left (ft) | y-left (ft) | x-right (ft) | y-right (ft) | Soil Unit Below Segment |
|---|---|---|---|---|---|
| 1 | .0 | 866.0 | 100.0 | 834.0 | 1 |
| 2 | 100.0 | 834.0 | 120.0 | 834.0 | 1 |
| 3 | 120.0 | 834.0 | 140.0 | 840.0 | 1 |
| 4 | 140.0 | 840.0 | 154.0 | 840.0 | 1 |
| 5 | 154.0 | 840.0 | 168.0 | 847.0 | 2 |
| 6 | 168.0 | 847.0 | 170.0 | 847.0 | 2 |
| 7 | 170.0 | 847.0 | 175.0 | 845.0 | 2 |
| 8 | 175.0 | 845.0 | 650.0 | 964.0 | 2 |
| 9 | 650.0 | 964.0 | 710.0 | 951.0 | 2 |

17 SUBSURFACE boundary segments

| Segment No. | x-left (ft) | y-left (ft) | x-right (ft) | y-right (ft) | Soil Unit Below Segment |
|---|---|---|---|---|---|
| 1 | 162.0 | 839.4 | 650.0 | 961.5 | 2 |
| 2 | 650.0 | 961.5 | 710.0 | 948.5 | 2 |
| 3 | 164.5 | 839.6 | 650.0 | 961.0 | 5 |
| 4 | 650.0 | 961.0 | 710.0 | 948.0 | 5 |
| 5 | 164.5 | 839.6 | 260.0 | 811.0 | 2 |
| 6 | 260.0 | 811.0 | 315.0 | 811.0 | 2 |
| 7 | 315.0 | 811.0 | 745.0 | 833.0 | 2 |
| 8 | 154.0 | 840.0 | 160.0 | 840.0 | 3 |
| 9 | 160.0 | 840.0 | 260.0 | 810.0 | 3 |
| 10 | 260.0 | 810.0 | 315.0 | 810.0 | 3 |

| | | | | | |
|---|---|---|---|---|---|
| 11 | 315.0 | 810.0 | 745.0 | 832.0 | 3 |
| 12 | 154.0 | 840.0 | 260.0 | 808.0 | 1 |
| 13 | 260.0 | 808.0 | 315.0 | 808.0 | 1 |
| 14 | 315.0 | 808.0 | 745.0 | 830.0 | 1 |
| 15 | .0 | 775.0 | 300.0 | 775.0 | 4 |
| 16 | 300.0 | 775.0 | 550.0 | 770.0 | 4 |
| 17 | 550.0 | 770.0 | 745.0 | 808.0 | 4 |

---
ISOTROPIC Soil Parameters
---

5 Soil unit(s) specified

| Soil Unit No. | Unit Weight Moist (pcf) | Unit Weight Sat. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Pore Pressure Parameter Ru | Pore Pressure Constant (psf) | Water Surface No. | |
|---|---|---|---|---|---|---|---|---|
| 1 | 120.0 | 120.0 | 200.0 | 20.00 | .000 | .0 | 1 | Natural Soil |
| 2 | 110.0 | 110.0 | .0 | 30.00 | .000 | .0 | 1 | Sand |
| 3 | 125.0 | 125.0 | 400.0 | 25.00 | .000 | .0 | 1 | Clay Soil |
| 4 | 145.0 | 145.0 | 10000.0 | 45.00 | .000 | .0 | 1 | Bedrock |
| 5 | 80.0 | 80.0 | 130.0 | 20.00 | .000 | .0 | 1 | Ash |

1 Water surface(s) have been specified

Unit weight of water = 62.40 (pcf)

Water Surface No. 1 specified by 3 coordinate points

**********
PHREATIC SURFACE,
**********

| Point No. | x-water (ft) | y-water (ft) |
|---|---|---|
| 1 | .00 | 775.00 |
| 2 | 300.00 | 775.00 |
| 3 | 745.00 | 797.00 |

A critical failure surface searching method, using a random technique for generating CIRCULAR surfaces has been specified.

400 trial surfaces will be generated and analyzed.

20 Surfaces initiate from each of 20 points equally spaced along the ground surface between x = 100.0 ft
and x = 200.0 ft

Each surface terminates between x = 550.0 ft

and x = 650.0 ft

Unless further limitations were imposed, the minimum elevation at which a surface extends is y = .0 ft

15.0 ft line segments define each trial failure surface.

---
ANGULAR RESTRICTIONS
---

The first segment of each failure surface will be inclined within the angular range defined by :

Lower angular limit := -45.0 degrees
Upper angular limit := (slope angle - 5.0) degrees

Factors of safety have been calculated by the :

* * * * * SIMPLIFIED BISHOP METHOD * * * * *

The most critical circular failure surface is specified by 36 coordinate points

| Point No. | x-surf (ft) | y-surf (ft) |
|---|---|---|
| 1 | 163.16 | 844.58 |
| 2 | 178.01 | 842.44 |
| 3 | 192.90 | 840.65 |
| 4 | 207.83 | 839.20 |
| 5 | 222.79 | 838.10 |
| 6 | 237.77 | 837.34 |
| 7 | 252.76 | 836.93 |
| 8 | 267.76 | 836.86 |
| 9 | 282.76 | 837.14 |
| 10 | 297.75 | 837.77 |
| 11 | 312.72 | 838.74 |
| 12 | 327.66 | 840.06 |
| 13 | 342.57 | 841.72 |
| 14 | 357.43 | 843.72 |
| 15 | 372.25 | 846.06 |
| 16 | 387.00 | 848.75 |
| 17 | 401.70 | 851.78 |
| 18 | 416.31 | 855.14 |
| 19 | 430.85 | 858.84 |
| 20 | 445.30 | 862.87 |
| 21 | 459.65 | 867.24 |
| 22 | 473.89 | 871.94 |
| 23 | 488.03 | 876.96 |

| | | |
|---|---|---|
| 24 | 502.04 | 882.31 |
| 25 | 515.93 | 887.98 |
| 26 | 529.68 | 893.97 |
| 27 | 543.29 | 900.27 |
| 28 | 556.75 | 906.89 |
| 29 | 570.06 | 913.81 |
| 30 | 583.20 | 921.04 |
| 31 | 596.17 | 928.57 |
| 32 | 608.97 | 936.40 |
| 33 | 621.58 | 944.52 |
| 34 | 634.00 | 952.93 |
| 35 | 646.23 | 961.63 |
| 36 | 649.10 | 963.77 |

**** Simplified BISHOP FOS = 1.766 ****

The following is a summary of the TEN most critical surfaces

Problem Description : DPC Final Cover Slope

| | FOS (BISHOP) | Circle Center x-coord (ft) | Circle Center y-coord (ft) | Radius (ft) | Initial x-coord (ft) | Terminal x-coord (ft) | Resisting Moment (ft-lb) |
|---|---|---|---|---|---|---|---|
| 1. | 1.766 | 263.14 | 1487.27 | 650.42 | 163.16 | 649.10 | 3.560E+08 |
| 2. | 1.772 | 245.10 | 1579.89 | 735.11 | 184.21 | 644.14 | 3.177E+08 |
| 3. | 1.781 | 291.69 | 1377.57 | 538.73 | 189.47 | 631.14 | 2.805E+08 |
| 4. | 1.782 | 277.11 | 1389.77 | 560.64 | 157.89 | 638.35 | 3.532E+08 |
| 5. | 1.786 | 228.21 | 1584.42 | 749.38 | 142.11 | 647.53 | 4.003E+08 |
| 6. | 1.786 | 201.38 | 1697.08 | 856.23 | 157.89 | 639.17 | 3.588E+08 |
| 7. | 1.790 | 222.48 | 1597.73 | 761.99 | 142.11 | 642.84 | 3.896E+08 |
| 8. | 1.790 | 219.39 | 1665.49 | 818.94 | 184.21 | 636.06 | 3.063E+08 |
| 9. | 1.791 | 244.31 | 1492.11 | 659.28 | 147.37 | 633.16 | 3.638E+08 |
| 10. | 1.791 | 233.61 | 1533.39 | 689.57 | 178.95 | 605.85 | 2.576E+08 |

*** END OF FILE ***

# Appendix G: Construction Quality Assurance Plan

744 Heartland Trail (53717-1934)
PO Box 8923 (53708-8923)
Madison, WI
Telephone (608) 831-4444
Fax (608) 831-3334

# CQA Plan

**July 2003**
**Revised February 2007**



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# Section 1
# Introduction

## 1.1 Project Background

This report presents the Construction Quality Assurance (CQA) Plan for the Dairyland Power Cooperative (DPC) Phase IV Ash Disposal Facility. The landfill consists of approximately 32.1 acres and is owned by DPC. This site is located in the NE ¼ of the NE ¼ of Section 19 and portions of Sections 18 and 20, T21N, R12W Town of Belvidere, Buffalo County, Wisconsin.

This CQA Plan has been prepared for, and is included in, the submittal of the Plan of Operation for the DPC Phase IV Ash Disposal Facility. This CQA Plan is intended to be a "working" document, in other words, one that is updated to reflect changes in specific materials, in installation practices, industry standards, or in tests and test methods.

## 1.2 Purpose and Scope

The purpose of this CQA Plan is to address the quality assurance procedures and requirements for the construction at the proposed DPC Phase IV Ash Disposal Facility, including all earthen materials (low-permeability layer, general soil, granular soil, and topsoil) and synthetic materials (geomembrane, geotextile, geosynthetic clay liner, and piping).

This CQA Plan provides procedures that will ensure that all of the landfill components are constructed in a manner that will maximize their performance and that will safeguard components from damage during construction. The plan procedures will also ensure that the landfill (composite liner and cover) is constructed, tested, and documented in accordance with the design criteria and regulatory requirements.

The scope of this report includes general CQA requirements in regard to the roles, responsibilities, and qualifications of parties involved; the preconstruction activities; and the general inspection and documentation procedures. Specifically, this plan establishes requirements for construction procedures and observation, field and laboratory testing frequencies and methods, and acceptance criteria for each component of the composite liner and cover. Testing and acceptance criteria are based on Chapter NR 500, Wisconsin Administrative Code (WAC), requirements where applicable. Geomembrane testing and acceptance criteria are based on representative manufacturer's product data, and on current acceptable industry standards and practice.

The CQA Plan addresses the construction of the following systems within the landfill facility**:**

- Low-permeability layer
- General soil
- Granular soil
- Topsoil
- Geomembrane
- Geotextile
- Geosynthetic clay liner
- Piping

## 1.3 Quality Assurance and Quality Control

Quality assurance and quality control are defined as follows:

- Quality assurance - A planned and systematic pattern of all means and actions designed to provide adequate confidence that materials or services meet contractual and regulatory requirements. This is typically performed to ensure the purchaser, owner, and/or regulatory agencies that delivered materials or services are of desired quality.
- Quality control - Those actions that provide a means to measure and regulate the characteristics of a material or service to meet contractual and regulatory requirements. This typically is performed by, or for, the provider of materials or services as a control mechanism on the quality of the provider's efforts.

In the context of this manual, the terms are further defined as follows:

- Quality assurance refers to the means and actions employed by the CQA Officer to ensure conformity of the systems' installation with the CQA Plan and the construction plans and specifications. Quality assurance is primarily provided by an independent third party (consultant or laboratory) under the oversight of the CQA Officer.
- Quality control refers to those actions taken by the Manufacturer, Fabricator, or Contractor/Installer to provide materials and workmanship that meet the requirements of the CQA Plan and the construction plans and specifications. Some testing efforts required by this CQA Plan may serve as both quality control and quality assurance measures.

## 1.4 General Testing Requirements

This CQA Plan includes references to test procedures of the American Society for Testing and Materials (ASTM) and the Geosynthetics Research Institute (GRI). Test procedure references

are always to the latest approved version up to the date of this document, unless specifically stated otherwise in this document.

Tests will be performed in strict accordance with the referenced test procedure and the description included in this plan, unless indicated otherwise. Any deviations to test procedures called out in this plan must be approved, in writing, by the CQA Officer prior to commencement of any work.

# Section 2
# CQA Roles, Responsibilities, and Qualifications

## 2.1 CQA Officer

The CQA Officer will supervise and be responsible for all observation, testing, and related construction documentation as described in this CQA Plan. The CQA Officer will be responsible for preparing the construction documentation report to certify substantial compliance with appropriate sections of Chapter NR 500. The CQA Officer will be a Professional Engineer registered in the State of Wisconsin.

The CQA Officer may delegate daily observation and documentation, testing, and sampling duties to a qualified technician or engineer with experience in the assigned aspect of construction who will serve as the Resident Project Representative (RPR). Although these duties may be delegated, the CQA Officer will retain the responsibility for these activities.

## 2.2 Resident Project Representative (RPR)

The RPR will carry out daily observation, testing, and sampling duties under the direct supervision of the CQA Officer as required by NR 516.04. The RPR will be a qualified technician or engineer with experience in the assigned aspect of construction. The RPR will observe and document construction and installation procedures. The RPR will prepare daily summary reports and will routinely transmit these to the CQA Officer. The RPR will immediately notify the CQA Officer of problems or deviations from the CQA Plan or construction plans and specifications. Reporting, documentation, and resolution of problems and deficiencies will be carried out as described in Section 4. The RPR will not have authority to approve design or specification changes without the consent of the CQA Officer.

## 2.3 Soil Testing Laboratory

The Soil Testing Laboratory retained will be experienced in landfill construction soil testing, the American Society of Testing and Materials Standards (ASTM), and other applicable standards. The selected laboratory will be required to be responsive to the project needs by providing test results within reasonable time frames. This will include providing verbal communication on the status of ongoing tests and immediate communication of test results as needed to facilitate ongoing construction. Such information may include hydraulic conductivity test data, maximum dry density and optimum moisture content values, and borrow source characterization data. Final laboratory reports will be certified by the soil testing laboratory and submitted to the CQA Officer.

## 2.4 Geosynthetics Testing Laboratory/Laboratories

The Geosynthetics Testing Laboratory/Laboratories will have experience in testing geosynthetics in accordance with standards developed by ASTM, Geosynthetics Research Institute (GRI), and other applicable test standards. The selected laboratory/laboratories will be required to be responsive to the project needs by providing test results within reasonable time frames. Final laboratory reports will be certified by the geosynthetics testing laboratory/laboratories and will be submitted to the CQA Officer.

## 2.5 Construction Contractor

The Construction Contractor's role will be to furnish earthwork, construction, and piping installation, and to provide overall construction responsibility for the completion of the landfill facility. The Construction Contractor will be experienced in solid waste landfill construction, knowledgeable about low-permeability soil liner construction techniques, and familiar with geosynthetic installations. The term "Contractor" is used interchangeably with "Construction Contractor" in this plan.

## 2.6 Geosynthetics Installers

The Geosynthetics Installer is the company hired by the Construction Contractor or owner to install the geosynthetic components referenced in this manual and to perform the nondestructive seam testing of the geomembrane as required by this plan. The term "Installer" is used throughout this plan when reference is made to the tasks and responsibilities of a Geosynthetics Installer.

The Installer will be trained and qualified to install the various geosynthetic components covered by this plan. The Installer of the geomembranes will be approved and/or licensed by the Manufacturer.

Prior to confirmation of any contractual agreements, the Installer of the geomembrane and geosynthetic clay liner (GCL) will provide the CQA Officer with the following written information, which must be approved by the CQA Officer:

- Corporate background information.
- Installation capabilities.
  - Information on equipment and personnel
  - Quality control manual for installation
- A list of at least 10 completed facilities, totaling a minimum of 2,000,000 square feet for which the Installer has completed the installation of polyethylene geomembrane. For each installation, the following information will be provided:

- Name and purpose of facility, its location, and date of installation
- Name of owner, project manager, designer, manufacturer, and fabricator (if any)
- Thickness and type of polyethylene geomembrane and the surface area of the installed geomembrane

- A list of at least 10 completed facilities, totaling a minimum of 1,000,000 square feet for which the Installer has completed the installation of GCL. For each installation, the following information will be provided:
  - Name and purpose of facility, its location, and date of installation
  - Name of owner, project manager, designer, manufacturer, and fabricator (if any)
  - Type of GCL and the surface area of the installed GCL

All personnel performing geomembrane seaming operations will be qualified by experience or by successfully passing seaming tests for the seaming methods to be used. At least one seamer will have experience seaming a minimum of 2,000,000 square feet of polyethylene geomembrane using the same type of seaming apparatus in use at the site. The most experienced seamer, the "master seamer," will provide direct supervision, as required, over less experienced seamers. No field seaming will take place without an experienced seamer (meeting the seaming criteria stated above) being present.

The Installer will provide the CQA Officer with a list of proposed seaming and testing personnel, and their professional records, prior to installation of the geosynthetics. This document will be reviewed by the CQA Officer. Any proposed seaming personnel deemed insufficiently experienced will not be accepted by the CQA Officer or will be asked to pass a seaming test.

The Installer will designate one representative as the Superintendent, who will represent the Installer at all site meetings and who will be responsible for acting as the Installer's spokesperson on-site. This Superintendent will be prequalified for this role, on the basis of experience, management ability, and authority.

# Section 3
# Preconstruction Activities

## 3.1 Preconstruction Meeting

Prior to commencement of each phase (i.e., cell or module) of construction at the landfill facility, a preconstruction meeting will be held. This meeting will include the parties involved in the construction, including the CQA Officer or designated representative, the RPR, the Construction Contractor, the Installer, and the Owner. If the Installer does not attend the preconstruction meeting, a second meeting, the preinstallation meeting, will be conducted with the Installer.

The purpose of this meeting is to begin the planning and coordination of construction tasks; to identify potential problems that might cause difficulties and delays in construction; to properly interpret the design intent by the Contractor(s); and to present the CQA Plan to all of the parties involved. It is important that the rules regarding testing, repairs, etc., be known and accepted by each party to this plan.

Specific topics considered for this meeting include the following, but will be dependant on the presence of the Installer:

- Review critical design details of the project, including the plans and specifications.
- Review measures for surface water runoff and runon diversion control, including sump locations, siltation control, and pumping requirements.
- Make appropriate modifications to the CQA Plan; develop project-specific addendums (if necessary).
- Review the responsibilities of each party.
- Review lines of authority and communication.
- Review methods for documenting and reporting and for distributing documents and reports.
- Review requirements of the soil testing laboratory and the geosynthetics testing laboratory regarding sample sizes, methods of collection, and shipment. Also, review turn times for sample data and their implications on the construction schedule, pending receipt of acceptance data.
- Review the number and locations of the tests required for soil and geosynthetic components.

- Review precautions to be taken to maximize bonding between lifts of compacted soil.
- Review the method for splicing segments of the compacted soil liner and cover.
- Review precautions to be taken to minimize desiccation cracking of the subbase layer surfaces.
- Review methods of subbase layer surface preparation and approval prior to GCL placement.
- Establish rules for writing on the geomembrane (*i.e.*, who is authorized to write, what can be written, and in which color); and outline procedures for packaging and storing archive samples.
- Review GCL and geomembrane panel and seam layout diagrams and numbering systems.
- Establish procedures for use of the geomembrane welding apparatus.
- Establish appropriate intervals for geomembrane seamers to record operating and ambient data.
- Finalize geomembrane field cutout sample sizes.
- Review geosynthetic repair procedures.
- Review the time schedule for all operations.
- Establish procedures for deployment of materials over completed GCL and geomembranes emphasizing protection of both layers. Specific discussion will address the deployment of textured geomembrane over the GCL and the deployment of select granular fill on the sidewalls.
- Observe where the site survey benchmarks are located, and review methods for maintaining vertical and horizontal control.
- Review permit documentation requirements.
- Review the survey documentation tables and plans that identify the locations where survey documentation information is required.
- Conduct a site walk-around to review material storage locations and general conditions relative to construction.
- Set up a time and place for regular construction progress meetings.

The meeting will be documented by the RPR or CQA Officer, and minutes will be distributed to all parties involved in the construction project.

## 3.2 Preconstruction Submittal

Prior to installation of the geosynthetics in each landfill area, a preconstruction submittal will be prepared and submitted to the WDNR a minimum of 15 days prior to the preconstruction meeting or the preinstallation meeting, whichever is applicable, depending on the Installers attendance at the preconstruction meeting. The preconstruction submittal will include the following information required under s. NR 516.04(5).

- Identification of the fabricators and installers selected for geomembrane and other geosynthetics
- Final version of the construction quality assurance plan, incorporating input, if any, from the selected installers, and documenting qualifications of the third-party construction quality assurance organization and testing laboratories
- Any modifications to the installation plan, with the final proposed version of the panel layout diagrams and any revisions to details of seaming, patching, penetrations, use of prefabricated specialty sections, or repair methods

## 3.3 Preinstallation Meeting

Prior to commencement of the geomembrane installation, a preinstallation meeting will be held if the Installer is not present at the preconstruction meeting. This meeting will include the parties involved in the installation of the geosynthetics, including the RPR, the Construction Contractor, and the Installer.

The purpose of this meeting is to begin the planning and coordination of installation tasks; to identify potential problems that might cause difficulties and delays during the installation; and to present the CQA Plan to all of the parties involved. It is important that the rules regarding testing, repairs, etc., be known and accepted by each party to this plan.

Specific topics considered for this meeting include the following:

- Review critical design details of the project, including the plans and specifications.
- Make appropriate modifications to the CQA Plan; develop project-specific addendums (if necessary).
- Review the responsibilities of each party.
- Review lines of authority and communication.
- Review methods for documenting and reporting and for distributing documents and reports.
- Establish rules for writing on the geomembrane (*i.e.*, who is authorized to write, what can be written, and in which color); and outline procedures for packaging and storing archive samples.

- Review GCL and geomembrane panel and seam layout diagrams and numbering systems.
- Establish procedures for use of the geomembrane welding apparatus.
- Establish appropriate intervals for geomembrane seamers to record operating and ambient data.
- Finalize geomembrane field cutout sample sizes.
- Review geosynthetic repair procedures.
- Review the time schedule for all operations.
- Establish procedures for deployment of materials over completed GCL and geomembranes emphasizing protection of both layers. Specific discussion will address the deployment of textured geomembrane over the GCL and the deployment of select granular fill on the sideslopes.
- Review permit documentation requirements.

The meeting will be documented by the RPR or CQA Officer, and minutes will be distributed to all parties involved in the construction project.

# Section 4
# General Construction Observation and Documentation

This section describes progress meetings, general documentation procedures to be implemented, including the use of forms, the identification and resolution of problems or deficiencies, and photographic documentation.

## 4.1 Progress Meetings

Progress meetings will be held regularly at the work area. At a minimum, the meeting will be attended by field supervisory and CQA personnel. The purposes of the meeting are as follows:

- Review health and safety issues.
- Review the work activity since the last progress meeting.
- Discuss the Contractor's and Installer's personnel and equipment assignments.
- Review the work schedule.
- Discuss possible problems.
- Review any new test data.
- Review data documentation requirements.

The meetings will be documented by a person designated at the beginning of the meeting, and minutes will be transmitted to all parties.

## 4.2 Daily Reports

A daily summary report will be prepared by the CQA Officer, or the RPR under direct supervision of the CQA Officer, for each day of activity and will include the following information:

- Date, project name, location, report preparer's name, and the names of representatives on-site performing CQA under the supervision of the CQA Officer
- Time work starts and ends each construction work day, along with the duration and reason for work stoppages (*i.e.*, weather delay, equipment shortage, labor shortage, unanticipated conditions encountered, etc.)
- Data on weather conditions, including temperature, humidity, wind speed and direction, cloud cover, and precipitation

- Construction contractor's work force, equipment in use, and materials delivered to, or removed from, the job site
- Chronological description of work in progress, including locations and type of work performed
- Summary of meetings held and a list of those in attendance
- A description of materials used and references or results of testing and documentation
- Discussion of problems/deficiencies identified and corrective actions taken as described in Subsection 4.4. (Problem/Deficiency Identification and Corrective Action)
- Identification/List of laboratory samples collected, marked, and delivered to laboratories, or clear reference to the document containing such information
- An accurate record of calibrations, recalibrations, or standardizations performed on field testing equipment, including actions taken as a result of recalibrations, plus the results of other data recording, such as geomembrane seam barrel temperature.

Field data sheets containing the following information, as necessary, will be prepared daily by each representative:

- Test or sample location and elevation
- Type of documentation (e.g., field moisture/density test, etc.)
- Procedures used
- Test data (e.g., proctor value, etc.)
- Results
- Personnel involved in the documentation and sampling activities
- Signature of the person performing the documentation

## 4.3 Forms, Checklists, and Data Sheets

Additional forms may be developed during the course of the project to provide specific needs, such as geomembrane or GCL CQA documentation, or simply to improve the efficiency of data collection. New forms will be approved by the CQA Officer prior to their use.

## 4.4 Problem/Deficiency Identification and Corrective Action

Problem and/or deficiency identification and corrective action will be documented in the daily report when a construction material or activity is observed or tested that does not meet the requirements set forth in this plan. The daily report should clearly reference other reports, photographs, or forms that contain data or observations leading to the determination of a

problem or deficiency. Problem and/or deficiency identification and corrective action documentation may include the following information:

- A description of the problem or deficiency, including reference to supplemental data or observations responsible for determining the problem or deficiency.
- The location of the problem or deficiency, including how and when the problem or deficiency was discovered, and an estimate of how long the problem or deficiency has existed.
- An opinion as to the probable cause of the problem or deficiency.
- A recommended corrective action for resolving the problem or deficiency. If the corrective action has already been implemented, then the observations and documentation to show that the problem or deficiency has been resolved should be included. If the problem or deficiency has not been resolved by the end of the day upon which it was discovered, then the report will clearly state that it is an unresolved problem or deficiency. Subsequent daily reports will indicate the status of problems or deficiencies until they are resolved.

If the problem or deficiency has not been resolved, then the CQA Officer and the RPR will discuss the necessary corrective actions. The CQA Officer will work with the Owner and Construction Contractor to implement actions as necessary to resolve the problem or deficiency. A description of such problems or deficiencies and corrective actions implemented will be provided in the Construction Documentation Report.

The CQA Officer, working with the Owner and Construction Contractor, will determine if the problem or deficiency is an indication of a situation that might require changes to the plans and specifications and/or the CQA Plan. Revisions to the plans or specifications or the CQA Plan must be approved by the CQA Officer and the site Owner after consultation with the WDNR. Documentation of the WDNR's concurrence and/or conditions regarding proposed changes will be incorporated into the Construction Documentation Report.

## 4.5 Photographic Documentation

Photographs will be taken to document observations, problems, deficiencies, corrective actions, and work in progress. Photographs will be in 35-mm slide or print format or digital and will be filed in chronological order in a permanent protective file by the CQA Officer or the RPR.

The following information will be documented in the daily report or a log book for each photograph:

- Date and time
- Information regarding the orientation of the photograph itself for proper viewing (e.g., looking south)

- Description of the subject matter
- Unique identifying number for reference in reports

## 4.6 Surveying

Documentation surveying requirements for each composite liner or cover component are described in their respective report sections. Required surveying will be performed by personnel experienced in construction surveying under the supervision of the CQA Officer. Surveys will be based on survey control points previously established at the site. Elevations will be based on mean sea level (M.S.L.) datum, and coordinates will be based on the Wisconsin State Plane Coordinate System. The location of field tests and samples will be recorded. Generally, these locations can be determined by reference to nearby construction stakes or markings; however, if such convenient reference is not readily available, the CQA Officer or the designated RPR will be responsible to provide or request survey control.

# Section 5
# Low-Permeability Layer

## 5.1 General

This section includes the quality assurance requirements for placement, backfilling, and compaction of the compacted select 2-foot low-permeability subbase soil layer (low-permeability layer) as part of the landfill liner. The low-permeability layer material will be obtained from on-site excavations of loess material. All field tests, soil sample types, and survey measurements will be recorded in the daily construction reports (see Subsection 4.2) as record construction data, including locations (by coordinates) and elevations of field tests and laboratory sample points.

## 5.2 Procedures and Observation

The RPR will observe the low-permeability layer construction activities and will document relevant observations to support certification of the following requirements:

- The RPR will confirm the uniformity of the excavated soil to be used as the low-permeability layer. Soil placement will be monitored for segregation and removal of unsuitable material and for changes in soil type, color, texture, and moisture content.
- The Construction Contractor will segregate and/or remove unsuitable materials, such as granular soil, silty or sandy clay not meeting acceptance criteria, boulders, cobbles, and organic material. Due to the thin and laterally discontinuous nature of the loess material, special care will be taken during the excavation of the low-permeability layer. As determined necessary during construction, the cleanest loess deposits will be segregated for use in the final lift (below the GCL). In addition, a provision for screening will be included in the technical specifications to allow processing of the loess material if the material specifications cannot be otherwise achieved.
- The RPR will observe the placement of the low-permeability layer and will measure field densities and moisture contents, using methods described in Subsection 5.3 (Sampling Requirements and Acceptance Criteria), to document that the soil is in substantial conformance with the placement specifications and that soil placement has been conducted in a manner to achieve a uniform, homogeneous mass.
- Voids created by nuclear density gauge (NDG) probes or as the result of Shelby tube samples will be backfilled with granular bentonite.
- Areas of unacceptable density or moisture content, as defined by Subsection 5.3 (Sampling Requirements and Acceptance Criteria), will be documented by the RPR. Corrective action will consist of moisture-conditioning of the soil and/or additional compactive effort as

necessary. Methods for moisture-conditioning soil are described below. Following corrective actions, such areas will be retested.

- If necessary, surfaces of liner to receive successive lifts of low-permeable soil will be moisture-conditioned either by scarification and addition of water where desiccated, or by discing and air drying where saturated to promote effective bonding of lifts. Following scarification, water will be applied with a spray bar applicator or equivalent method to achieve uniform distribution.
- Soil placement will be performed in a manner to achieve continuous and complete keying together of low-permeable layer construction areas. Stepped joints will be utilized to connect lateral segments of low-permeable soil layer construction.
- No frozen soil will be used to construct the low-permeability layer. Frozen soil in the compaction work area will be removed.
- Stones and other penetrating objects 1 inch or larger protruding from the surface of the final lift of low-permeability layer will be removed to avoid puncturing the GCL and/or geomembrane. The RPR will observe the liner during this process and will document the removal of stones and other objects by the Contractor. Voids made by the removal of stones will be filled with low-permeable soil or bentonite, and the entire liner surface will be rolled with a smooth-drum compactor.
- Preconstruction planning will be undertaken to sequence construction activities to minimize the length of time any portion of the low-permeability layer surface will be exposed prior to receiving protective cover. Protective cover will be provided by the installation of the GCL and the geomembrane.

## 5.3 Sampling Requirements and Acceptance Criteria

Field and laboratory sampling frequencies are based on the area or volume of material placed. This section describes the required analyses, methods, sample frequencies, and acceptance limits. The RPR will perform field tests and will collect soil samples for laboratory analysis.

### 5.3.1 Field Testing

The following field testing methods will be used by the RPR during construction:

| PARAMETER | METHOD |
|---|---|
| Moisture content | ASTM D3017 |
| Soil density | ASTM D2922 Method B |

Field density and moisture content tests will be performed on a 100-foot grid pattern for each 1-foot thickness of compacted low-permeable soil placed. The testing pattern will be offset on alternate lifts. In confined areas where compaction equipment is hindered

or hand compaction is necessary, a minimum of two field density and moisture content tests will be performed for each 1-foot thickness of low-permeable soil placed.

#### *Field Testing Acceptance Criteria*

Acceptance criteria for field density will require soil compaction to a minimum of 90 percent of the Modified Proctor (ASTM D1557) maximum dry density. Moisture content requirements will be at least wet of optimum. The acceptable range will be based on Proctor moisture-density relationships and compaction versus permeability relationships.

### 5.3.2 Laboratory Testing

Routine laboratory testing of the low-permeability layer will be performed on samples from the soil borrow area and on the in-place soil samples collected by the RPR. Samples for determining in-place properties will be collected by pushing Shelby tubes. Soil characteristics will be determined from representative samples and from Shelby tube samples.

#### *Undisturbed Sample Analysis*

One undisturbed sample will be taken for each acre or less for every 1-foot thickness of soil placed and will be submitted to the Soil Testing Laboratory.

The following analyses will be performed on all undisturbed samples obtained:

| PARAMETER | TEST METHOD |
|---|---|
| Moisture content and dry density | ASTM D2216 |

#### *Representative Sample Analysis*

Representative (grab) samples will be obtained on the basis of three criteria. First, an initial sample will be obtained from the borrow source and analyzed prior to construction. This will confirm soil characteristics and provide an initial maximum dry density and optimum moisture content for field moisture/density testing. Second, routine samples will be obtained for every 5,000 cubic yards placed. Third, in the event that changes in physical appearance or soil characteristics are observed, a sample will be obtained and analyzed. The maximum dry density and optimum moisture content values used for compaction testing may be adjusted during the course of liner construction based on the results of the above sampling.

The following laboratory analyses will be performed on all representative samples obtained:

| PARAMETER | TEST METHOD |
|---|---|
| Moisture-density relationship using Modified/Standard Proctor compaction | ASTM D1557 [a, b]/ ASTM D698 [a, b] |

Notes:
[a] Five-point Proctor analysis required for first and second sampling criteria.
[b] A one-point Proctor analysis may be utilized for representative samples collected for the third sampling criteria (apparent changes in soil quality) to verify applicability of previously analyzed moisture-density relationships. If the result does not verify applicability, then a five-point analysis will be performed in accordance with the first sampling criteria.

## 5.4 Thickness Documentation

The top of the low-permeability layer grades will be surveyed on the same 50-foot grid pattern and key locations surveyed for the subbase grades. Key locations include breaks in grade, toes of slopes, mid-points, and tops of sideslopes. In the alignment for leachate collection lines, bottom of trench elevations will be surveyed at 25-foot intervals (or 50-foot intervals if a total station or laser equipment is used to set elevations) in the same locations surveyed for trench undercuts. The low-permeability layer thickness will be determined at surveyed locations and reported in a tabular fashion. The minimum acceptable liner thickness will be 2 feet (-0.0/+0.1 foot).

# Section 6
# General Soil

## 6.1 General

This section includes the quality assurance requirements for placement, compaction, and grading of general soil (i.e., general fill). General soil may be any inorganic soil. General soil will be used in the construction of the following landfill components:

- Final cover
- Access roads
- Berms

All field tests, soil sample types, and survey measurements will be recorded in the daily summary reports (see Subsection 4.2) as record construction data, including locations (by coordinates) and elevations of all field tests and laboratory sample points.

## 6.2 Procedures and Observation

The RPR will observe general soil placement activities and will document relevant observations to support certification of the following requirements:

- The RPR will periodically observe loads of general fill for general conformance to material specifications and may randomly sample loads. The RPR will perform routine conformance sampling as defined in Subsection 6.3.2.
- General soil used as the grading layer will have no stones or other penetrating objects 1 inch or larger protruding from the surface of the final lift. The RPR will observe the grading layer during placement and will document the removal of stones and other objects by the contractor. Voids made by the removal of items will be filled with general fill or bentonite, and the entire layer will be rolled with a smooth-drum compactor.
- No frozen soil will be used for backfilling. Any frozen soil in the compaction work area will be removed.
- Loose lift thickness for general soil compaction will not exceed 18 inches.
- General soil used as structural fill (e.g., access roads and berms) will be placed with a compacted effort to achieve a minimum of 90 percent or 95 percent of the maximum dry density as determined by the modified or standard Proctor test, respectively.

- Unacceptable compaction density, as defined above, will be reported to the CQA Officer by the RPR. Corrective action will consist of moisture-conditioning of the soil and/or additional compactive effort as necessary.

Field densities using methods described in Subsection 6.3.1 will be measured to document that the in-place soil is in substantial conformance with the required density.

## 6.3 Sampling Requirements and Acceptance Criteria

No field or laboratory testing of general soil will be required.

Routine laboratory testing of the general soil will be performed on samples from the general soil borrow area or stockpile for general soil used as structural fill. The following laboratory test method will be performed by the Soil Testing Laboratory on samples collected by the RPR:

| PARAMETER | TEST METHOD |
|---|---|
| Moisture/Density using Modified or Standard Proctor compaction | ASTM D1557 or ASTM D698 |

Samples of the borrow area or stockpiled soil will be collected by the RPR prior to the use of the material and whenever physical appearance or other changes are noticeable. These samples will be submitted to the Soil Testing Laboratory for the above testing.

## 6.4 Thickness Documentation

Base and top of subbase grades for the final cover grading layer will be documented on an approximate 100-foot grid for cells larger than 4 acres and on an approximate 50-foot grid for cells smaller than 4 acres, and at other key locations, such as breaks in grade, toes of slope, mid-points, and tops of slopes. In the alignment for leachate collection undercuts, the bottom of trench undercut elevations will be surveyed at 25-foot intervals. The minimal acceptable thickness will be 6 inches. The allowable tolerance in elevation will be ±0.1 foot.

Top of final cover rooting zone grades will be surveyed on an approximate 100-foot grid for cells larger than 4 acres and on an approximate 50-foot grid for cells smaller than 4 acres, and at other key locations, such as breaks in grade and toes of slopes. The minimum acceptable thickness will be 1.0 foot. The allowable tolerance in elevation will be ±0.1 foot

In addition to survey measurements for elevation, measurements for horizontal location will also be performed using previously established horizontal control to document the boundaries and alignment of the general soil placement.

# Section 7
# Granular Soil

## 7.1 General

Granular soil includes select granular fill and pipe bedding material. Select granular fill refers to material used for the granular drainage layer overlying the geomembrane liner and for the granular drainage layer in the final cover. The pipe bedding material refers to the gravel to be used for structural support of the leachate collection pipes. Limestone and dolomite stone will not be used in the leachate collection system unless no other suitable material is reasonably available. The gravel should be rounded to subangular.

## 7.2 Procedures and Observation

The RPR will observe granular soil placement activities and will document relevant observations to support certification of the following requirements:

- The RPR will periodically observe loads of granular soil for general conformance to material specifications and may randomly sample loads. The RPR will perform routine conformance sampling as defined in Subsection 7.3.
- Guidance will be provided to the machine operators placing soil on the geomembrane by the use of an observer with an unobstructed view of the advancing lift of granular soil.
- No trucks or heavy equipment will travel directly on the geomembrane. Only low-ground pressure tracked equipment (< 5 psi) may operate over the geomembrane when there is a minimum 12-inch–thick layer of select granular fill in-place. Flotation tire-equipped vehicles and tracked vehicles may not travel over the geomembrane unless a minimum of 2 feet of select granular fill are in place. Traditional rubber-tired equipment may not travel over the geomembrane unless a minimum of 3 feet of select granular fill are in place. Procedures for deployment of pipe, sand, gravel, and/or geotextiles overlying geomembranes will be planned at the preconstruction meeting. Special requirements for geomembrane protection and equipment necessary to deploy materials must be approved by the CQA Officer.
- Care will be exercised during placement of granular soil to prevent undue damage to pipes, geomembrane, and geotextiles. Stone will not be dropped from a height greater than 3 feet above the pipe trench.
- A geotextile cushion will be placed between the geomembrane and the pipe bedding material placed in the leachate collection trenches.

- A minimum of 4 inches of pipe bedding material will be placed under leachate collection pipes prior to pipe placement, and a minimum of 12 inches of bedding material will be placed over the top of the leachate collection pipes.
- If granular soil is stockpiled on-site prior to use, measures will be taken to minimize contamination by fines such as wind-blown particles and surface soil during loading operations.

## 7.3 Sampling Requirements and Acceptance Criteria

Field sampling and laboratory testing frequencies are based on proportionate sampling of construction areas or volumes of material placed as specified by s. NR 516.06. This section describes the required analyses, methods, sampling frequencies, and acceptance limits. The RPR will collect soil samples for laboratory analysis.

### 7.3.1 Field Testing

No field testing will be required for select granular fill or pipe bedding material soil. However, as stated in Subsection 7.2 above, the RPR will perform a visual inspection of this soil for conformance to material specifications and may randomly sample deliveries.

### 7.3.2 Laboratory Testing

Representative (grab) samples will be obtained from the proposed select granular fill and pipe bedding material sources prior to delivery of the material. The source sampling frequency will be dependent on the apparent uniformity of the source and must be approved by the CQA Officer.

Grab samples of granular material placed will be collected and analyzed as follows:

| SOIL TYPE | FREQUENCY | PARAMETER | TEST METHOD |
|---|---|---|---|
| Select granular fill | 1/1,000 CY [a, b] | Grain size | ASTM D422[c] |
| Select granular fill | 1/2,500 CY [b, d] | Remolded hydraulic conductivity | ASTM D2434 |
| Pipe bedding material | 1/1,000 LF of trench [e] | Grain size | ASTM D422[c] |
| Pipe bedding material (solid-wall leachate or transfer pipes) | 1/1,000 LF of trench | Grain size | ASTM D422[f] |

Notes:
[a] For lesser volumes, a minimum of four samples will be tested.
[b] This frequency may be reduced for uniform sources. Proposed reductions will be submitted for WDNR approval prior to implementation.
[c] Testing is required only to the #200 sieve.
[d] For lesser volumes, a minimum of two samples will be tested.
[e] For documentation areas with less than 3,000 feet of pipe trench, a minimum of three samples will be tested.
[f] Testing is required only to the #4 sieve.

#### *Laboratory Testing Acceptance Criteria*

Select granular fill material will contain no more than 5 percent by weight of fines passing the #200 sieve, will have a uniformity coefficient less than 4 for gravelly soil and less than 6 for sandy soil, and will have a remolded hydraulic conductivity of $1 \times 10^{-2}$ cm/s or greater at the anticipated field density. Select granular fill with material retained on the #4 sieve will require a geotextile cushion between the geomembrane and select granular fill (see Section 9). Pipe bedding material will have a uniformity coefficient less than 4, will contain no more than 5 percent by weight passing the #4 sieve, will have a maximum particle diameter of ½ inch, and will have a rounded to subangular particle shape.

## 7.4 Thickness Documentation

The finished elevation of the select granular fill drainage layer portion of the composite liner system will be surveyed on a 50-foot grid. The finished elevation of the select granular fill drainage layer portion of the final cover system will be surveyed on a 100-foot grid (50-foot grid for areas less than 4 acres). The minimum acceptable drainage layer thickness will be 12 inches (-0.0/+0.2 foot). Gravel placed along collection pipe alignments will be surveyed for elevation prior to pipe placement and following pipe backfilling at 25-foot intervals (50-foot intervals if a total station or laser equipment is used to set elevation) to document the thickness of gravel placed below pipe inverts and above the top of pipe.

# Section 8
# Topsoil

## 8.1 General

This section includes the quality assurance requirements for the excavation and placement of the topsoil and for the fertilization, seeding, mulching, and watering of the topsoil layer for vegetation. Topsoil is the final layer of soil material installed on the final cover, along the outside slopes of the perimeter berms, along the ditches, and on other perimeter areas. Topsoil will be obtained from on-site stockpiles created by the clearing of the landfill footprint and associated disturbed perimeter areas.

## 8.2 Procedures and Observation

Work covered by this section will be performed in accordance with the construction plans and specifications. The RPR will observe topsoil placement activities and will document relevant observations to support certification of the following requirements:

- The RPR will confirm the source and uniformity of topsoil used. Soil excavation and placement will be monitored for minimization of inorganic soil not compatible for establishment of vegetation.
- Prior to seeding, the topsoil will be worked to prepare a suitable seedbed.
- Fertilizing, seeding, and mulching will be performed in a timely manner.

## 8.3 Sampling Requirements and Acceptance Criteria

The topsoil will be suitable for the establishment and long-term maintenance of the selected vegetation seed mix with appropriate fertilization. At the RPR's discretion, or if required by the construction specifications, samples will be collected for laboratory testing.

## 8.4 Surveying

The thickness of topsoil placement will be documented on a 100-foot grid for cells larger than 4 acres and on a 50-foot grid for cells smaller than 4 acres by surveying or by hand shoveling and measuring the observed thickness of topsoil.

# Section 9
# Geomembrane

## 9.1 General

This section of the CQA Plan applies to the high-density polyethylene (HDPE) geomembrane used in the landfill composite liner and the very flexible polyethylene (VFPE) geomembrane, or equal, used in the composite final cover.

The geomembrane will be supplied to the site in factory rolls. No factory seams will be used to prepare larger panels of geomembrane for delivery to the site. This plan, therefore, does not contain any QA/QC requirements for factory seaming.

This section is divided into four major subheadings, which cover the CQA requirements for the preinstallation (includes Resin Manufacturers and Geomembrane Manufacturers), installation, field seaming, and post-installation (includes the final examination of the geomembrane prior to placing the appropriate material above the geomembrane). The terms preinstallation, installation, field seaming, and post-installation are applicable only to the geomembrane installation and do not apply to the overall construction of the landfill facility.

## 9.2 Preinstallation

This section describes the quality control measures that are applicable to the polyethylene (PE) Resin Manufacturers and Geomembrane Manufacturers, and to the delivery of the finished geomembrane roll to the site.

The geomembrane must be fabricated from polyethylene resin. The resin from which the geomembrane is made will have a density range of 0.940 g/cc or higher for HDPE and 0.939 g/cc or less for VFPE. In addition, the geomembrane will have a melt index value per ASTM D1238 of less than 1.0 g per 10 minutes for HDPE and 0.6 g per 10 minutes for VFPE. The resin shall be virgin material with no more than 10 percent rework. If rework is used, it must be of the same formulation as the parent material. No post-consumer resin (PCR) of any type shall be added to the formulation.

In the event that, during the course of construction, geomembrane materials are obtained from a different manufacturer or are made from different resins, seam samples formed by joining the original and the proposed geomembrane will be tested to confirm the construction compatibility of the two geomembrane materials. Prior to the use of the new geomembrane material, a minimum of two seamed samples (as described above) will be submitted to the geosynthetics

laboratory for destructive seam testing as described in Subsection 9.4.5. The CQA Officer will review the testing results prior to authorizing the use of the new geomembrane material.

### 9.2.1 Manufacturing

#### *Material Specifications*

The following list specifies the required membrane materials for liner and final cover construction:

| | |
|---|---|
| Base liner sideslopes (3H:1V typical) | 60-mil HDPE-textured |
| Base liner | 60-mil HDPE (textured optional) |
| Final cover top (5 percent slope) | 40-mil VFPE (textured optional) |
| Final cover sideslopes (4H:1V typical) | 40-mil VFPE (textured) |

#### *Quality Control Requirements*

Prior to the delivery of any geomembrane rolls to the site, the Geomembrane Manufacturer will provide the CQA Officer with the following information:

- The Resin Supplier's name, the location of the Resin Supplier's production plant(s), and the resin brand name and product number
- Any results of tests conducted by the Geomembrane Manufacturer's and/or the Resin Manufacturer's testing laboratories to document the quality of the resin used in fabricating the geomembrane
- The Quality Control Plan that the Geomembrane Manufacturer will be using for the geomembrane being supplied

Every roll of geomembrane for delivery to the site must be manufactured and inspected by the Geomembrane Manufacturer according to the following requirements:

- First quality polyethylene resin must be used.
- The geomembrane must contain no more than a maximum of 1 percent by weight of additives, fillers, or extenders, excluding carbon black.
- Carbon black for ultraviolet protection shall be added during manufacturing of the geomembrane.
- The geomembrane must be free of holes, blisters, undispersed raw materials, or any other sign of contamination by foreign matter.

The Geomembrane Manufacturer will routinely perform specific gravity (ASTM D792) and melt index (ASTM D1238) tests on the raw resin to document the quality of the HDPE and VFPE resin used to manufacture the geomembrane rolls assigned to this project. The results will be submitted to the CQA Officer, prior to the acceptance of the geomembrane.

#### *Manufacturer's Certification*

The Geomembrane Manufacturer will test the geomembrane produced for the site according to the test methods and frequencies listed in Table 9-1. The Geomembrane Manufacturer will provide certification, based on tests performed by either the Geomembrane Manufacturer's laboratory or other outside laboratory contracted by the Geomembrane Manufacturer, that the geomembrane supplied under this plan will meet the specifications presented in Tables 9-2 and 9-3. Additionally, the Geomembrane Manufacturer will provide certification that the Manufacturer's Quality Control Plan was fully implemented for the geomembrane material supplied under this plan. The Geomembrane Manufacturer will provide documentation to verify results of the Manufacturer's Quality Control Plan implementation if requested by the CQA Officer.

### 9.2.2 Delivery, Handling, and Storage of Geomembrane Rolls

The geomembrane will be protected during shipment from excessive heat or cold, puncture, cutting, or other damaging or deleterious conditions. The geomembrane rolls will be stored on-site in a designated area and will be protected from long-term ultraviolet exposure prior to actual installation.

Each geomembrane roll will be marked by the Geomembrane Manufacturer with the following information (on a durable gummed label, or equivalent, on the inside of core):

- Name of manufacturer
- Product type and identification number (if any)
- Roll length and width
- Batch (or lot) number
- Nominal product thickness
- Date of manufacture
- Roll (or field panel) number

**Table 9-1**
**HDPE and VFPE Geomembrane Tests and Test Methods**

| PROPERTY | TEST METHOD | MINIMUM TESTING FREQUENCY [1] |
|---|---|---|
| Carbon black content | ASTM D4218 | 1/68,000 sf |
| Carbon black dispersion | ASTM D5596 | 1/154,000 sf |
| Density | ASTM D792 or D1505 | 1/100,000 sf |
| Melt flow index | ASTM D1238 with load of 2.16 kg at 190°C | 1/100,000 sf |
| Tear resistance [2] | ASTM D1004 | 1/154,000 sf |
| Puncture resistance | ASTM D4833 | 1/154,000 sf |
| Tensile properties [2]<br>Yield stress<br>Yield elongation<br>Break stress<br>Break elongation | ASTM D638<br>HDPE - Type IV specimen at 2 inches/minute<br>VFPE - Type IV specimen at 20 inches/minute | 1/100,000 sf |
| Single-point notched constant load (SPNCL) | ASTM D5397 | 1/resin batch |
| Thickness | ASTM D5199 (smooth)<br>ASTM D5994 (textured) | 5 times/roll |

Notes:
(1) The Geomembrane Manufacturer will perform quality control testing at the specified frequencies (minimum) on geomembrane rolls to be supplied for this project.
(2) These tests will be performed and results will be reported for both machine and cross direction.

**Table 9-2**
**60-mil HDPE Geomembrane Acceptance Criteria**

| PROPERTY | UNITS | TYPE OF CRITERION | ACCEPTABLE VALUE [1] |
|---|---|---|---|
| Carbon black content | % by weight | Range | 2 - 3 |
| Carbon black dispersion | NA | Range | Category 1, 2 or 3 [2] |
| Density | NA | Minimum avg. | 0.940 |
| Tear resistance [3] | lb | Minimum avg. | 42 |
| Puncture resistance | lb | Minimum avg. | 108 (90) [4] |
| Tensile properties [3] | | | |
| Yield stress | ppi | Minimum avg. | 126 |
| Yield elongation | % | Minimum avg. | 12 |
| Break stress | ppi | Minimum avg. | 228 (90) [4] |
| Break elongation | % | Minimum avg. | 700 (100) [4] |
| SPNCL | hours | Minimum avg. | 200 |
| Thickness (lowest individual) [5] | mils | Minimum avg. | 54 (51)[4] |
| Thickness (minimum average) | mils | Minimum avg. | 60 |

Notes:
(1) Values are based on representative manufacturer's product data.
(2) For 10 different views, nine must be Category 1 or 2, and one must be Category 3.
(3) Test is performed in both machine and cross direction.
(4) Parenthetical values are for textured geomembrane.
(5) For smooth geomembrane, lowest individual value of 10 values; for textured geomembrane, lowest individual value for 8 out of 10 values.

**Table 9-3**
**40-mil VFPE Geomembrane Acceptance Criteria**

| PROPERTY | UNITS | TYPE OF CRITERION | ACCEPTABLE VALUE [1] |
|---|---|---|---|
| Carbon black content | % by weight | Range | 2 - 3 |
| Carbon black dispersion | N/A | Range | Category 1, 2, or 3 [2] |
| Density | N/A | Maximum | 0.939 |
| Puncture resistance | lb | Minimum | 52 |
| Tear resistance [3] | lb | Minimum | 22 |
| Tensile properties [3] | | | |
| Break stress [5] | ppi | Minimum | 152 (72) [4] |
| Break elongation | % | Minimum | 625 (200) [4] |
| SPNCTL | hours | Minimum | 200 |
| Thickness (lowest individual) [5] | mils | Minimum | 36 (34) [6] |
| Thickness (minimum average) | mils | Average | 40 |

Notes:
(1) Values are based on representative manufacturer's product data.
(2) For 10 different views, nine must be Category 1 or 2, and one must be Category 3.
(3) Test performed in both machine and cross direction.
(4) Parenthetical values are for textured geomembrane.
(5) For smooth geomembrane, lowest individual value of 10 values; for textured geomembrane, lowest individual value for 8 of 10 values.
(6) For textured geomembrane, lowest individual value of any of the 10 values.

When cores are required for preparing the geomembrane for shipment, the Manufacturer will use cores with sufficient crushing strength to prevent collapse or other damage while in use.

The following practices will be used as a minimum in receiving and storing geomembrane rolls in the designated storage area at the job site:

- While unloading or transferring the geomembrane rolls from one location to another, care will be taken to prevent damage to the geomembrane itself. The preferred method involves using a spreader-bar, straps, and a loader. Rolls will not be dragged.
- Geomembrane rolls will be stored in a manner so as to ensure that they are adequately protected from the following:
    - Equipment damage
    - Strong oxidizing chemicals, acids, or bases
    - Flames, including welding sparks
    - Temperatures in excess of 160°F
    - Dust and dirt

The RPR will observe and document, throughout the preinstallation, installation, and post-installation periods that the Installer provides adequate handling equipment for moving geomembrane rolls and that the equipment and the handling methods used do not pose unnecessary risk of damage. The Installer will be responsible for the means and methods to implement the work.

The Installer will be responsible for ensuring that all materials installed meet specifications (*i.e.*, that the roll marking label information indicates required specifications and properly represents materials). The RPR will maintain a log of geomembrane roll deliveries. The following information, at a minimum, will be recorded on the log for each shipment received at the job site:

- Date of delivery at job site
- For each geomembrane roll, the following information:
    - Roll number
    - Batch (lot) number

## 9.3 Installation

This section includes discussions of geomembrane roll testing requirements, earthwork required for geomembrane placement, placement of the geomembrane, defects and repairs of geomembrane, and requirements applicable to other materials in contact with the geomembrane. Subsection 9.4 describes the installation and testing requirements for geomembrane seams.

***All parties involved in the installation of the geomembrane will be familiar with geomembrane and will focus on protecting the geomembrane from damage during construction activities.***

### 9.3.1 Testing Requirements

This subsection describes the test methods, including sampling procedures and frequencies, and the role of the geosynthetics testing laboratory in testing the geomembrane roll samples. Subsection 9.2.1, under Quality Control Requirements, describes the test methods that are performed on an infrequent basis to demonstrate the uniformity of resin used to fabricate geomembrane shipped to the job site. Seam testing is described in Subsections 9.4.4 and 9.4.5.

#### *Test Methods*

Geomembrane roll samples will be collected by the RPR at the rate of one sample per 100,000 square feet of geomembrane delivered to the site. At least one sample will also be obtained for each geomembrane production batch in each shipment. The Installer will not ship to, or receive at, the site, geomembrane from more than two production batches in any single shipment without the prior written approval of the CQA Officer.

Samples will be 3 feet long by the full width of the roll and will not include the first 3 feet of any roll. Since machine direction for geomembrane rolls is the direction in which the material comes off the roll, machine direction for any sample will always be along the 3-foot length of the sample.

Tables 9-1, 9-2 and 9-3 list the tests and the test methods to be performed on the HDPE and VFPE geomembrane roll samples. The specifications and methods used in evaluating the results are discussed below under Procedures for Determining Geomembrane Roll Test Failures. Unless specified otherwise, sample specimens will be prepared in accordance with the referenced test method. The results for tear resistance and each of the tensile property tests will be reported for both the machine and cross direction.

### *Role of Testing Laboratory*

The geosynthetics testing laboratory will be responsible for performing the tests on samples submitted to them as described above under Test Methods. The results of the tests performed will be reported to the CQA Officer and the RPR.

Retesting of geomembrane rolls for quality assurance purposes because of failure to meet any or all of the acceptance specifications listed in Tables 9-2 and 9-3 can only be authorized by the CQA Officer.

The Geomembrane Manufacturer and/or Installer may perform their own tests according to the methods and procedures defined in Table 9-1; however, the results will only be applicable to their own quality control needs. These results will not be substituted for the quality assurance testing described herein.

### *Procedures For Determining Geomembrane Roll Test Failures*

Tables 9-2 and 9-3 list the acceptance specifications for HDPE and VFPE geomembranes. These tables apply to both textured and smooth geomembranes. For those tests where results are reported for both machine and cross direction, each result will be compared to the listed specification to determine acceptance. The HDPE geomembrane values listed in the acceptance specifications of Table 9-3 are based on representative manufacturer's product data for smooth and textured HDPE geomembrane.

The VFPE geomembrane acceptance values listed in Table 9-3 are based on the review of product literature from several geomembrane manufacturers. Textured geomembranes will be required to meet the same specifications listed for nontextured geomembranes unless otherwise noted.

The following procedure will be used for interpreting results:

- If the test values meet the specifications stated in Tables 9-2 and 9-3, then the roll and the lot will be accepted for use at the job site. If the sample represents all rolls from an entire shipment, then the entire shipment will also be considered accepted.
- If the result does not meet the specifications, then the roll and the batch may be retested using specimens either from the original roll sample or from another sample collected by the RPR. For retesting, two additional tests will be performed for the failed test procedure. (Each additional test will consist of multiple specimen tests if multiple specimens are called for in the test procedure.) If both of the retests are acceptable, then the roll and

batch will be considered to have passed this particular acceptance test; if either of the two additional tests fail, then the roll and batch will be considered unsuitable without further recourse. The CQA Officer may obtain samples from other rolls in the batch. On the basis of testing these samples, the CQA Officer may choose to accept a portion of the batch while rejecting the remainder.

- If retesting does not result in passing test results as defined in the preceding paragraph, or if there is any other nonconformity with the material specifications, then the Installer will withdraw the rolls from use in the project at the Installer's sole risk, cost, and expense. The Installer will be responsible at his/her sole risk, cost, and expense for removing this geomembrane from the site and replacing it with acceptable geomembrane.

### 9.3.2 Earthwork

The Construction Contractor will be responsible for preparing the supporting soil according to the plans and specifications and Section 5 of this CQA Plan. The geomembrane will be deployed directly above the geosynthetic clay liner (GCL). Prior to the installation of the GCL, the Installer will certify in writing that the surface on which the GCL/geomembrane will be installed is acceptable. This certification of acceptance will be reported by the Installer prior to the start of GCL/geomembrane installation in the area under consideration. Unacceptable areas noted by the Installer will be immediately reported to the RPR.

The soil surface will also be examined by the RPR to evaluate any areas softened by precipitation or cracked due to desiccation. The daily observation will be documented in the daily report. Areas determined to be unacceptable will be reworked by the Construction Contractor until acceptable.

### 9.3.3 Placement

#### *Location and Panel Layout Drawing*

A panel layout drawing for the geomembrane installation covered by this plan will be prepared by the Installer prior to installation and submitted to the CQA Officer, showing the proposed location and orientation of geomembrane panels to be installed in relation to slope, collection trenches, anchor trench and phase boundaries, seaming methods, and phased construction. This panel layout drawing will be submitted to the WDNR in a preconstruction or preinstallation submittal prior to construction. The CQA Officer will review the panel layout

drawing and document that it is consistent with accepted practice and the construction plans and specifications. Geomembrane panels and seams will be identified by the RPR by the corresponding geomembrane roll number on the layout drawing as they are installed.

### *Installation Techniques*

Geomembrane panels will be installed by placing one at a time, and each panel will be seamed by the end of the day on which it was placed. The RPR will document that the condition of the supporting surface has not changed detrimentally during installation. The RPR will record the roll number, location, and date of each geomembrane panel installed.

The Installer will take the following precautions while installing the geomembrane:

- Ensure that the equipment used does not damage the geomembrane by the way it is handled, by excessive heat, by leakage of hydrocarbons, or by other means.
- Ensure that personnel working on the geomembrane do not smoke, wear damaging clothing, or engage in other activities that could damage the geomembrane.
- Ensure that the method used to unroll the geomembrane does not cause scratches or crimps in the geomembrane and does not damage the GCL or supporting soil.
- Ensure that the method used to place the rolls minimizes wrinkles (especially differential wrinkles between adjacent panels).
- Ensure that adequate temporary loading or anchoring (continuously placed, if necessary), which will not damage the geomembrane, is placed to prevent uplift by the wind.
- Ensure that direct contact with the geomembrane is minimized. The geomembrane will be protected by geotextile, extra geomembrane, or other suitable materials, in areas where excessive traffic may be expected.

### *Weather Conditions*

Geomembrane will not be placed in an area of ponded water, during precipitation events, or in the presence of excessive winds (greater than 20 mph). The RPR will document that this condition is fulfilled. The CQA

Officer will stop or postpone geomembrane placement when conditions are unacceptable.

#### *Damages*

The RPR will examine each panel for damage after placement and will determine which panels, or panel portions, should be rejected, repaired, or accepted. Damaged panels or panel portions that have been rejected will be marked, and their removal from the site will be recorded by the RPR. Panel repairs will be made according to the procedures described in Subsection 9.3.4.

### 9.3.4 Defects and Repairs

This section applies to all defects and repairs resulting from examinations, tests, or visual observations performed on the geomembrane material itself and on the seams used in joining rolls in the field.

#### *Identification*

All seam and nonseam areas of the geomembranes will be examined and documented by the RPR for identification of defects, holes, blisters, undispersed raw materials, and any signs of contamination by any foreign matter. Because light reflected by the geomembrane helps to detect defects, the surface of the geomembrane will be clean at the time of examination. The geomembrane surface will be swept with a broom and/or washed by the Installer if the amount of dust or mud inhibits examination.

#### *Evaluation*

Each suspect area identified will be nondestructively tested using the vacuum box test method described in Subsection 9.4.4. Each location that fails the nondestructive tests will be marked by the RPR and repaired by the Installer.

#### *Repair Procedures*

Any portion of the geomembrane exhibiting a flaw or failing a destructive or nondestructive test will be repaired. Several procedures exist for the repair of these areas. The procedures available include the following:

- Patching is used to repair large holes, tears, undispersed raw materials, and contamination by foreign matter.
- Grinding and rewelding are used to repair small sections of extruded seams.

- Spot welding or seaming is used to repair small tears, pinholes, or other minor, localized flaws.
- Capping is used to repair large lengths of failed seams.
- Topping is used to repair areas of inadequate seams that have an exposed edge.
- Other procedures may be used at the recommendation of the Installer if agreed upon by the CQA Officer and the RPR.

The repair procedures, materials, and techniques will be approved in advance of the specific repair by the CQA Officer, RPR, and Installer. At a minimum, the following provisions will be satisfied:

- Patches or caps will extend at least 6 inches beyond the edge of the defect, and all corners of patches will be rounded with a radius of at least 3 inches.
- The geomembrane below large caps will be appropriately cut to avoid water or gas collection between the two sheets.

### *Examination of Repairs*

Each repair will be numbered and logged by the RPR. Each repair will be nondestructively tested according to Subsection 9.4.4. Repairs that pass the above testing will be considered to be adequate, except that large caps may be of sufficient extent to require destructive seam sampling and testing, at the discretion of the RPR, according to the provisions of Subsection 9.4.5.

Failed tests indicate that the repair was inadequate, and the repair will be redone and retested until a passing result is obtained. The RPR will document that all repairs have been subjected to nondestructive testing and will record the number of each repair, the date, and the test outcome.

### *Large Wrinkles*

When seaming of the geomembrane is completed, the RPR will examine the geomembrane for wrinkles and determine which wrinkles should be cut and seamed by the Installer. The wrinkle repair will be done in accordance with the equipment and procedures described in Subsections 9.4.2 and 9.4.3 (General Seaming Procedures), respectively, and it will be nondestructively tested using the vacuum box test method described in Subsection 9.4.4.

### 9.3.5 Materials In Contact With Geomembranes - Anchor Trench System and Backfilling

The anchor trench for the geomembrane will be excavated by the Construction Contractor, unless otherwise specified, to the lines and grades shown on the plans and specifications. The trench will use a "U" configuration. No more than the amount of trench required for the geomembrane to be anchored in 1 day will be excavated to minimize the desiccation potential of the anchor trench soil.

The anchor trench will be backfilled and compacted by the Contractor. Care will be taken when backfilling the trenches to prevent any damage to the geomembrane or other geosynthetics that may also be placed in the trench prior to backfilling. The anchor trench will be adequately drained to prevent ponding or softening of the adjacent soil while the trench is open.

The RPR will observe the backfilling and compacting operations and will advise the CQA Officer of the adequacy of the soil installation. The RPR will also advise the CQA Officer of observed problems.

## 9.4 Field Seaming

This section covers the quality assurance procedures on seams used to join the rolls of geomembrane into a continuous layer. The installation of each of the geomembranes at the landfill facility will include 100 percent nondestructive testing of all field seams for joining adjacent rolls of geomembranes to document that no openings or gaps exist between geomembrane sheets. In addition, destructive testing will be performed at a routine interval for determining the strength and mode of failure of field seams in both the shear and peel modes.

The allowable field seam methods, equipment, personnel qualifications, and destructive and nondestructive testing methods are described in this section.

### 9.4.1 Seam Layout

No horizontal seams will be allowed on slopes greater than 5 horizontal to 1 vertical. In corners and at other odd-shaped geometric intersections, the number of horizontal seams will be minimized. A seam numbering system comparable and compatible with the geomembrane roll numbering system will be agreed upon at the preconstruction/preinstallation meeting (Subsections 3.1 and 3.3).

### 9.4.2 Seaming Equipment

The approved process for production field seaming (panel to panel) are the dual hot wedge (fusion-type) seam method and the extrusion fillet weld process. Specialty seams

and repair seams (nonproduction) will be done by the extrusion fillet weld process. No other processes can be used without prior written authorization from the CQA Officer and the RPR. Only equipment that has been specifically approved by make and model will be used.

#### *Dual Hot Wedge Process*

The Installer will meet the following requirements regarding the use, availability, and cleaning of the equipment to be used at the job site:

- An automated self-propelled type of apparatus will be used.
- The welding apparatus will be equipped to continuously monitor applicable temperatures.
- One spare operable seaming device will be maintained on-site at all times.
- Equipment used for seaming will not damage the geomembrane.
- The geomembrane will be protected in areas of heavy traffic to prevent damage as discussed in Subsection 9.3.3.
- For cross seams, the edge of the cross seams will be ground to a smooth incline (top and bottom) prior to welding.
- For cross seams, the intersecting dual hot wedge seam will be patched using the extrusion fillet process described below.
- The electric generator for the equipment will be placed on a smooth base in such a way that no damage occurs to the geomembrane. Similarly, a smooth insulating plate or fabric will be placed beneath the hot equipment after use.

The Installer will keep records for each seamer performing dual hot wedge seaming, including welding machine I.D. number, ambient air temperature, geomembrane surface temperature, and machine operating pressures and temperatures. These data will be recorded at intervals as agreed upon at the preconstruction or preinstallation meeting.

#### *Extrusion Fillet Process*

The Installer will meet the following requirements regarding the use, availability, and cleaning of extrusion welding equipment to be used at the job site:

- The welding apparatus will be equipped to continuously monitor temperature at the nozzle.

- One spare operable seaming device will be maintained on-site at all times.
- Equipment used for seaming will not damage the geomembrane.
- The geomembrane will be protected in areas of heavy traffic to prevent damage.
- The extruder will be cleaned and purged prior to beginning seaming, and at any time during which seaming operations are stopped, until all heat-degraded extrudate has been removed from the barrel.
- The electric generator for the equipment will be placed on a smooth base in such a way that no damage occurs to the geomembrane. Similarly, a smooth insulating plate or fabric will be placed beneath the hot equipment after use.
- Geomembrane surfaces will not be ground for welding preparation more than 1 hour prior to seaming.

The Installer and, if applicable, the Geomembrane Manufacturer will provide documentation to the CQA Officer regarding the quality of the extrudate used in the welding apparatus. At a minimum, the extrudate will be compatible with the base liner material and will contain the same grade and quality of polyethylene resin as used in the base material.

The Installer will keep records for each seamer performing extrusion weld seaming, including welding machine I.D. number, extrudate, and ambient air and geomembrane surface temperatures. These data will be recorded at intervals as agreed upon at the preconstruction or preinstallation meeting.

### 9.4.3 Initial Requirements

#### *Personnel Qualifications*

All personnel performing seaming operations will be qualified by experience or by successfully passing seaming tests for the type of seaming equipment to be used. At least one seamer will have experience in seaming a minimum of 2,000,000 square feet of polyethylene geomembrane using the same type of seaming apparatus to be used at the landfill facility. The most experienced seamer, the "master seamer," will have direct supervisory responsibility at the job site over less experienced seamers.

The Installer will provide a list of proposed seaming personnel and their experience records to the CQA Officer and the RPR for their review and approval.

### *Weather Conditions*

The weather conditions under which geomembrane seaming can be performed are as follows:

- Unless otherwise authorized in writing by the CQA Officer, no seaming will be attempted or performed at an ambient temperature below 32° F (0°C) or above 104°F (40°C).
- Between ambient temperatures of 32°F (0°C) and 50°F (10°C), seaming will be performed only if the geomembrane is preheated by either sun or a hot air device, provided there is no excessive ambient cooling resulting from high winds.
- Above 50°F (10°C), no preheating of the geomembrane will be required.
- Geomembrane will be dry and protected from the wind.
- Seaming will not be performed during any precipitation event unless the Installer erects satisfactory shelter to protect the geomembrane areas for seaming from water and/or moisture.
- Seaming will not be performed in areas where ponded water has collected below the surface of the geomembrane.

If the Installer wishes to use methods that may allow seaming at ambient temperatures below 32°F or above 104°F, the Installer will demonstrate and certify that the methods and techniques used to perform the seaming produce seams that are entirely equivalent to seams produced at temperatures above 50°F and below 104°F, and that the overall quality of the geomembrane is not adversely affected.

The RPR will document the following items:

- Ambient temperature at which seaming is performed.
- Precipitation events occurring at the site, including the time of such occurrences, the intensity, and the amount of precipitation.

The RPR will inform the CQA Officer if any of the conditions relating to the weather are not being fulfilled. The CQA Officer will stop or postpone the geomembrane seaming when weather conditions are unacceptable.

### *Overlapping and Temporary Bond*

The Installer will be responsible for ensuring that the following requirements are met:

- Panels of geomembrane will have a finished overlap of a minimum of 3 inches for extrusion welding and 4 inches for fusion welding; but, in any event, sufficient overlap will be provided to allow peel tests to be performed on the seam.
- No solvents or adhesives will be used on the geomembrane unless the product has been approved in writing by the CQA Officer. Approval can only be obtained by submitting samples and data sheets to the CQA Officer for testing and evaluation.
- Procedures used to temporarily bond adjacent geomembrane rolls must not damage the geomembrane; in particular, the temperature of the hot air at the nozzle of any spot welding apparatus will be controlled such that the geomembrane is protected at all times against potential damage.

### *Trial Seams*

Trial seams will be made on fragments of geomembrane to document that seaming conditions are adequate. Such trial seams will be made at the beginning of each seaming period, following work interruptions, at changes in weather, and at least once for every 5 hours of seaming activities, for each seaming apparatus used that day. A minimum of one trial seam per welding machine will be made at the start of each day by each seaming technician performing welding that day. Also, each seamer will make at least one trial seam each day. Trial seams will be made under the same conditions as actual seams.

The trial seams will be examined by the Installer for squeeze-out, foot pressure applied by seaming equipment, and general appearance. If the seam fails any of these examinations, it will be repeated until satisfactory seams are obtained.

The trial seam samples will be at least 3 feet long by 1 foot wide after seaming, with the seam centered lengthwise. Seam overlap will be as indicated above under Overlapping and Temporary Bond.

Two adjoining specimens, each 1 inch wide, will be cut from each end of the trial seam sample by the Installer. The specimens will be tested by the Installer in shear and peel, respectively, using a field tensiometer, and they should not fail in the seam. If a specimen fails, then the entire test will be repeated using

two additional specimens cut from each end of the trial seam sample. If the second set of specimens also fails, then the seaming apparatus and seamer will not be accepted and will not be used for seaming until the deficiencies are corrected and two consecutive successful trial seams are achieved.

The remainder of the trial seam sample will be identified and marked by the RPR as follows:

- The sample will be assigned a number and marked as to the welding apparatus used and the seamer's name.
- The date, time, applicable operating temperatures of the welding equipment, and ambient temperature at the time of seaming will be noted.
- Whether the sample passes or fails will be indicated.

The RPR will observe trial seam procedures. The sample itself will be cut into three pieces, one for the Owner's record, one to be retained by the RPR, and one to be made available to the Installer.

The RPR may randomly select trial seam samples for destructive testing by the geosynthetics testing laboratory according to the test procedures described in Subsection 9.4.5. The frequency for trial seam laboratory testing will be at the discretion of the RPR and the CQA Officer.

If a trial seam sample fails a destructive test performed by the geosynthetics testing laboratory, according to the acceptance criteria stated in Subsection 9.4.5, then a destructive test seam sample(s) will be taken from each of the seams completed by the seamer during the shift related to the failed trial seam test. These samples will be forwarded by the RPR to the geosynthetics testing laboratory and, if any of them fails the tests, then the procedures described in Subsection 9.4.5 will apply. The conditions of this paragraph will be considered met if a destructive seam test sample, collected and tested according to the provisions under Location and Sampling Frequency and Sampling Procedure of Subsection 9.4.5, has already been taken and has passed.

### *Seam Preparation*

The Installer will ensure that the following conditions for each of the geomembrane installations covered by this plan are met:

- Prior to seaming, the seam area is clean and free of moisture, dust, dirt, debris of any kind, and foreign material.

- If seam overlap grinding is required, then the grinding process will be completed according to the Geomembrane Manufacturer's instructions within 1 hour of the seaming operation, and in a way that will not damage the geomembrane or cause excessive striation of the geomembrane surface.
- Seams will be aligned so as to minimize the number of wrinkles and "fishmouths."

#### *General Seaming Procedure*

Unless otherwise specified, the general seaming procedure to be used by the Installer for each of the geomembrane installations covered by this plan, and observed by the RPR, will be as follows:

- A firm substrate will be provided to achieve proper support for seaming.
- Fishmouths or wrinkles at the seam overlaps will be cut along the ridge of the wrinkle in order to achieve a flat overlap. The cut fishmouths or wrinkles will be seamed, and any portion where the overlap is inadequate will then be patched with the same geomembrane (including thickness) extending a minimum of 6 inches beyond the cut in all directions.
- If seaming operations are to be conducted at night, adequate illumination will be provided.

### 9.4.4 Nondestructive Testing

Each field seam will be nondestructively tested over its full length using one of the methods described in this section. The purpose of nondestructive testing is to determine the continuity of the seams. Nondestructive testing, at this stage of development, does not provide any information on the strength of seams. Seam strengths will be determined by destructive testing methods that are described in Subsection 9.4.5. Failure of any of the nondestructive or destructive tests will require the repair of the failed section according to the procedures contained in Subsection 9.3.4.

Nondestructive testing as described in this section will be performed on seams for every geomembrane installation covered by this plan. The recommended test methods for conducting the nondestructive seam testing are the air pressure test for dual hot wedge seams and the vacuum box test for extrusion fillet welds. These two nondestructive testing methods are described below.

The RPR will perform the following documentation tasks:

- Observe nondestructive seam testing, and examine seams for squeeze-out, foot pressure, and general appearance. Failure of these criteria will be considered as failure of the seam, and repair or reconstruction will be required.
- Document location, date, test unit number, name or number of tester, and outcome of all testing.
- Inform the Installer of any required repairs.
- Document that appropriate repairs are made and that the repairs are retested nondestructively with passing results.

### *Air Pressure Testing*

The following test procedure is applicable only to dual hot wedge seams. The equipment for performing the test should meet the following minimum requirements:

- An air compressor or hand pump equipped with a pressure gauge and regulator capable of producing and sustaining a pressure between 25 to 30 psig and mounted on a cushion to protect the geomembrane surface
- Fittings, rubber hose, valves, etc., to operate the equipment, and a sharp hollow needle or other approved pressure feed device

Air pressure testing will be performed according to the following procedure:

1. Seal both ends of the seam to be tested.
2. Insert needle or other approved pressure feed device into the air space at one end of the dual hot wedge seam.
3. Energize the air compressor or hand pump to a pressure of 25-30 psig. Close the valve, and monitor the pressure in the seam air space for approximately 7 minutes for HDPE and approximately 4 minutes for VFPE.
4. Record the pressure in the seam at the end of 2 minutes and again at the end of 7 minutes for HDPE and approximately 4 minutes for VFPE.

   Acceptable air pressure loss shall be determined in accordance with GRI GM6: for 40-mil, 4 psig; 60-mil, 3 psig.
5. If the pressure difference between the 2-minute and 7-minute or 4-minute readings exceeds 3 psi for HDPE or 4 psi for VFPE, or if the pressure does not stabilize within the 7-minute or 4-minute period, then allow for one more pressure monitoring interval.

6. If the pressure loss over both intervals exceeds the allowable pressure drop or if the pressure does not stabilize, then consider the seam as having failed the test.
7. If the pressure loss over either interval does not exceed the allowable pressure drop, then consider the seam as having passed the test.
8. The Installer must verify that the air channel tested was not obstructed by noting a release of air pressure at the end of the tested seam interval opposite the pressure gauge.

For any seam interval that fails the air pressure nondestructive test, additional nondestructive testing or visual inspection will be used to identify, if possible, the faulty area of the seam. The faulty area will be repaired and retested. If the faulty area cannot be identified, then the entire seam will be repaired and retested.

### *Vacuum Box Test*

Vacuum box testing is to be used on those seams made by the extrusion fillet process, to locate precisely the defects identified from air pressure testing, or to evaluate suspect seam and nonseam areas as discussed in Subsection 9.3.4.

Vacuum box testing equipment must meet the following minimum standards:

- A five-sided vacuum box with an open bottom, a clear viewing panel on top, and a pliable gasket attached to the bottom
- A steel vacuum tank and pump assembly equipped with a pressure controller and pipe connections capable of achieving a vacuum of 26 inches of mercury (Hg) (or approximately 2 psia)
- A vacuum gauge on the tank with an operating range from 0 to 26 inches of vacuum, and a vacuum gauge on the vacuum box with an operating range from 0 to 10 inches of vacuum

The following procedure will be used in performing the vacuum box test:

1. Clean the seams to be tested so that they are relatively free from soil or foreign objects that might prohibit a good seal from being formed between the vacuum chamber and the geomembrane.
2. Energize the vacuum pump, and reduce the tank pressure to approximately 24 inches of vacuum (or approximately 3 psia).

3. Wet a strip of geomembrane approximately twice the size of the vacuum box with the soapy solution.
4. Place and center the vacuum box with the gasket in contact with the geomembrane surface over the wetted area of the seam.
5. Applying a normal force to the top of the vacuum box, close the bleed valve and open the vacuum valve. Check to make certain that a tight seal is created between the geomembrane and the vacuum box. A minimum vacuum of 5 inches will be used for testing with the maximum allowable testing pressure never exceeding 10 inches of vacuum.
6. With the vacuum drawn, use the viewing panel to examine the geomembrane seam for bubbles resulting from the flow of air through the seam. Continue this examination for not less than 10 seconds.
7. Remove the vacuum box by first closing the vacuum valve and then opening the bleed valve. Proceed to Step 8 if bubbles appear in Step 6. If no bubbles appear in Step 6, then proceed directly to Step 9.
8. If bubbles appear through the geomembrane, mark the defective area for repair according to the provisions of Subsection 9.3.4. All repairs will be tested until nondestructive results are passing.
9. Move the vacuum box along the seam to be tested, overlapping the previously tested area by no less than 3 inches.

### 9.4.5 Destructive Seam Testing

Destructive seam testing will be performed on the geomembrane seams covered by this plan. Destructive seam testing is performed to determine the strength of the seam in both shear and peel failure modes. Destructive seam testing will be performed within 48 hours of sampling either in an on-site laboratory by personnel under the direction of the CQA Officer or at the geosynthetics testing laboratory.

#### *Location and Sampling Frequency*

The RPR will select locations where seam samples will be cut out for the destructive testing. Test locations will be determined during seaming at the RPR's discretion. Selection of such locations may be prompted by suspicion of excess crystallinity, contamination, offset welds, or any other potential causes of an imperfect seam. The Installer will not be informed in advance of any location where seam samples will be taken.

The minimum frequency of sample collection will be one test location per every 500 linear feet of seam length. This minimum frequency will be taken as an average for the entire installation area.

### *Sampling Procedure*

Samples will be cut under the direction of the RPR as the seaming progresses. For each sample location, the following information will be documented:

- Assigned sample number.
- Sample location on layout drawing.
- The reason for collecting the sample (*e.g.*, as part of statistical testing program, suspicious seam, etc.). Record this by the sample number.
- For the peel test, which geomembrane is the top and which is the bottom with respect to seams performed using dual hot wedge (fusion) weld techniques.

Specimens for qualitative field testing will be taken prior to removal of the laboratory sample. Samples for field tensiometer testing will be 1 inch wide by 12 inches long with the seam centered parallel to the width. The distance between the two samples will be 42 inches measured from inside edge to inside edge. If both samples pass the field tensiometer test described below under Field Test Methods, then the sample for laboratory testing will be taken according to the procedure described below.

The sample for laboratory testing will be located between the two samples used for field testing. Therefore, the laboratory sample will be 12 inches wide by 42 inches long with the seam centered lengthwise. The sample will be cut by the Installer into three parts and distributed as follows:

- A sample, 12 inches by 12 inches, will be kept by the Installer for testing if so desired.
- A sample, 12 inches by 12 inches, will be given to the Owner for record storage.
- A sample, 18 inches by 12 inches, will be transmitted to the geosynthetic testing laboratory or on-site testing laboratory by the RPR.

All holes cut into the geomembrane resulting from destructive seam sampling will be immediately repaired by the Installer in accordance with the repair procedures described in Subsection 9.3.4. The repaired area will be

nondestructively tested in accordance with the requirements of Subsection 9.4.4.

### *End-of-Seam Sampling*

In addition to the 42-inch sample cut for laboratory testing, an additional sample will be cut from each end of each continuous production field seam for field testing as described below. These samples, often referred to as bones, need to be only 1 inch wide and can be cut from the portion of the seam that extends into/past the anchor trench so as not to require an additional repair.

### *Field Test Methods*

The two 1-inch–wide samples described above under Sampling Procedure as well as the end-of-seam samples described above under End-of Seam Sampling will be field-tested for both peel and shear. Testing will be performed using a field tensiometer or equivalent device to qualitatively determine the mode of failure. The seam will be considered as having passed if the failure in both peel and shear does not occur within the seam. If the samples fail the field tensiometer test, then the repair procedures of Subsection 9.3.4 for the holes left by the cut-out samples, and the seam reconstruction procedures for the repair of the defective seam, discussed later in this subsection, will be implemented.

### *Laboratory Test Methods*

Laboratory testing of the destructive seam samples will be performed by the geosynthetics testing laboratory or an on-site testing laboratory under the direction of the CQA Officer. All destructive seam tests, whether performed on trial seam samples (as described above) or on samples cut out from production seams, will be performed in general accordance with the methodology of ASTM D4437, which stipulates that at least five specimens will be tested in shear and five in peel. Samples will be cut in alternating order (*e.g.*, shear and peel, peel and shear) and will also be tested in the order of cutting, to determine if any trend in seam quality along the length of the sample exists. All specimens will be cut as 1-inch–wide strips to ensure that the seam does not exceed the test gauge length of the specimen.

The following tests will be performed on each seam sample submitted for laboratory testing:

- <u>Shear and peel maximum tension</u> is the maximum load per unit width of a 1-inch–wide specimen expressed in pounds per inch of width in both the

shear and peel mode, according to ASTM D4437 as modified by NSF Standard 54.

- Shear elongation at break is the extension at break expressed as a percentage of the initial distance between the edge of the fused track and the nearer grip. This distance should be the same on both sides of the seam and is usually 2 inches. No referenced ASTM test exists for this procedure as defined; however, the specimen will be elongated to a maximum of 100 percent with any failures of individual specimens noted. For specimens that fail below 100 percent elongation, the value at which failure occurred will be noted on the results.
- Peel seam separation estimates the area of seam interface separation expressed as a percentage of the original area.

Also, for both the seam shear and peel tension tests, an indication will be given for each specimen tested that defines the locus of the failure.

For shear tests, the following values will be reported for each specimen tested:

- Maximum tension in pounds per inch
- Elongation at break indicating at what percentage the specimen failed (up to a tested maximum of 100)
- The locus of failure using the above designations

For peel tests, the following values will be reported for each specimen tested:

- Maximum tension in pounds per inch
- Seam separation expressed as percent of original seam area
- Locus of failure

### *Role of Testing Laboratory*

The geosynthetics testing laboratory or on-site testing laboratory will be responsible for performing the tests on samples submitted to them as described above. The results of tests performed will be reported to the CQA Officer and the RPR. Retesting of seams, because of failure to meet any or all of the specifications listed below, can only be authorized by the CQA Officer.

The Geomembrane Manufacturer and/or the Installer may perform their own quality control testing in accordance with the methods and procedures defined above under Laboratory Test Methods; however, the results, if substantially

different from those obtained by the geosynthetics testing laboratory or on-site laboratory, may only be used to request a retesting by the geosynthetics testing laboratory or on-site testing laboratory. All quality assurance test results from the geosynthetics testing laboratory or on-site laboratory govern over any test results from the Geomembrane Manufacturer or Installer. Only the CQA Officer is authorized to approve a retesting request.

### *Procedures For Determining Destructive Seam Test Failures*

The procedures described in this section apply to the procedures for destructive testing defined above under Field Test Methods and Laboratory Test Methods. Procedures for repairing failed seams are given in Subsection 9.3.4 of this plan.

The results from the shear and peel tests for the HDPE geomembranes will be evaluated against the criteria tabulated in Table 9-4, and the VFPE geomembrane will be evaluated against the criteria presented in Table 9-5.

All of the tabular criteria for each respective geomembrane type must be met for a given seam to be considered acceptable.

**Table 9-4**
**60-mil HDPE Geomembrane Seam Acceptance Criteria**

| PROPERTY | TEST METHOD | UNITS | TYPE OF CRITERION | ACCEPTANCE VALUES | |
|---|---|---|---|---|---|
| | | | | NON-TEXTURED | TEXTURED [1] |
| Shear strength [2] | ASTM D6392 | ppi | Minimum | 120 | 120 |
| Shear elongation | -- | percent | Minimum | 50 | 50 |
| Peel strength [2] - Fusion | ASTM D6392 | ppi | Minimum | 78 | 78 |
| Peel strength [2] - Extrusion | ASTM D6392 | ppi | Minimum | 78 | 78 |
| Peel separation | -- | percent | Maximum | 25 | 25 |

Notes:
[1] If the lengthwise edges of the textured geomembrane panels are nontextured, then the nontextured specifications will apply for the testing of seams made along these edges.
[2] Four out of the five specimens must meet these requirements. The fifth specimen must achieve 80 percent of the listed peel strength.

**Table 9-5**
**40-mil VFPE Geomembrane Seam Acceptance Criteria**

| PROPERTY | TEST METHOD | UNITS | MINIMUM AVERAGE VALUE | |
|---|---|---|---|---|
| | | | NON-TEXTURED | TEXTURED [1] |
| Shear strength [2] | ASTM D4437 | ppi | 44 | 44 |
| Shear elongation [2] | -- | percent | 50 | 50 |
| Peel strength [3],[4] - Fusion | ASTM D4437 | ppi | 40 | 40 |
| Peel strength [3],[4] – Extrusion | ASTM D4437 | ppi | 40 | 40 |
| Peel separation [5] | -- | percent | 10 | 10 |

Notes:
(1) If the lengthwise edges of the textured geomembrane panels are nontextured, then the nontextured specifications shall apply for the testing of seams made along these edges.
(2) Five out of the five test specimens must meet these requirements. In addition, failure type must be film-tear bond (FTB) for all five specimens.
(3) Four out of the five specimens must meet these requirements. The fifth specimen must achieve 90 percent of the listed peel strength.
(4) Failure type must be film-tear bond (FTB) for 4 out of 5 test specimens.
(5) Maximum Acceptance Value for four out of five test specimens. The fifth specimen must have no more than 50 percent peel separation.

The Installer has the following two options in determining the repair boundary whenever a seam has failed either the field tensiometer testing or laboratory destructive testing:

- The seam can be reconstructed between any two previously tested and passed destructive seam test locations.
- The Installer can trace the welding path to an intermediate location (at a 10-foot minimum from the point of the failed test in each direction) and request that field tensiometer tests be performed at these intermediate locations. If the field tensiometer sample results are acceptable, then full laboratory samples will be taken and tested. If the laboratory tests are acceptable, then the seam will be reconstructed between these intermediate locations. If either sample fails, then the process will be repeated until acceptable destructive seam tests have been performed in both directions away from the original failed sample location. For all retesting of seams, according to this procedure, the sampling methodology described earlier in this plan under Sampling Procedure will be used.

For seams reconstructed due to a failing destructive seam sample that are in excess of 150 feet long, an additional sample taken from the reconstructed zone must pass destructive seam testing.

The RPR will be responsible for documenting all actions, including test results submitted by the geosynthetics testing laboratory, taken in conjunction with seam testing. The RPR will also be responsible for keeping the CQA Officer informed on seam testing results and seaming progress.

## 9.5 Post-installation

Each geomembrane covered by this plan will be examined by the RPR. Any defects, whether due to failed seams, pinholes, or other penetrations, will be repaired.

Placement of the select granular fill drainage layer material will proceed as soon as practical following the RPR's testing and acceptance of completed geomembrane areas. The granular layer will provide ultraviolet protection, thermal insulation, and protection from physical damage.

Low-ground pressure tracked equipment (< 5 psi) will be used to place the drainage layer material over the geomembrane. At a minimum, 1 foot of cover material is required between the geomembrane and low-ground pressure equipment, 2 feet of cover soil are required

between the geomembrane and all other tracked or floatation wheeled equipment, and 3 feet of cover soil are required between the geomembrane and all rubber-tired vehicles.

Following the installation of the select granular fill drainage layer material over the geomembrane liner, electrical resistivity testing will be conducted over the entire lined area. Detected defects will be uncovered and repaired in accordance with industry standards and manufacturer's recommendations.

# Section 10
# Geotextile

## 10.1 General

This section of the CQA Plan applies to nonwoven geotextile used throughout the landfill facility. Geotextile will be installed in the following systems of the landfill facility:

- Leachate collection system (LCS)

This section is divided into three major subheadings, which cover the quality assurance requirements for preinstallation (which includes Geotextile Manufacturers), installation, and post-installation (which includes the final examination of the geotextiles prior to placing the appropriate material above the geotextile). The terms preinstallation, installation, and post-installation are applicable only to the geotextile and do not apply to the overall construction of the landfill facility.

## 10.2 Preinstallation

### 10.2.1 Manufacturing

The geotextile will be supplied to the site in factory rolls. Prior to the delivery of any geotextile rolls to the site, the Geotextile Manufacturer will provide the CQA Officer with the Manufacturer's Quality Control Plan used for production of the geotextile rolls.

Every roll of geotextile for delivery to the site will be manufactured and inspected by the Geotextile Manufacturer, according to the following requirements:

- The geotextile must contain no needles used for punching.
- The geotextile must be free of holes and any other sign of contamination by foreign matter.

The Geotextile Manufacturer will provide certification, based on tests performed in accordance with the methods listed in Table 10-1 that the geotextile cushion supplied under this plan will meet the material specifications listed in Table 10-2. These tests may be performed by the Geotextile Manufacturer's laboratory or a laboratory

**Table 10-1**
**Geotextile Material Acceptance Criteria**
**(minimum average roll values)**

| PROPERTY | TEST METHOD | UNITS | GEOTEXTILE TYPE AND FUNCTION | |
|---|---|---|---|---|
| | | | A | B |
| | | | NONWOVEN FABRIC CUSHION FOR LEACHATE COLLECTION TRENCHES | NONWOVEN FABRIC BELOW GROUTED RIPRAP |
| Mass per unit area | ASTM D5261 | $oz/yd^2$ | 12 | — |
| Apparent opening size (maximum) | ASTM D4751 | mm | 0.15 | 0.21 |
| Permittivity(1) | ASTM D4491 | 1/s | 0.9 | 1.5 |
| Grab strength | ASTM D4632 | lb | 300 | 160 |
| Tear strength | ASTM D4533 | lb | 115 | 60 |
| Puncture strength | ASTM D4833 | lb | 190 | 80 |
| Wide-width tensile strength | ASTM D4595 | lb/in | — | — |
| Elongation at ultimate strength(2) | ASTM D4595 | % | — | — |

Notes:
(1) Assumed geotextile thickness of 0.1 cm to estimate minimum permittivity.
(2) Measured in machine and cross-machine direction.

contracted by the Geotextile Manufacturer. Additionally, the Geotextile Manufacturer will provide certification that the Manufacturer's Quality Control Plan was fully implemented for the geotextile materials supplied under this plan. The Geotextile Manufacturer will provide documentation to verify the results of the Manufacturer's CQA Plan implementation if required by the CQA Officer.

The geotextile rolls will be tested and evaluated prior to acceptance. The CQA Officer may perform/require additional testing (*i.e.*, conformance testing) as required by detailed specifications or as required in the judgment of the CQA Officer to verify that the geotextile meets the specifications.

### 10.2.2 Delivery, Handling, and Storage of Geotextile Rolls

Each geotextile roll to be used at the landfill facility will be marked by the Geotextile Manufacturer with the following information and in the following manner:

- When fabric is rolled on a core, each roll will be identified with a durable gummed label, or an equivalent, on the inside of the core and on the outside of the protective wrapping for the roll.
- Each roll label will contain the following information at a minimum:
    - Name of manufacturer (or supplier)
    - Style and type number
    - Roll length and width
    - Batch (or lot) number
    - Nominal product thickness
    - Date of manufacture
    - Roll number

The Geotextile Manufacturer will use the following guidelines in packaging, wrapping, and preparing all geotextile rolls for shipment:

- When cores are required, those that have a crushing strength sufficient to avoid collapse or other damage while in use will be used.
- Each roll will be covered with a wrapping material that will protect the geotextile from damage due to shipment, water, sunlight, or contaminants.

The following practices will be used as a minimum in receiving and storing geotextile rolls in the designated storage area at the job site:

- While unloading or transferring the geotextile rolls from one location to another, care will be taken to prevent damage to the wrapping or to the geotextile itself. If practicable, the Installer may use fork lift trucks fitted with poles that can be inserted into the cores of rolls. The poles will be at least two-thirds the length of the rolls, to prevent breaking the cores and possibly damaging the geotextile. Rolls will not be dragged.
- The geotextile rolls will be stored in such a manner so as to ensure that they are adequately protected from the following:
    - Precipitation
    - Ultraviolet radiation, including sunlight
    - Strong oxidizing chemicals, acids or bases
    - Flames, including welding sparks
    - Temperatures in excess of 160°F
    - Soiling

Throughout the preinstallation, installation, and post-installation periods, the RPR will observe and document that the Installer provides adequate handling equipment for moving geotextile rolls and that the equipment and handling methods do not pose unnecessary risk of damage. The Installer will be responsible for the means and methods to implement the work.

The Installer will be responsible for ensuring that all materials installed meet specifications (*i.e.*, the roll marking label information indicates required specifications and properly represents materials). The RPR will maintain a log of geotextile roll deliveries. The following information, at a minimum, will be recorded on the log for each shipment received at the job site:

- Date of delivery at job site
- For each geotextile roll, the following information:
    - Roll number
    - Batch (lot) number

## 10.3 Installation

This section describes the quality assurance requirements applicable to the installation, observation, and documentation of geotextile.

### 10.3.1 Placement

The Installer will install all geotextile in such a manner as to ensure that it is not damaged and in a manner that complies with the following requirements:

- On sideslopes, the geotextile will be securely anchored and then rolled down the slope in such a manner as to continually keep the geotextile in tension.
- In the presence of wind, all geotextile will be secured by suitable methods. The temporary securing material will be left in place until replaced with cover material as shown on the design plans and specifications.
- In-place geotextile will be cut with special care to protect other materials from damage that could be caused by the cutting of the geotextile.
- The Installer will take necessary precautions to prevent damage to any underlying layers during placement of the geotextile.
- During placement of geotextile, care will be taken not to entrap in the geotextile any stones, excessive dust, or moisture that could damage the geotextile, or generate clogging of drains or filters.
- A visual examination of the geotextile will be carried out over the entire surface after installation by the Installer to ensure that no potentially harmful foreign objects, such as needles, are present.
- The edges of the geomembrane between phases will be protected with a geotextile wrap and/or an overlying protective material until the edges are spliced together with the liner system of the adjacent phase.

### 10.3.2 Seams and Overlaps

The following requirements will be met with regard to seaming and overlapping of geotextile rolls:

- Geotextile seams will be continuously heat-bonded or sewn (spot heat bonding or sewing will not be allowed). Geotextile will be overlapped 6 inches prior to seaming. The sewing method and stitch type will be per the Manufacturer's recommendation, but must be approved by the CQA Officer. Overlapping of geotextile without sewing may be acceptable for certain applications (e.g., under riprap emergency spillways) with approval from the CQA Officer.
- No horizontal seams will be allowed on slopes steeper than 5 horizontal to 1 vertical (*i.e.*, seams will be along, not across, the slope), except as part of a geotextile repair.
- Sewing will be performed with thread made from the same base material as the geotextile, or suitable equivalent.

- The Installer will pay particular attention to seams to ensure that no earthen materials could be inadvertently trapped beneath the geotextile.

The RPR will be responsible for observing and documenting that the above provisions are performed by the Installer in an acceptable manner.

## 10.4 Post-installation

### 10.4.1 Final Examination

The RPR will perform a final geotextile examination after the installation of each geotextile layer has been completed. The objectives of the final examination are as follows:

- To examine for the presence of holes, tears, or other deterioration
- To examine geotextile for excessive tension due to stretching of the fabric during installation

If there will be an extended time delay between completion of the geotextile and the start of the installation of any overlying cover, then the Installer will make provisions, by temporarily covering or using other suitable methods, to protect the geotextile against exposure to sunlight and ultraviolet radiation.

### 10.4.2 Placement of Soil Materials

The Construction Contractor will place all soil materials located on top of a geotextile in such a manner as to minimize the following:

- Damage to the geomembrane
- Slippage of the geotextile on underlying layers
- Excessive tensile stresses imposed on the geotextile

# Section 11
# Geosynthetic Clay Liner

## 11.1 Introduction

This section is divided into three major subheadings, which cover the quality assurance requirements for preinstallation (includes the GCL Manufacturer), installation, and post-installation (includes the final examination of GCL prior to the placement of the geomembrane). The terms preinstallation, installation, and post-installation are applicable only to the GCL installation and do not apply to the overall construction of the landfill facility.

## 11.2 Preinstallation

Preinstallation activities are designed to help ensure that a high-quality product is being manufactured and that it is properly delivered, handled, and stored to maintain its quality.

### 11.2.1 Manufacturer's Quality Control Plan (MQCP)

The manufacturer of each component of the GCL and the GCL itself will have a Manufacturer's Quality Control Plan (MQCP) to ensure that their product meets all of the stated minimum properties. These manufacturers include the Bentonite Supplier, the Geotextile Manufacturer, and the GCL Manufacturer.

#### *Bentonite Supplier*

The Bentonite Supplier will have a MQCP that will be adhered to in the manufacturing process. This plan will include the following information:

- Documentation that the bentonite is sodium bentonite
- Testing that demonstrates that the bentonite meets specified gradation requirements
- Testing that demonstrates that the bentonite meets specified index test requirements
- Testing that demonstrates that the bentonite has not been treated with synthetic chemicals or polymers

#### *Geotextile Manufacturer*

The Geotextile Manufacturer will have an MQCP that will be adhered to in their manufacturing process. This plan will include the following provisions:

- Testing that demonstrates that the product is made of specified polymers
- Testing that demonstrates that the product meets certain minimum average roll values (for geotextiles)

***GCL Manufacturer***

The GCL manufacturer will have an MQCP that describes the procedures for accomplishing quality in the final product. At a minimum, the tests shown in Table 11-1 shall be performed by the Manufacturer.

This MQCP will also dictate the following requirements:

- Overlap alignment lines are to be marked on the edges.
- Completed rolls are to be securely wrapped in plastic.
- Completed rolls are to be stored indoors, and provisions are to be in place to prevent rolls from being stacked too high, to prevent rolls from becoming too wet, and to prevent damage during handling.
- Quality control certificates are to be provided.

### 11.2.2 Materials

The GCL will consist of a layer of pure sodium bentonite clay encapsulated between two geotextiles, and will comply with all of the manufacturing processes and physical/chemical criteria listed in this section.

The bentonite clay utilized in the manufacture of the GCL, as well as any accessory bentonite clay (e.g., Volclay® granular sodium bentonite or approved equivalent) provided for seaming and detail work, will meet the manufacturer's minimum requirements, as specified in the MQCP.

The geotextile component of the GCL, and the geosynthetic clay liner itself, will meet the minimum requirements of the respective MQCPs.

### 11.2.3 GCL Delivery, Handling, and Storage

The GCL panels will be supplied to the site in factory-produced rolls, which are of standard factory roll dimensions.

**Table 11-1**
**GCL Material Tests, Test Methods, and Acceptance Criteria**

| PROPERTY | TEST METHOD | UNITS | VALUE |
|---|---|---|---|
| Bentonite properties: | | | |
| Free Swell | ASTM D5890 | mL/2 g | 24 (MARV)(1) |
| Fluid Loss | ASTM D5891 | mL | 18 |
| Hydraulic properties: | | | |
| Hydraulic Conductivity | ASTM D 5887 | cm/sec | $5 \times 10^{-9}$ max. |
| Flux(2)(3) | ASTM 5887 | $m^3/m^{2-S}$ | $1 \times 10^{-8}$ |
| Physical GCL properties | | | |
| Bentonite Mass Per Unit Area | ASTM D5993 | lb/sqf | 0.75 (MARV)(1) |
| Grab Strength | ASTM D 4632 | lb | 90 (MARV)(1) |
| | ASTM D 6768 | lb/in. | 22.5 (MARV)(1 |
| Peel Strength | ASTM D 4632 | lb | 15 min. |
| | ASTM D 6496 | lb/in. | 2.5 min. |
| Hydrated Internal | ASTM D 5321 | lb | 15 min. |
| Shear Strength | ASTM D 6243 | lb/sqf | 500 |

Notes:
(1) Minimum average roll value (MARV).
(2) Flux is defined as "flow rate/unit area" which can be converted to permeability using the equation:

permeability = flux/hydraulic gradient

(3) Report results at a maximum confining stress of 69 Kpa (5 psi) and 34 Kpa (2 psi) head pressure.
(4) The values provided in the original table for "Fluid loss" and "Flux" shall be considered maximum permitted values.

Each roll of GCL supplied to the site will be labeled with the following information:

- Name of manufacturer
- Product type and identification number (if any)
- Lot (Batch) number
- Date of manufacture
- Roll number

The GCL Manufacturer will ensure that the crushing strength of all GCL roll cores will be sufficient to avoid collapse or other damage while in use.

The rolls of GCL will be carefully unloaded by the Contractor upon arrival at the site. At a minimum, the following practices will be followed in receiving and storing GCL rolls in the covered storage area at the job site:

- While unloading or transferring the GCL rolls from one location to another, prevent damage to the GCL.
- For standard rolls, insert a steel support pipe through the cardboard roll core. Attach the slings or lifting chains at one end to the support pipe and at the other end to the bucket of a front-end loader or lifting device. Use a spreader bar to support and spread the slings. Ensure that the bar and support pipe are long enough to prevent damage to the edges of the GCL during hoisting.
- Alternatively, modify the fork lift trucks to lift the rolls with a steel bar, securely attached to the fork lift and inserted into the roll core. Do not lift the rolls by sliding the forks under the roll.
- Store the rolls of GCL in their original, unopened, wrapped cover in a clean, dry area. Store the material off the ground on pallets or by other suitable techniques that provide continuous support over the entire length of the roll. Cover the roll with a heavy, protective tarpaulin, or store the roll beneath a roof. Care will be used to protect the GCL from the following:
    - Precipitation
    - Ultraviolet radiation, including sunlight
    - Strong oxidizing chemicals, acids or bases
    - Flames, including welding sparks
    - Temperatures in excess of 160°F

Throughout the preinstallation, installation, and post-installation periods, the RPR will be responsible for observing and documenting that the Installer provides adequate handling equipment for moving GCL rolls and that the equipment and handling methods do not pose any risk of damage.

The RPR will be responsible for making certain that the name of the manufacturer, the type, and the thickness of each roll (as noted on the roll marking label described above) are correct. The RPR will also maintain a log of GCL roll deliveries. The following information, at a minimum, will be recorded on the log for each shipment received at the job site:

- Date of receipt of delivery at job site
- For each GCL roll, the following information will be noted:
  - Roll number
  - Batch (lot) number

### 11.2.4 Submittals

Submittals will be made prior to installation of the GCL concerning the GCL Manufacturer/production information and the GCL installer information.

The GCL Manufacturer/production information will include the following:

- Corporate background information
- Manufacturer's Quality Control Plan (MQCP) for bentonite, geotextile, and GCL manufacturers
- Project reference list consisting of the principal details of at least 10 projects totaling at least 8 million square feet of GCL installation, if required by the RPR or CQA Officer
- Results of tests conducted by the Bentonite Supplier and Geotextile Supplier to document the quality of the materials used to manufacture the GCL rolls assigned to the project
- Copy of quality control certificates, signed by a responsible entity of the Manufacturer. Each quality control certificate will include roll identification numbers, and the results of quality control tests (refer to Subsection 11.2.3 above for minimum testing requirements)
- Manufacturer's written certification that the GCL meets the project specifications, that the GCL has been continuously inspected and found to be needle-free, that the bentonite will not shift during transportation or installation, and that the bentonite and geotextile materials meet the Manufacturer's specifications

GCL Installer information will include the following:

- Corporate background information
- Project reference list consisting of the principal details of at least five projects totaling at least 1 million square feet, if required by the RPR or CQA Officer
- List of personnel performing field operations, along with pertinent experience information, if required by the RPR or CQA Officer

Also submitted prior to the preconstruction/preinstallation meeting will be the proposed panel layout diagram identifying placement of the GCL panels and seams, as well as any variances or additional details that deviate from the engineering drawings. The layout will be drawn to scale, will include information such as dimensions and details, and will be adequate for use as a construction plan.

## 11.3 Installation

The following installation procedures are designed to ensure the effectiveness of the GCL in meeting its design requirements and to simplify the deployment procedures. These procedures are to be followed by the Installer, unless the Installer proposes alternative procedures in writing and the CQA Officer approves them in writing prior to installation.

### 11.3.1 Testing Requirements

This subsection describes the test methods, including sampling procedures and frequencies, and the role of the Geosynthetic Testing Laboratory in testing the GCL roll samples. Unless specified otherwise, all sampling procedures will be performed in accordance with the referenced test method defined in this section.

GCL roll samples will be collected by the Contractor at the discretion of, and under the direction of, the RPR, at a rate specified by the RPR.

Samples will be 3 feet long by the full width of the roll and will not include the first 3 feet of any roll.

Table 11-1 lists the tests and the test methods that may be performed on GCL roll samples. The specifications and methods used in evaluating the results are discussed later in this subsection.

### *Role of Testing Laboratory*

The Geosynthetic Testing Laboratory will be responsible for performing the tests on samples submitted to them. The results of tests performed will be reported to the RPR and CQA Officer.

Retesting of GCL rolls for quality assurance purposes, because of failure to meet any or all of the acceptance specifications in this section, can only be authorized by the CQA Officer.

The GCL Manufacturer and/or Installer may perform their own tests according to the methods and procedures defined in Table 11-1; however, the results will only be applicable to their own quality control needs. These results will not be substituted for the quality assurance testing described herein.

### *Procedure For Determining GCL Roll Test Failures*

Table 11-1 lists the specifications that are applicable to the GCL. For any referenced test method that requires the testing of multiple specimens, the criteria in Table 11-1 will be met based on the average results of the multiple specimen tests.

The following procedure will be used for interpreting the results relative to acceptance or rejection of rolls, lots, and shipments of GCL to the site:

1. If the test values meet the stated specifications, then the roll and batch will be accepted for use at the job site. If the sample represents all rolls from an entire shipment, then the entire shipment will also be considered accepted.
2. If the results do not meet the specification, then the roll and the batch will be retested at the Contractor's expense using specimens either from the original roll sample or from another sample collected by the RPR. For retesting, two additional tests will be performed for the failed test procedure. (Each additional test will consist of multiple specimen tests if multiple specimens are called for in the failed test procedure.) If both of the retests are acceptable, then the roll and batch will be considered as having passed this particular acceptance test; if either of the two additional tests fail, then the roll and batch will be considered as being unsuitable without further recourse. The RPR may obtain samples from other rolls in the batch. On the basis of testing these samples, the CQA Officer may choose to accept a portion of the batch while rejecting the remainder.

   If retesting does not result in passing test results as defined in the preceding paragraph, or if there is any other nonconformity with the

material specifications, then the Contractor will withdraw the rolls from use in the project at Contractor's sole risk, cost, and expense. Once withdrawn, the same rolls will not be resubmitted for use. Expenses for removing this GCL from the site and replacing it with acceptable GCL will be the sole risk and responsibility of Contractor.

### 11.3.2 Required Equipment

The following installation equipment is required on-site:

- Front end loader, crane, or other similar equipment. The selected piece of equipment will not cause damage to the subgrade, such as rutting. The Installer will verify in the presence of the RPR that the selected piece of equipment does not damage the subgrade
- A spreader bar to prevent slings from damaging the ends of the rolls.
- Several steel pipes to be inserted into the roll's core for lifting.
- Wooden pallets for aboveground storage of the GCL rolls.
- Heavy waterproof tarps for protecting all GCL rolls.
- Sandbags for securing the GCL during installation and for securing the tarps.
- Adhesive or tape for securing patches.
- Granular bentonite for seams and patches, and for securing around penetrations and structures as shown on the drawings.

### 11.3.3 Surface/Subgrade Preparation

GCL liner installation will not begin until a proper subbase has been prepared to accept the bentonite liner. Base material, including material in the vee trenches constructed for the leachate collection system piping, will be fine-grained soil free from angular rocks, roots, grass, and vegetation. Foreign materials and protrusions will be removed, and all cracks and voids will be filled; the surface will be made smooth and uniformly sloping. Unless otherwise required by the contract specifications and drawings, the prepared surface will be free from excessive moisture, loose earth, rocks or clay clods larger than 1 inches in diameter, rubble, and other foreign matter. The subgrade will be uniformly compacted to ensure against localized settlement and rutting under wheel loads and will be smoothed with a smooth drum or vibratory roller. Refer to Subsection 9.3.2 for additional earthwork-related requirements.

The surface on which the liner is to be placed will be maintained in a firm, clean, and smooth condition, free of standing water, during liner installation.

### 11.3.4 Deployment

As each roll is moved from the storage area, the labels will be removed by the Installer or RPR for storage in the project file.

The rolls of GCL will be brought to the area to be lined with a front-end loader, and support pipe will be set up such that the roll of liner is fully supported across its length. A spreader bar or similar device will be used to prevent the lifting chains or slings from damaging the edges. Dragging of the GCL liner will be minimized.

The Contractor will ensure, and the RPR will verify, that the following criteria are being met:

- The equipment used does not damage the GCL by handling, excessive heat, leakage of hydrocarbons, or by other means.
- The prepared surface underlying the GCL has not deteriorated since previous acceptance, and it is still acceptable at the time of GCL placement.
- Personnel working on the GCL do not smoke, wear damaging clothing, or engage in other activities that could damage the GCL.
- The method used to unroll the GCL does not cause damage to the GCL, and/or the subgrade.
- The method used to place the rolls minimizes wrinkles (especially wrinkles between adjacent panels).

GCL must not be placed during precipitation events, in the presence of excessive moisture, in any area of ponded water, or during excessive winds. The GCL must be dry when installed and must be dry when covered.

The proper side of the GCL, as per the manufacturer's recommendation, will face upward (unless otherwise dictated by project requirements). The liner will be placed over the prepared surface such that material handling will be minimized.

The GCL panels will be placed in a manner that ensures sufficient overlap as described in Subsection 11.3.5. Horizontal seams will not occur on slopes steeper than 10 horizontal:1 vertical.

The cover material (i.e., geomembrane) will be placed over the bentonite liner during the same day as the placement of the GCL. Only those GCL rolls that can be covered that same day will be unpacked and placed in position.

When wind conditions could affect installation, the GCL liner installation will be started at the upwind side of the project and will proceed downwind. The leading edge of the liner will be secured at all times with sandbags or other means sufficient to hold it down during high winds.

The GCL will be installed in a relaxed condition and will be free of tension or stress upon completion of the installation. Stretching of the liner to fit will not be allowed. Deployed rolls (panels) will be straightened by the installation personnel to smooth out creases or irregularities.

The RPR will visually inspect the geotextile's quality, the bentonite uniformity, and the degree of hydration, if any, of the GCL. Any areas in need of repair will be marked.

### 11.3.5 Seaming

Once the first panel has been deployed, adjoining panels will be laid with a 6-inch minimum overlap on longitudinal seams, and 24 inches on the panel end seams, depending on project specifications. To assist in obtaining the proper overlap, 6-inch overlap lines will be marked on the liner. All dirt, gravel, or other debris will be removed from the overlap area of the GCL.

Seam overlaps, whenever possible, will be placed such that the direction of flow is from the top panel to the underlying panel to form a shingle effect.

If the GCL requires a granular bentonite seam, then the overlapping panel edge will be pulled back and granular Volclay® (or approved equivalent) sodium bentonite will be poured continuously along all seams and lap areas from the panel edge to the 6-inch lap line, at a minimum application rate of ¼ pound per linear foot.

### 11.3.6 Patches/Repairs

Irregular shapes, cuts, or tears in the installed GCL will be covered with sufficient liner to provide a 12-inch overlap in all directions beyond the damaged area. A layer of granular bentonite will be placed in the overlap zone in accordance with the Manufacturer's recommendations. An epoxy-based adhesive, or other approved method, will be used to secure the patch during backfill operations. Alternatively, the patch can be placed underneath the defective liner.

### 11.3.7 Penetration Seals

The GCL will be sealed around penetrations, pipes, and structures in accordance with the recommendations of the GCL Manufacturer.

Pipe penetrations will incorporate a collar of GCL wrapped around the pipe and securely fastened. A bentonite or mastic grout will be placed around the corners for additional protection.

An additional GCL skirt placed over the bentonite grout is also recommended to provide a third level of protection and to prevent the bentonite grout from being displaced.

If the seal requires granular bentonite, then a 1- to 2-inch cut will be excavated around the circumference of the pipe, into the subgrade at least 12 inches out from the pipe. Volclay® sodium bentonite (or approved equivalent) will then be packed around the pipe in the subgrade excavation and on adjacent areas so that the pipe is surrounded with granular bentonite.

The GCL panel will then be placed over the pipe by penetrating the GCL with slits in a "pie" configuration where the pipe is to protrude in a manner that will create a snug fit between the GCL and the pipe.

More sodium bentonite will then be spread around the cut edges of the GCL against the pipe and over adjacent areas.

To complete the pipe penetration seal, a collar of GCL will be cut in a manner similar to that made on the main panel and will be fit around the pipe, with additional Volclay® sodium bentonite (or approved equivalent) being applied into any gaps that may remain.

### 11.3.8 Covering GCL

Only the amount of GCL that can be inspected, repaired, and covered in the same day will be installed. The GCL must be covered the same day on which it is installed.

#### *Geosynthetics*

When covering the GCL, precautions will be taken to prevent damage to the GCL by restricting heavy equipment traffic. If a textured geomembrane is to be placed over the GCL, a slip sheet (such as 20-mil smooth HDPE) will be placed over the GCL to allow the textured geomembrane to slide into its proper position. The slip sheet will be removed after the geomembrane is in place.

***Soil***

The following requirements apply to soil placement over the GCLs:

- Equipment used for placing the soil must not be driven directly on the GCL.
- A minimum thickness of 1 foot of soil is specified between a light dozer (*i.e.*, maximum contact pressure of 8 lb/sq. inch) and the GCL.
- A minimum thickness of 3 feet of soil is specified between rubber-tired vehicles and the GCL.

Any leading edge or panels of GCL left unprotected must be covered with a heavy, waterproofing tarp that is secured and protected with sandbags or other ballast.

### 11.3.9 Submittals

The following will be submitted during installation:

- Daily records/logs prepared by the Installer documenting work performed, personnel involved, general working conditions, and any problems encountered or expected on the project. These records will be submitted on a weekly basis.
- Copy of subgrade acceptance forms by the Installer.
- Quality control documentation.

## 11.4 Post-installation

### 11.4.1 Final Examination

The RPR will perform a final GCL examination after portions of installation have been completed. The RPR will examine the GCL for the following:

- Tears or defects
- Proper overlaps

If any portion of the GCL requires repairs based on the above examination, it will be repaired in accordance with the procedures in Subsection 11.3.6.

### 11.4.2 Submittals

The following will be submitted after installation is completed:

- Installation certification prepared by the Installer certifying that the GCL was installed in substantial accordance with the specifications and the CQA Plan.

- An as-build panel layout diagram prepared by the Installer identifying the placement of panels and seams. The numbering sequence will be as agreed upon between the RPR and the Installer prior to commencing installation.
- A copy of the Warranty obtained from the Manufacturer/Installer.

# Section 12
# Piping

## 12.1 General

This section includes quality assurance requirements for piping used throughout the facility. Piping will be used in the construction of the following items:

- Leachate collection system
- Leachate conveyance (or transfer) system
- Leachate head well piping

This section is divided into three major subheadings, which cover the quality assurance requirements for the preinstallation (includes Piping Manufacturers and Fabricators), installation, and post-installation (includes the final observation and documentation of piping installations). The terms preinstallation, installation, and post-installation are applicable only to the piping installation and do not apply to the overall construction.

Individual pipe sizes and standard dimension ratios (SDRs) to be used for each individual pipe installation are not detailed in this section; the plans and specifications will be used for the determination of correct size and wall thickness.

## 12.2 Preinstallation

### 12.2.1 Manufacturing

#### *High-Density Polyethylene Material Specifications*

High-density polyethylene (HDPE) pipe must be made from extra high molecular weight (EHMW) polyethylene (PE) resin, and the manufactured piping must be classified as Type III, Class C, Category 5, Grade P34 material according to ASTM D1248 and must also have a cell classification of 345434C as defined by ASTM D3350.

#### *Polyvinyl Chloride Material Specifications*

All polyvinyl chloride (PVC) pipe fittings must be Schedule 120 PVC molded fittings. Extruded fittings may not be used unless specifically approved in writing by the CQA Officer.

#### *Fabricator*

The Piping Fabricator will be responsible for perforating the pipe delivered by the Piping Manufacturer according to the plans and specifications.

### 12.2.2 Delivery, Handling, and Storage of Piping

Pipe will be protected during shipment from excessive heat or cold, puncture, or other damaging or deleterious conditions. The pipe will be stored on-site in a manner suitable to protect it from long-term ultraviolet exposure prior to actual installation.

Throughout the preconstruction, construction, and post-construction periods, the RPR will be responsible for observing and documenting that the Contractor provides adequate handling equipment for moving pipe and that the equipment and handling methods do not pose any risk of damage.

The RPR will maintain a log of pipe deliveries throughout the installation. The following information, at a minimum, will be recorded on the log for each shipment received at the job site:

1. Date of receipt of delivery at job site
2. Pipe size and type

## 12.3 Installation

### 12.3.1 Connections

#### *HDPE Pipe*

Unless approved otherwise by the CQA Officer, HDPE pipe connections will be made by the butt fusion procedure. The following procedure will be used regarding butt fusion seams:

- Seams will be made at the Manufacturer's recommended temperature for fusing pipe and fittings.
- For pipe diameter sizes 4 inches (nominal) and larger, seams will be made using the hydraulic fusion machines. For pipe diameters of less than 4 inches, manual fusion equipment can be used.
- Care will be taken to make certain that adequate pressures are used for fusing pipes and that sufficient cooling periods are allowed prior to testing, bending, or backfilling of pipe sections.

***PVC Pipe***

Unless approved otherwise by the CQA Officer, all PVC pipe connections will be made according to the Standard Practice for Making Solvent-Cemented Joints with Polyvinyl chloride (PVC) Pipe and Fittings, ASTM D2855. Particular care will be taken regarding required set and cure times for solvent-cemented joints, which vary for ambient temperature conditions. Joints will not be subjected to stresses by moving or backfilling prior to the specified set times. ASTM D2855 Section 5.2.4 discusses shelf life and signs of deterioration of PVC solvent cements. Only original quality solvent cement may be used since expired shelf life and deteriorated cements may cause inadequate connections.

### 12.3.2 Placement

Pipe placement will be done in accordance with the following procedure and requirements:

- Piping will be bedded and backfilled according to the plans and specifications.
- The prepared surface underlying the piping will not show evidence of deterioration since previous acceptance and must be acceptable prior to piping placement.
- The method used to place the piping will not cause damage to the piping and will not disturb the supporting backfill.
- The pipe bedding material will be shovel-sliced, or compacted to the spring line of the pipe to ensure proper bedding.
- Observations and measurements will be made to ensure that the pipes are of the specified size and dimension ratio, manufactured of the specified material, and that pipe perforations are sized and spaced as specified.
- All piping will be located as noted in the plans and specifications. Locations, grades, and size requirements are specified on the details of the plan set. Observations and surveying measurements will be made to ensure that the pipes are placed at the specified locations and grades and in the specified configuration. Deviations from the plans and specifications will be brought to the attention of the CQA Officer for evaluation of the necessity of corrective action.

### 12.3.3 Damage

Damaged pipes or portions of pipes that have been rejected will be marked and removed from the installation area.

## 12.4 Post-Installation

The integrity of each leachate collection piping system installed will be documented by flushing with water, by pulling a mandrel, or by another equivalent method after completion of construction of the backfill/leachate drainage layer. The RPR will observe and document that this operation is carried out and that the pipes are free flowing. Any systems that do not appear to be free flowing will be immediately reported to the CQA Officer, and corrective action will be taken.

Solid-wall pipe (single- and double-walled) outside the limits of waste will be air pressure–tested to document that the piping system is airtight. The line will be air-pressurized to 5.0 pounds/square inch (gauge pressure). The valve on the pressurizing unit will be closed, and the system will be pressure-monitored. A system pressure of 4.5 psig or greater maintained for 30 minutes after the valve closing will be considered as acceptable. The RPR will observe and document that this operation is carried out and that the pipes are airtight.

Pipe invert elevations will be documented every 50 linear feet by survey, as well as at key points, including changes in grade, intersections, and end points.

# Appendix H: GCL Conformance Demonstration

- H.1: Liquid Flow Rate Comparison
- H.2: GCL Compatibility Demonstration
  - H.2.1: 2009 Leaching Potential and GCL Compatibility Analysis
  - H.2.2: 2013 Plan of Operation Modification

# H.1
# Liquid Flow Rate Comparison

| | | |
|---|---|---|
| PROJECT / LOCATION: Dairyland Power Cooperative 2022 Plan Modification | | PROJECT / PROPOSAL NO. |
| SUBJECT: GCL vs. Soil Barrier Liquid Flow Rate Comparison | | 469888.0001.0000 |
| PREPARED BY: Z. Bauman | DATE: 12/7/2022 | FINAL ☐ |
| CHECKED BY: B. Kahnk | DATE: 12/28/2022 | REVISION ☐ |

In accordance to s. NR 504.12(3)(5), a liner that utilizes GCL and soil barrier shall be designed to have a liquid flow rate no greater than the liquid flow rate through 2 feet of compacted soil with a hydraulic conductivity of 1 x $10^{-7}$ cm/sec. The liquid flow rate comparison shall be made using Darcy's Law:

$$\frac{Q}{A} = q = k(\frac{h}{t} + 1)$$

Q = flow rate ($cm^3$/sec)
A = surface area of liner ($cm^2$)
q = flow rate per unit area ($cm^3$/sec/$cm^2$)
k = hydraulic conductivity (cm/sec)
h = hydraulic head above liner (cm)
t = thickness of liner (cm)

**2 -ft Compacted Soil**

| | | |
|---|---|---|
| k | 1E-07 | cm/sec |
| h | 30.48 | cm |
| t | 60.96 | cm |
| q | 1.5E-07 | $cm^3$/sec/$cm^2$ |

Good

**GCL with 2 ft soil barrier**

| | | |
|---|---|---|
| k | 1.23E-09 | cm/sec |
| h | 30.48 | cm |
| t | 0.5 | cm |
| q | 7.62E-08 | $cm^3$/sec/$cm^2$ |

Assumptions

1) The maximum head on the liner will be 1 ft, which is the maximum head allowed according to WDNR

2) Hydraulic Conductivity of the GCL is based on latest documentation results during the construction of Cell 3B liner (TRC, 2015).

3) GCL thickness is typically 5mm to 12 mm. 5 mm (0.5 cm) was used as the thickness to remain conservative.

Conclusion: Based on the tested hydraulic conductivity of the GCL, the flow rate of the GCL and soil barrier are not greater than that of a 2 ft compacted soil liner system with a hydraulic conductivity of 1 x $10^{-7}$ cm/sec and thus, satisfies s. NR 504.12(3)(5). As detailed in the Section 3.2.2.2.2 of the 2023 Plan Modification, the effect of the CCR leachate on the GCL is minimal and does not substantially impact the GCL hydraulic conductivity.

July 20, 2015

**Mail To:**

**Mr. Scott Solotorovsky**
**CETCO**
2870 Forbs Avenue
Hoffman Estates, IL 60192

email: scott.solotorovsky@cetco.com
kathy.brazeau@colloid.com

**Bill To:**

**<= Same**

Dear Mr. Soltorovsky:

Thank you for consulting TRI/Environmental, Inc. (TRI) for your geosynthetics testing needs. TRI is pleased to submit this final report for laboratory testing.

| | |
|---|---|
| Project: | **MQC Weston Disposl Site No. 3** |
| TRI Job Reference Number: | E2392-69-07 |
| Material(s) Tested: | One Bentomat ST GCL |
| Test(s) Requested: | Index Flux (ASTM D5887) |

If you have any questions or require any additional information, please call us at 1-800-880-8378.

Sincerely,

John M. Allen, P.E.
Division Director
Geosynthetic Services Division
www.GeosyntheticTesting.com



The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested. TRI neither accepts responsibility for nor makes claim as to the final use and purpose of the material. TRI observes and maintains client confidentiality. TRI limits reproduction of this report, except in full, without prior approval of TRI.

TRI ENVIRONMENTAL, INC.
9063 BEE CAVES RD. – AUSTIN, TX 78733 – USA | PH: 800.880.TEST OR 512.263.2101

GCL TEST RESULTS
TRI Client: CETCO
Project: MQC Weston Disposf Site No. 3

Material: Bentomat ST GCL
TRI Log #: E2392-69-07

| PARAMETER | TEST REPLICATE NUMBER 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | MEAN | STD. DEV. | PROJ. SPEC. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Index Flux (ASTM D5887)** | | | | | | | | | | | | | |
| **Sample Identification: Lot 201529LO Roll 3759** | | | | | | | | | | | | | |
| Index Flux ($m^3/m^2/sec$) | | 1.5E-09 | | | | | | | | | 1.5E-09 | | |
| Hydraulic Conductivity (cm/sec) | | 9.4E-10 | | | | | | | | | 9.4E-10 | | 5.3E-09 max |



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TRI ENVIRONMENTAL, INC.
9063 BEE CAVES RD. – AUSTIN, TX 78733 – USA | PH: 800.880.TEST OR 512.263.2101

July 29, 2015

**Mail To:**

**Terrence Halena**
**TRC Environmental Corporation**
708 Heartland Trail, Suite 3000
Madison, WI 53717

email: thalena@trcsolutions.com
cc email: twmartin@trcsolutions.com

**Bill To:**

**<= Same**

Dear Mr. Halena:

Thank you for consulting TRI/Environmental, Inc. (TRI) for your geosynthetics testing needs. TRI is pleased to submit this final report for laboratory testing.

| | |
|---|---|
| Project: | **DPC Alma Off-Site Ash Disposal Facility Cell 3B** |
| TRI Job Reference Number: | E2392-71-05 |
| Material(s) Tested: | Four GSE BentoLiner NSL GCL(s) |
| Test(s) Requested: | Mass/Unit Area (ASTM D5993)<br>Index Flux (ASTM D5887) |

If you have any questions or require any additional information, please call us at 1-800-880-8378.

Sincerely,

John M. Allen, P.E.
Division Director
Geosynthetic Services Division
www.GeosyntheticTesting.com



The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested. TRI neither accepts responsibility for nor makes claim as to the final use and purpose of the material. TRI observes and maintains client confidentiality. TRI limits reproduction of this report, except in full, without prior approval of TRI.

TRI ENVIRONMENTAL, INC.
9063 BEE CAVES RD. – AUSTIN, TX 78733 – USA | PH: 800.880.TEST OR 512.263.2101

**GCL TEST RESULTS**
**TRI Client: TRC Environmental Corporation**
**Project: DPC Alma Off-Site Ash Disposal Facility Cell 3B**

**Material: GSE BentoLiner NSL GCL**
**Sample Identification: 502256840**
**TRI Log #: E2392-71-05**

| PARAMETER | TEST REPLICATE NUMBER 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | MEAN | STD. DEV. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Bentonite - Mass/Unit Area (ASTM D5993, result @ 0% M.C.)** | | | | | | | | | | | | |
| Bentonite mass/unit area (lbs/ft$^2$) | 0.79 | 0.80 | 0.92 | 0.88 | 0.80 | | | | | | 0.84 | 0.06 |
| Moisture Content (%) | 9.8 | 9.9 | 9.8 | 9.7 | 9.7 | | | | | | 9.8 | 0.1 |
| **Index Flux (ASTM D5887)** | | | | | | | | | | | | |
| Index Flux (m$^3$/m$^2$/sec) | | 3.3E-09 | | | | | | | | | 3.3E-09 | |
| Hydraulic Conductivity (cm/sec) | | 2.8E-09 | | | | | | | | | 2.8E-09 | |

MD Machine Direction TD Transverse Direction NA Not Available



The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested. TRI neither accepts responsibility for nor makes claim as to the final use and purpose of the material. TRI observes and maintains client confidentiality. TRI limits reproduction of this report, except in full, without prior approval of TRI.

TRI ENVIRONMENTAL, INC.
9063 BEE CAVES RD. – AUSTIN, TX 78733 – USA | PH: 800.880.TEST OR 512.263.2101

**GCL TEST RESULTS**
**TRI Client: TRC Environmental Corporation**
**Project: DPC Alma Off-Site Ash Disposal Facility Cell 3B**

**Material: GSE BentoLiner NSL GCL**
**Sample Identification: 502256860**
**TRI Log #: E2392-71-05**

| PARAMETER | TEST REPLICATE NUMBER 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | MEAN | STD. DEV. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Bentonite - Mass/Unit Area (ASTM D5993, result @ 0% M.C.)** | | | | | | | | | | | | |
| Bentonite mass/unit area (lbs/ft$^2$) | 0.83 | 0.76 | 0.81 | 0.90 | 0.74 | | | | | | 0.81 | 0.06 |
| Moisture Content (%) | 10.3 | 10.5 | 10.6 | 10.8 | 10.6 | | | | | | 10.6 | 0.2 |
| **Index Flux (ASTM D5887)** | | | | | | | | | | | | |
| Index Flux (m$^3$/m$^2$/sec) | | 3.6E-09 | | | | | | | | | 3.6E-09 | |
| Hydraulic Conductivity (cm/sec) | | 2.8E-09 | | | | | | | | | 2.8E-09 | |

MD Machine Direction TD Transverse Direction NA Not Available



The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested. TRI neither accepts responsibility for nor makes claim as to the final use and purpose of the material. TRI observes and maintains client confidentiality. TRI limits reproduction of this report, except in full, without prior approval of TRI.

TRI ENVIRONMENTAL, INC.
9063 BEE CAVES RD. – AUSTIN, TX 78733 – USA | PH: 800.880.TEST OR 512.263.2101

**GCL TEST RESULTS**
**TRI Client: TRC Environmental Corporation**
**Project: DPC Alma Off-Site Ash Disposal Facility Cell 3B**

**Material: GSE BentoLiner NSL GCL**
**Bentonite - Mass/Unit Area (ASTM D5993, result @ 0% M.C.)**
**TRI Log #: E2392-71-05**

| PARAMETER | TEST REPLICATE NUMBER 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | MEAN | STD. DEV. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample Identification: 502256830** | | | | | | | | | | | | |
| Bentonite mass/unit area (lbs/ft$^2$) | 0.88 | 0.82 | 0.92 | 0.81 | 0.81 | | | | | | 0.85 | 0.05 |
| Moisture Content (%) | 9.5 | 9.6 | 9.7 | 9.6 | 9.7 | | | | | | 9.6 | 0.1 |
| **Sample Identification: 502256850** | | | | | | | | | | | | |
| Bentonite mass/unit area (lbs/ft$^2$) | 0.82 | 0.90 | 0.88 | 0.85 | 0.78 | | | | | | 0.85 | 0.05 |
| Moisture Content (%) | 10.3 | 10.3 | 10.3 | 10.1 | 10.2 | | | | | | 10.2 | 0.1 |

MD Machine Direction TD Transverse Direction NA Not Available



The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested. TRI neither accepts responsibility for nor makes claim as to the final use and purpose of the material. TRI observes and maintains client confidentiality. TRI limits reproduction of this report, except in full, without prior approval of TRI.

TRI ENVIRONMENTAL, INC.
9063 BEE CAVES RD. – AUSTIN, TX 78733 – USA | PH: 800.880.TEST OR 512.263.2101

July 29, 2015
September 23, 2015 Reissued to add roll number

**Mail To:**

**Terrence D. Halena**
**TRC Environmental Corporation**
708 Heartland Trail, Suite 3000
Madison, WI 53717

email: thalena@trcsolutions.com
cc email: twmartin@trcsolutions.com
cc email: ssellner@trcsolutions.com

**Bill To:**

**<= Same**

Dear Mr. Halena:

Thank you for consulting TRI/Environmental, Inc. (TRI) for your geosynthetics testing needs. TRI is pleased to submit this final report of the laboratory testing for the sample listed below.

| | |
|---|---|
| Project: | **DPC Cell 3 B Construction** |
| TRI Job Reference Number: | E2392-74-03 |
| Material Tested: | One GCL |
| Test Requested: | Index Flux (ASTM D5887) |

If you have any questions or require any additional information, please call us at 1-800-880-8378.

Sincerely,

Richard S. Lacey, P.E.
Senior Engineer
Geosynthetic Services Division
www.Geosynthetic-Testing.com



The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested. TRI neither accepts responsibility for nor makes claim as to the final use and purpose of the material. TRI observes and maintains client confidentiality. TRI limits reproduction of this report, except in full, without prior approval of TRI.

GCL TEST RESULTS
TRI Client: TRC Environmental Corporation
Project: DPC Cell 3 B Construction

Material: GCL
Sample Identification: 502252239
TRI Log #: E2392-74-03

| PARAMETER | TEST REPLICATE NUMBER 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | MEAN | STD. DEV. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Index Flux (ASTM D5887)** | | | | | | | | | | | | |
| Index Flux ($m^3/m^2/sec$) | | 2.9E-09 | | | | | | | | | 2.9E-09 | |
| Hydraulic Conductivity (cm/sec) | | 2.3E-09 | | | | | | | | | 2.3E-09 | |

MD Machine Direction TD Transverse Direction NA Not Available



The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested. TRI neither accepts responsibility for nor makes claim as to the final use and purpose of the material. TRI observes and maintains client confidentiality. TRI limits reproduction of this report, except in full, without prior approval of TRI.

TRI ENVIRONMENTAL, INC.
9063 BEE CAVES RD. – AUSTIN, TX 78733 – USA | PH: 800.880.TEST OR 512.263.2101

# H.2
# GCL Compatibility Demonstration

# H.2.1
# 2009 Leaching Potential and GCL Compatibility Analysis

RMT

• ENVIRONMENT • ENERGY • ENGINEERING

April 16, 2009

Mr. Bill Kowalski
Dairyland Power Cooperative
P.O. Box 817
3200 East Avenue South
La Crosse, WI 54601

Subject: Evaluation of the Leaching Potential of Sherco Unit 3 Scrubber Material for GCL Compatibility; Phase IV Disposal Area; License #4126; Alma Off-Site Disposal Facility

Dear Bill:

As directed by Dairyland Power Cooperative (DPC) RMT, Inc., (RMT) has finalized our Technical Memorandum which presented the evaluation of the leaching potential of Sherco Unit 3 scrubber material for geosynthetic clay liner (GCL) compatibility. Based on the findings presented in the Technical Memorandum dated April 14, 2009, we recommend that you submit a cover letter requesting an expedited plan modification, under NR 514.09, to the Wisconsin Department of Natural Resources (WDNR). The plan modification request will include two items. The first item will request that based on the findings contained in the Technical Memorandum dated April 14, 2009, that the Department modify the existing Conditional Plan of Operation Approval, dated May 15, 2001, for the Alma Off-Site (AOS) Phase IV Disposal Facility to allow for the disposal of coal combustion byproducts (e.g., flue gas desulfurization material) from the sulfur dioxide scrubbing unit currently under construction at Genoa Station Unit 3.

The second plan modification item will request the elimination of annual coal ash testing for GCL compatibility required by Condition No. 30.b. of the May 15, 2001, Plan of Operation Conditional Approval. This request can be justified based on the favorable findings of the annual coal ash testing for GCL compatibility for the Phase IV Disposal Area. These findings were submitted annually by RMT on behalf of DPC, for the years of 2004 through 2008, as well as the favorable findings contained in RMT's Technical Memorandum dated April 14, 2009.

744 Heartland Trail • Madison, WI 53717 • 608.831.4444 • 608.831.3334 FAX • www.rmtinc.com

Please contact Curt Madsen, at (608)662-5475, with any questions or comments.

Sincerely,

Curtis D. Madsen, P.E.
Senior Project Manager

Attachments

cc: Mike Giblin-DPC, (letter only)
Bob Stanforth-RMT

RMT

# Technical Memorandum

**Date:** April 15, 2009

**To:** Project File 3081.93

**cc:** Bill Kowalski – DPC
Curt Madsen – RMT, Inc.

**From:** Robert Stanforth, Ph.D.
Consulting Chemist – RMT, Inc.

**Subject:** Evaluation of the Leaching Potential of Sherco Unit 3 Scrubber Material for GCL Compatibility

## Introduction

Sulfur dioxide ($SO_2$) scrubbing equipment is currently being installed at the Dairyland Power Cooperative (DPC) Genoa Station Unit 3 (G3) power plant. The flue gas desulfurization (FGD) waste collected from the $SO_2$ scrubbing unit will contain both the fly ash currently collected in the baghouse as well as the product from the $SO_2$ scrubbing process. The FGD waste that cannot be diverted for beneficial use will be disposed of in the Phase IV Disposal Area at the Alma Off-Site Disposal Facility. The Phase IV Disposal Area is lined by a composite liner that includes a geosynthetic clay liner (GCL) of low permeability. DPC would like to place the FGD waste that cannot be beneficially used into the landfill, as well. However, the leaching characteristics of the new material (FGD waste) could potentially be sufficiently different from the material currently placed in the landfill to adversely affect the GCL, in which case it would not be appropriate to place the FGD waste in the landfill. It is therefore important to evaluate the leaching characteristics of the FGD waste to determine whether it is acceptable for placement in the landfill.

The material from the air pollution control system is not currently available, since the system will not become operational until later in 2009. However, FGD waste from a similar process is available from the Sherco power plant in Minnesota. The Sherco unit burns a coal blend (e.g., low Btu and medium Btu coal) that is similar to that burned at Genoa Unit 3, and has the same type of $SO_2$ scrubber system (e.g., dry scrubber process) that is currently under construction at Genoa Unit 3. Testing has been conducted on the Sherco Unit 3 product to evaluate the chemical composition and leaching characteristics for comparison with the fly ash that is currently placed in the landfill. The testing on the Sherco product consisted of the following:

1. Compositional analysis
2. ASTM Water Leaching Test

3. The DPC Leachate Generation Procedure, which is a modification of the ASTM Water Leaching Test designed to provide a more realistic simulation of the actual leachate generated by the waste in the field.

The compositional analysis and the ASTM Test were done by Pace Laboratories. The DPC Leachate Generation Procedure leaching tests were done in the RMT Applied Chemistry Laboratory, with the leachate being analyzed by Pace Laboratories.

## Results

### Compositional Analysis

A comparison of the Sherco Unit 3 material with the fly ash from the other DPC plants is provided in Table 1. The laboratory reports are provided in Attachment A.

The Sherco material has higher levels of aluminum, boron, calcium, and sodium, but has lower levels of arsenic, chromium, cobalt, copper, iron, and zinc. Most of the differences are likely due to the presence of the lime and calcium scrubber products (calcium sulfate and sulfite), which increase the calcium concentrations while decreasing trace metal concentrations in the fly ash. Changes in the composition of the material do not in and of themselves predict changes in leaching chemistry. For that, we need to evaluate the leaching potential of the different materials.

### ASTM Water Leach Test

The results of the ASTM water leaching test run on the Sherco material are presented in Table 2. The laboratory reports are provided in Attachment A.

### DPC Leachate Generation Procedure

The ASTM Water Leaching Test provides a convenient means of evaluating the leaching potential of the material being leached under conditions in which the material controls the pH of the leaching solution. However, the Leaching Tests employ a relatively small amount of solid per unit volume of leaching solution (e.g., 1 g solid per 20 mL leaching solution), which is not representative of the solid to solution ratio found as rainwater percolates through a landfill. A more realistic view of the leachate can be obtained by running a series of leaching tests using the same leaching solution and contacting fresh solid with the same batch of leachate. This approach is used in the DPC Leachate Generation Procedure. The leaching procedure is presented in Attachment B.

This procedure was utilized on the Sherco Unit 3 ash. The results are presented in Table 3, along with the results from the same test procedure run on yearly composites of the ash currently disposed in the landfill. The laboratory reports are presented in Attachment A.

The Sherco material had leachate concentrations that are in the same range as the fly ash from previous years. Calcium is slightly elevated over the previous year's results, which is not

surprising, since lime (CaO) is used to "scrub" the $SO_2$. The key question is whether the leachate from the new material will influence the permeability of the clay liner more than the current leachate does. The effect of leachate composition on clay (benotonite) liner permeability is discussed in a paper by Kolstad *et al.* (2004) presented in Attachment C. They found that the key factors influencing the liner's permeability are the monovalent to divalent cation ratio (referenced to as RMD), and the ionic strength of the solution. The influences of both of these factors are shown on a figure in the paper, which is reproduced on Figure 1. Both ionic strength and the RMD exert significant influences on the hydraulic conductivity of the bentonite liner. The calculated ionic strengths due to the cations and RMD are shown in Table 4. The total ionic strength has a component due to both cations and anions. If we assume that the anion component equals the cation component, then the total ionic strength is in the region of between 0.02 and 0.15 M, in other words, on the left-hand side of the graph on Figure 1. Plotting the results for the current fly ash results and the Sherco results on the graph from Kolstad *et al.* shows that the Sherco ash falls at a permeability slightly above the previous results, going from a maximum hydraulic conductivity of around $8 \times 10^{-9}$ cm/s for the previous results to around $4 \times 10^{-8}$ cm/s (see Figure 2). The hydraulic conductivity points for the fly ash currently disposed at the site range from less than $1 \times 10^{-9}$ to $8 \times 10^{-8}$ cm/s. The change in hydraulic conductivity from the Sherco ash is less than the variability now seen for the fly ash.

Based on the results of the leaching study of the Sherco scrubber material and the fly ash currently disposed of in the landfill, disposal of the Sherco ash may cause a slight increase in the liner permeability, but the permeability should still be well below $1 \times 10^{-7}$ cm/s.

FIGURES 1 and 2

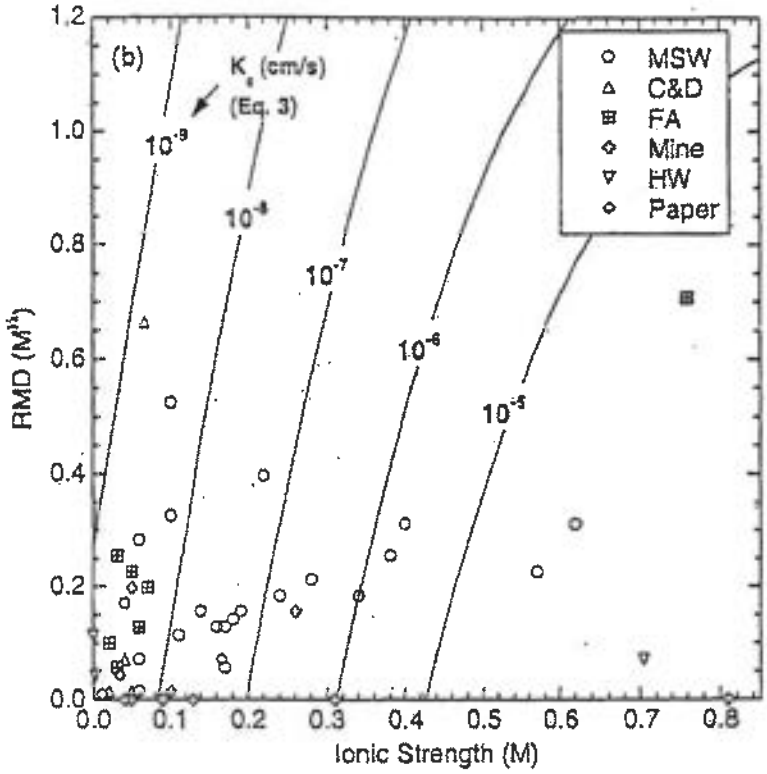


Fig. 1. Contours of hydraulic conductivity as a function of RMD and ionic strength predicted with Eq. 3 along points corresponding to ionic strength and RMD of various leachates. Data from Williams (1975) (I = 1.87 M and RMD = 0) and Kolstad (2000) (I = 1.37 M and RMD = 2.52 $mM^{1/2}$) are off the scale in (b).

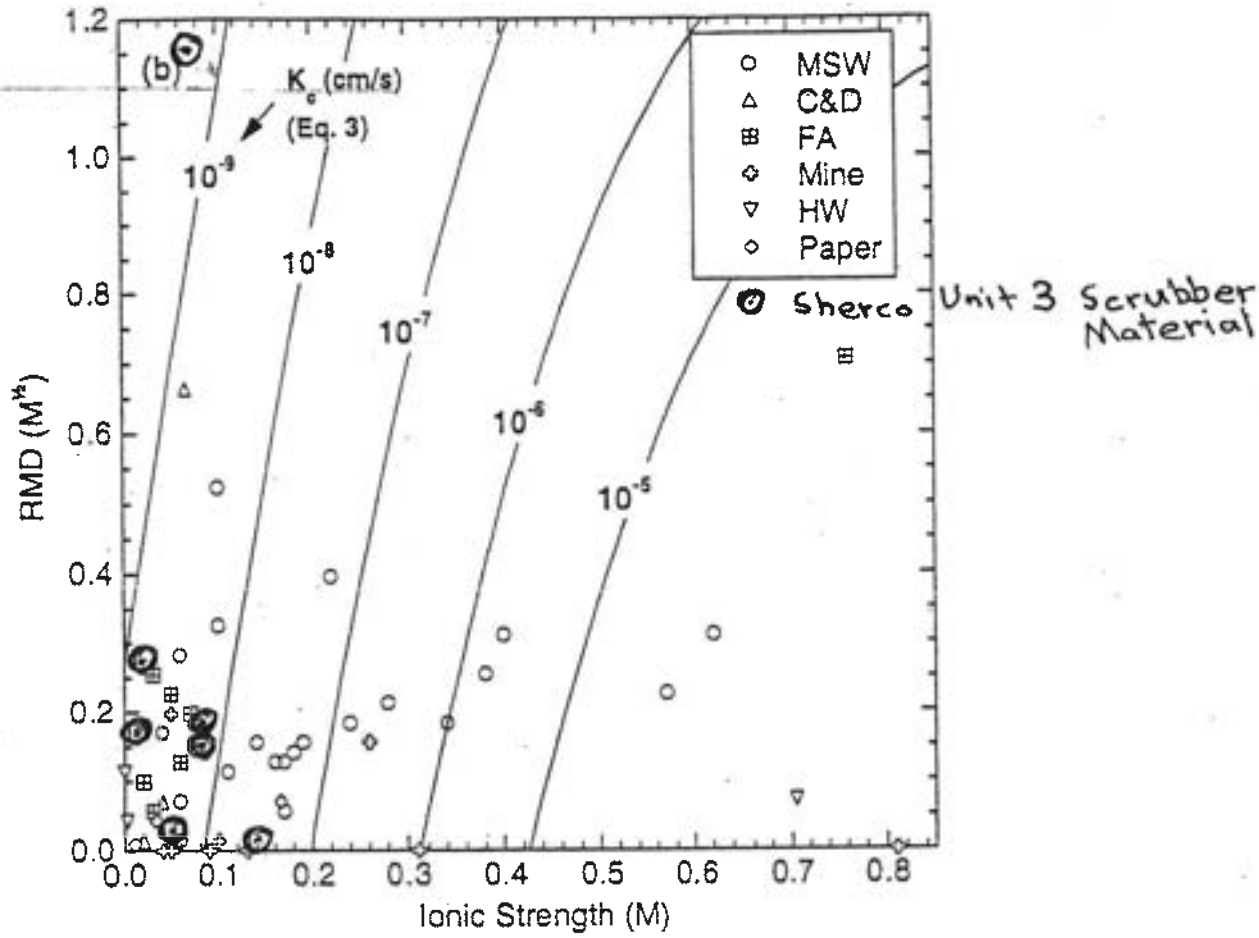


Figure 2. The graph showing the relationship of hydraulic conductivity with changes in ionic strength and RMD. The graph is from Kolstad et al. (2004) (corrected figure), with the data points for the DPC fly ash leachates shown as well.

Prepared by: R. Stainforth 3/30/09
Checked by: C. Madsen 4/1/09

TABLES 1, 2, 3 and 4

Table 1.
Compositional Analysis of Sherco Unit 3 material and Fly Ash from other DPC Units.

| Parameter | Compositional Analysis of Fly Ash from, mg/kg | | | |
|---|---|---|---|---|
| | Genoa* | Alma* | JPM* | Sherco |
| Aluminum | 32,600 | 37,000 | 59,200 | 69,800 |
| Antimony | 0.157 | <0.146 | 0.078 | 0.74 (J) |
| Arsenic | 109 | 76.2 | 56.0 | 7.7 (J) |
| Barium | 73.1 | 11 | 113 | 123 |
| Beryllium | 5.07 | 5.0 | 1.60 | 1.3 |
| Boron | 127 | 110 | 63 | 701 |
| Cadmium | 1.80 | 2.09 | 2.29 | 0.34 |
| Calcium | 26,900 | 69,200 | 98,800 | 147,000 |
| Chromium | 60.7 | 49.5 | 69.2 | 27.2 |
| Cobalt | 9.0 | 10.1 | 7.9 | 2.7 |
| Copper | 73.8 | 88.3 | 156 | 37.6 |
| Iron | 41,300 | 18,500 | 22,700 | 11,000 |
| Lead | 95.3 | 53.8 | 31.4 | 28.4 |
| Magnesium | 6,080 | 10,700 | 23,900 | 7,630 |
| Manganese | 87.0 | 148 | 311 | 310 |
| Molybdenum | 12.1 | 15.0 | 1.46 | 4.2 |
| Nickel | 47.3 | 52.6 | 33.3 | 8.3 |
| Selenium | 1.82 | 5.55 | 1.02 | 3.8 (J) |
| Silver | 0.23 | 0.062 | 0.25 | 0.63 |
| Sodium | 2,060 | 5,300 | 5,710 | 7,840 |
| Strontium | 558 | 1,500 | 1,960 | 2,980 |
| Thallium | 2.07 | 1.65 | 0.086 | <1.9 |
| Vanadium | 155 | 206 | 24 | 42.8 |
| Zinc | 101 | 156 | 30.7 | 15.1 |

(J) – Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit.

* results from Feasibility Report - Phase IV Disposal Area Alma Off-Site Disposal Facility, September, 1997

Table 2
Analysis of Leachate from ASTM Water Leaching Test on Sherco Unit 3 Material

| Parameter | Units | Leachate Concentration |
|---|---|---|
| pH | su | 12.1 |
| Total Dissolved Solids | µg/L | 1,680,000 |
| Specific Conductance | µmhos/cm | 2490 |
| Sulfate | µg/L | 784,000 |
| Aluminum | µg/L | 630 |
| Antimony | µg/L | 1.8 (J) |
| Arsenic | µg/L | 2.7 (J) |
| Barium | µg/L | 2,600 |
| Beryllium | µg/L | <0.040 |
| Boron | µg/L | 400 |
| Cadmium | µg/L | 0.21 (J) |
| Calcium | µg/L | 483,000 |
| Chromium | µg/L | 110 |
| Copper | µg/L | 3.0 (J) |
| Iron | µg/L | <7.2 |
| Lead | µg/L | 2.7 (J) |
| Magnesium | µg/L | 93 (J) |
| Manganese | µg/L | <0.66 |
| Mercury | µg/L | <0.10 |
| Nickel | µg/L | 0.33 (J) |
| Selenium | µg/L | 21 |
| Silver | µg/L | <0.34 |
| Sodium | µg/L | 10,400 |
| Thallium | µg/L | <1.4 |
| Zinc | µg/L | <2.6 |

(J) – Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit.

Table 3

Results of the DPL Leachate Generation Procedure on the Sherco material and on the annual composites of the fly ash currently disposed in the landfill

| Parameter | | DPL Leachate Concentration in Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| ID | units | 1997 | 2000 | 2003 | 2004 | 2005 | 2006 | 2007 | Sherco | |
| Boron | µg/L | 9700 | 240 | 8100 | 13000 | 30000 | 73000 | 7630 | 369 | |
| Calcium | µg/L | 97000 | 120000 | 87000 | 200000 | 570000 | 550000 | 383000 | 1,280,000 | |
| Chromium | µg/L | | 4.1 | 580 | 5900 | 870 | 980 | 764 | 988 | |
| Potassium | µg/L | 71000 | 16000 | 47000 | 75000 | 44000 | 81000 | 36600 | 42,300 | |
| Sodium | µg/L | 1,300,000 | 330,000 | 160,000 | 2,900,000 | 410,000 | 430,000 | 350,000 | 144,000 | |
| Chloride | Mg/L | 13 | 13 | 27 | 42 | 90 | 62 | 18.7 | 548 | |
| Specific Conductance | µmhos/cm | 10,000 | 3,900 | 2,500 | 9,900 | 3,800 | 3,800 | 3,180 | 8,380 | |
| Sulfate | Mg/L | <4.9 | 0.38 | 940 | 7,000 | 2,100 | 1,700 | 1,930 | 1,260 | |
| TSS | Mg/L | 120 | 40 | <2.5 | 100 | 2.2 | 1.8 | <0.78 | 6.0(J) | |

Table 4

Results of the DPL Leachate Genertaion Procedure presented in molar units, and the calculated ionic strength and RMD values for the leachates.

| Parameter | | DPL Leachate Concentration in Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| ID | units | 1997 | 2000 | 2003 | 2004 | 2005 | 2006 | 2007 | Sherco | |
| Calcium | mM | 2.43 | 3.00 | 2.18 | 5.0 | 14.3 | 13.8 | 9.58 | 32 | |
| Potassium | mM | 1.82 | 0.41 | 1.21 | 1.92 | 1.13 | 2.08 | 0.94 | 1.08 | |
| Sodium | mM | 56.5 | 14.3 | 6.96 | 126 | 17.8 | 18.7 | 15.2 | 6.26 | |
| Ionic Strength (cations) | M | 0.034 | 0.0134 | 0.00845 | 0.074 | 0.0381 | 0.038 | 0.0272 | 0.0677 | |
| Estimated total ionic strength | | 0.07 | 0.03 | 0.02 | 0.15 | 0.08 | 0.08 | 0.05 | 0.14 | |
| RMD | √M | 1.18 | 0.268 | 0.175 | 1.81 | 0.158 | 0.177 | 0.165 | 0.041 | |

# APPENDIX A

## Pace Laboratory Test Results

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March 09, 2009

CURT MADSEN
RMT - MADISON
744 HEARTLAND TRAIL
Madison, WI 53717

RE: Project: 3081.93 DAIRYLAND POWER COOP
Pace Project No.: 4014247

Dear CURT MADSEN:
Enclosed are the analytical results for sample(s) received by the laboratory on February 20, 2009. The results relate only to the samples included in this report. Results reported herein conform to the most current NELAC standards, where applicable, unless otherwise narrated in the body of the report.

If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Tod Noltemeyer

Tod Noltemeyer

tod.noltemeyer@pacelabs.com
Project Manager

Enclosures



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nelac

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## CERTIFICATIONS

Project: 3081.93 DAIRYLAND POWER COOP
Pace Project No.: 4014247

**Green Bay Certification IDs**

Wisconsin DATCP Certification #: 105-444
Wisconsin DATCP Certification #: 105-444
Wisconsin Certification #: 405132750
Wisconsin Certification #: 405132750
South Carolina Certification #: 83006001
South Carolina Certification #: 83006001
North Dakota Certification #: R-200
North Dakota Certification #: R-150
North Carolina Certification #: 503
North Carolina Certification #: 503
New York Certification #: 11888
New York Certification #: 11887
Minnesota Certification #: 055-999-334
Minnesota Certification #: 055-999-334
Louisiana Certification #: 04169
Louisiana Certification #: 04168
Kentucky Certification #: 83
Kentucky Certification #: 82
Illinois Certification #: 200051
Illinois Certification #: 200050
Florida/NELAP Certification #: E87951
Florida/NELAP Certification #: E87948



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## SAMPLE SUMMARY

Project: 3081.93 DAIRYLAND POWER COOP
Pace Project No.: 4014247

| Lab ID | Sample ID | Matrix | Date Collected | Date Received |
|---|---|---|---|---|
| 4014247001 | CONC. LEACHATE-PRESERVED | Water | 02/18/09 16:00 | 02/20/09 08:30 |
| 4014247002 | CONC. LEACHATE | Water | 02/18/09 16:00 | 02/20/09 08:30 |
| 4014247003 | SHERCO #3 SCRUBBER MAT | Solid | 02/18/09 16:00 | 02/20/09 08:30 |
| 4014247004 | SHERCO #3 SCRUBBER MAT | Water | 02/18/09 16:00 | 02/20/09 08:30 |



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## SAMPLE ANALYTE COUNT

Project: 3081.93 DAIRYLAND POWER COOP
Pace Project No.: 4014247

| Lab ID | Sample ID | Method | Analysts | Analytes Reported |
|---|---|---|---|---|
| 4014247001 | CONC. LEACHATE-PRESERVED | EPA 6010 | DLB | 5 |
| 4014247002 | CONC. LEACHATE | EPA 120.1 | MY | 1 |
| | | EPA 300.0 | DDY | 2 |
| | | SM 2540D | RRS | 1 |
| 4014247003 | SHERCO #3 SCRUBBER MAT | ASTM D2974-87 | MRN | 1 |
| | | EPA 300.0 | DDY | 1 |
| | | EPA 6010 | MES | 20 |
| | | EPA 6010 | MES | 24 |
| | | EPA 7470 | LMS | 1 |
| 4014247004 | SHERCO #3 SCRUBBER MAT | EPA 120.1 | DEY | 1 |
| | | SM 2540C | DEY | 1 |
| | | SM 4500-H+B | DEY | 1 |



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# PROJECT NARRATIVE

Project: 3081.93 DAIRYLAND POWER COOP
Pace Project No.: 4014247

**Method:** EPA 6010
**Description:** 6010 MET ICP
**Client:** RMT - MADISON
**Date:** March 09, 2009

**General Information:**
1 sample was analyzed for EPA 6010. All samples were received in acceptable condition with any exceptions noted below.

**Hold Time:**
The samples were analyzed within the method required hold times with any exceptions noted below.

**Sample Preparation:**
The samples were prepared in accordance with EPA 3050 with any exceptions noted below.

**Initial Calibrations (including MS Tune as applicable):**
All criteria were within method requirements with any exceptions noted below.

**Continuing Calibration:**
All criteria were within method requirements with any exceptions noted below.

**Method Blank:**
All analytes were below the report limit in the method blank with any exceptions noted below.

**Laboratory Control Spike:**
All laboratory control spike compounds were within QC limits with any exceptions noted below.

**Matrix Spikes:**
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

QC Batch: MPRP/2297

A matrix spike and matrix spike duplicate (MS/MSD) were performed on the following sample(s): 4014313009

M0: Matrix spike recovery was outside laboratory control limits.

- MS (Lab ID: 129565)
  - Antimony
  - Chromium
  - Copper
  - Nickel
  - Thallium
  - Vanadium
- MSD (Lab ID: 129566)
  - Antimony
  - Chromium
  - Copper
  - Nickel
  - Strontium
  - Thallium
  - Vanadium

R1: RPD value was outside control limits.

- MS (Lab ID: 129565)



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# PROJECT NARRATIVE

Project: 3081.93 DAIRYLAND POWER COOP
Pace Project No.: 4014247

**Method:** EPA 6010
**Description:** 6010 MET ICP
**Client:** RMT - MADISON
**Date:** March 09, 2009

QC Batch: MPRP/2297

A matrix spike and matrix spike duplicate (MS/MSD) were performed on the following sample(s): 4014313009

R1: RPD value was outside control limits.

- Barium
- Lead
- Manganese
- Sodium

- MSD (Lab ID: 129566)
  - Barium
  - Lead
  - Manganese
  - Sodium
  - Zinc

**Duplicate Sample:**
All duplicate sample results were within method acceptance criteria with any exceptions noted below.

**Additional Comments:**

Analyte Comments:

QC Batch: MPRP/2297

D3: Sample was diluted due to the presence of high levels of non-target analytes or other matrix interference.

- SHERCO #3 SCRUBBER MAT (Lab ID: 4014247003)
  - Arsenic
  - Antimony
  - Selenium
  - Thallium



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# PROJECT NARRATIVE

Project: 3081.93 DAIRYLAND POWER COOP
Pace Project No.: 4014247

**Method:** EPA 6010
**Description:** 6010 MET ICP, ASTM
**Client:** RMT - MADISON
**Date:** March 09, 2009

**General Information:**
1 sample was analyzed for EPA 6010. All samples were received in acceptable condition with any exceptions noted below.

**Hold Time:**
The samples were analyzed within the method required hold times with any exceptions noted below.

**Sample Preparation:**
The samples were prepared in accordance with EPA 3010 with any exceptions noted below.

**Initial Calibrations (including MS Tune as applicable):**
All criteria were within method requirements with any exceptions noted below.

**Continuing Calibration:**
All criteria were within method requirements with any exceptions noted below.

**Method Blank:**
All analytes were below the report limit in the method blank with any exceptions noted below.

**Laboratory Control Spike:**
All laboratory control spike compounds were within QC limits with any exceptions noted below.

**Matrix Spikes:**
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

**Duplicate Sample:**
All duplicate sample results were within method acceptance criteria with any exceptions noted below.

**Additional Comments:**

Analyte Comments:

QC Batch: MPRP/2296

2j: Analyte was detected in the associated extraction blank at 0.0026 mg/L.
- SHERCO #3 SCRUBBER MAT (Lab ID: 4014247003)
  - Copper

3j: Analyte was detected in the associated extraction blank at 0.21 mg/L.
- SHERCO #3 SCRUBBER MAT (Lab ID: 4014247003)
  - Nickel



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# PROJECT NARRATIVE

Project: 3081.93 DAIRYLAND POWER COOP
Pace Project No.: 4014247

**Method:** EPA 6010
**Description:** 6010 MET ICP, Dissolved
**Client:** RMT - MADISON
**Date:** March 09, 2009

**General Information:**
1 sample was analyzed for EPA 6010. All samples were received in acceptable condition with any exceptions noted below.

**Hold Time:**
The samples were analyzed within the method required hold times with any exceptions noted below.

**Sample Preparation:**
The samples were prepared in accordance with EPA 6010 with any exceptions noted below.

**Initial Calibrations (Including MS Tune as applicable):**
All criteria were within method requirements with any exceptions noted below.

**Continuing Calibration:**
All criteria were within method requirements with any exceptions noted below.

**Method Blank:**
All analytes were below the report limit in the method blank with any exceptions noted below.

**Laboratory Control Spike:**
All laboratory control spike compounds were within QC limits with any exceptions noted below.

**Matrix Spikes:**
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

**Duplicate Sample:**
All duplicate sample results were within method acceptance criteria with any exceptions noted below.

**Additional Comments:**



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# PROJECT NARRATIVE

Project: 3081.93 DAIRYLAND POWER COOP
Pace Project No.: 4014247

**Method:** EPA 7470
**Description:** 7470 Mercury, ASTM D3938
**Client:** RMT - MADISON
**Date:** March 09, 2009

**General Information:**
1 sample was analyzed for EPA 7470. All samples were received in acceptable condition with any exceptions noted below.

**Hold Time:**
The samples were analyzed within the method required hold times with any exceptions noted below.

**Sample Preparation:**
The samples were prepared in accordance with EPA 7470 with any exceptions noted below.

**Initial Calibrations (Including MS Tune as applicable):**
All criteria were within method requirements with any exceptions noted below.

**Continuing Calibration:**
All criteria were within method requirements with any exceptions noted below.

**Method Blank:**
All analytes were below the report limit in the method blank with any exceptions noted below.

**Laboratory Control Spike:**
All laboratory control spike compounds were within QC limits with any exceptions noted below.

**Matrix Spikes:**
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

**Duplicate Sample:**
All duplicate sample results were within method acceptance criteria with any exceptions noted below.

**Additional Comments:**



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# PROJECT NARRATIVE

Project: 3081.93 DAIRYLAND POWER COOP
Pace Project No.: 4014247

**Method:** ASTM D2974-87
**Description:** Percent Moisture
**Client:** RMT - MADISON
**Date:** March 09, 2009

**General Information:**
1 sample was analyzed for ASTM D2974-87. All samples were received in acceptable condition with any exceptions noted below.

**Hold Time:**
The samples were analyzed within the method required hold times with any exceptions noted below.

**Initial Calibrations (including MS Tune as applicable):**
All criteria were within method requirements with any exceptions noted below.

**Continuing Calibration:**
All criteria were within method requirements with any exceptions noted below.

**Internal Standards:**
All internal standards were within QC limits with any exceptions noted below.

**Surrogates:**
All surrogates were within QC limits with any exceptions noted below.

**Method Blank:**
All analytes were below the report limit in the method blank with any exceptions noted below.

**Laboratory Control Spike:**
All laboratory control spike compounds were within QC limits with any exceptions noted below.

**Matrix Spikes:**
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

**Duplicate Sample:**
All duplicate sample results were within method acceptance criteria with any exceptions noted below.

**Additional Comments:**



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# PROJECT NARRATIVE

Project: 3081.93 DAIRYLAND POWER COOP
Pace Project No.: 4014247

**Method:** EPA 120.1
**Description:** 120.1 Specific Conductance
**Client:** RMT - MADISON
**Date:** March 09, 2009

**General Information:**
2 samples were analyzed for EPA 120.1. All samples were received in acceptable condition with any exceptions noted below.

**Hold Time:**
The samples were analyzed within the method required hold times with any exceptions noted below.

**Method Blank:**
All analytes were below the report limit in the method blank with any exceptions noted below.

**Laboratory Control Spike:**
All laboratory control spike compounds were within QC limits with any exceptions noted below.

**Matrix Spikes:**
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

**Duplicate Sample:**
All duplicate sample results were within method acceptance criteria with any exceptions noted below.

**Additional Comments:**

Analyte Comments:

QC Batch: WET/3138

1j: Analyte was detected in the associated ASTM blank at 1.51umho/cm.
- SHERCO #3 SCRUBBER MAT (Lab ID: 4014247004)
  - Specific Conductance



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# PROJECT NARRATIVE

Project: 3081.93 DAIRYLAND POWER COOP
Pace Project No.: 4014247

**Method:** SM 2540C
**Description:** 2540C Total Dissolved Solids
**Client:** RMT - MADISON
**Date:** March 09, 2009

**General Information:**
1 sample was analyzed for SM 2540C. All samples were received in acceptable condition with any exceptions noted below.

**Hold Time:**
The samples were analyzed within the method required hold times with any exceptions noted below.

**Method Blank:**
All analytes were below the report limit in the method blank with any exceptions noted below.

**Laboratory Control Spike:**
All laboratory control spike compounds were within QC limits with any exceptions noted below.

**Matrix Spikes:**
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

**Duplicate Sample:**
All duplicate sample results were within method acceptance criteria with any exceptions noted below.

**Additional Comments:**



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# PROJECT NARRATIVE

Project: 3081.93 DAIRYLAND POWER COOP
Pace Project No.: 4014247

**Method:** SM 2540D
**Description:** 2540D Total Suspended Solids
**Client:** RMT - MADISON
**Date:** March 09, 2009

**General Information:**
1 sample was analyzed for SM 2540D. All samples were received in acceptable condition with any exceptions noted below.

**Hold Time:**
The samples were analyzed within the method required hold times with any exceptions noted below.

**Method Blank:**
All analytes were below the report limit in the method blank with any exceptions noted below.

**Laboratory Control Spike:**
All laboratory control spike compounds were within QC limits with any exceptions noted below.

**Matrix Spikes:**
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

**Duplicate Sample:**
All duplicate sample results were within method acceptance criteria with any exceptions noted below.

**Additional Comments:**



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# PROJECT NARRATIVE

Project: 3081.93 DAIRYLAND POWER COOP
Pace Project No.: 4014247

**Method:** SM 4500-H+B
**Description:** 4500H+ pH, Electrometric
**Client:** RMT - MADISON
**Date:** March 09, 2009

**General Information:**
1 sample was analyzed for SM 4500-H+B. All samples were received in acceptable condition with any exceptions noted below.

**Hold Time:**
The samples were analyzed within the method required hold times with any exceptions noted below.

H6: Analysis initiated more than 15 minutes after sample collection.
- SHERCO #3 SCRUBBER MAT (Lab ID: 4014247004)

**Method Blank:**
All analytes were below the report limit in the method blank with any exceptions noted below.

**Laboratory Control Spike:**
All laboratory control spike compounds were within QC limits with any exceptions noted below.

**Matrix Spikes:**
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

**Duplicate Sample:**
All duplicate sample results were within method acceptance criteria with any exceptions noted below.

**Additional Comments:**



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# PROJECT NARRATIVE

Project: 3081.93 DAIRYLAND POWER COOP
Pace Project No.: 4014247

**Method:** EPA 300.0
**Description:** 300.0 IC Anions 28 Days,Diss
**Client:** RMT - MADISON
**Date:** March 09, 2009

**General Information:**
1 sample was analyzed for EPA 300.0. All samples were received in acceptable condition with any exceptions noted below.

**Hold Time:**
The samples were analyzed within the method required hold times with any exceptions noted below.

**Initial Calibrations (Including MS Tune as applicable):**
All criteria were within method requirements with any exceptions noted below.

**Continuing Calibration:**
All criteria were within method requirements with any exceptions noted below.

**Method Blank:**
All analytes were below the report limit in the method blank with any exceptions noted below.

**Laboratory Control Spike:**
All laboratory control spike compounds were within QC limits with any exceptions noted below.

**Matrix Spikes:**
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

**Duplicate Sample:**
All duplicate sample results were within method acceptance criteria with any exceptions noted below.

**Additional Comments:**



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# PROJECT NARRATIVE

Project: 3081.93 DAIRYLAND POWER COOP
Pace Project No.: 4014247

**Method:** EPA 300.0
**Description:** 300.0 IC Anions ASTM 28 Days
**Client:** RMT - MADISON
**Date:** March 09, 2009

**General Information:**
1 sample was analyzed for EPA 300.0. All samples were received in acceptable condition with any exceptions noted below.

**Hold Time:**
The samples were analyzed within the method required hold times with any exceptions noted below.

**Initial Calibrations (Including MS Tune as applicable):**
All criteria were within method requirements with any exceptions noted below.

**Continuing Calibration:**
All criteria were within method requirements with any exceptions noted below.

**Method Blank:**
All analytes were below the report limit in the method blank with any exceptions noted below.

**Laboratory Control Spike:**
All laboratory control spike compounds were within QC limits with any exceptions noted below.

**Matrix Spikes:**
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

**Duplicate Sample:**
All duplicate sample results were within method acceptance criteria with any exceptions noted below.

**Additional Comments:**

This data package has been reviewed for quality and completeness and is approved for release.



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# ANALYTICAL RESULTS

Project: 3081.93 DAIRYLAND POWER COOP
Pace Project No.: 4014247

**Sample: CONC. LEACHATE-PRESERVED** Lab ID: 4014247001 Collected: 02/18/09 16:00 Received: 02/20/09 08:30 Matrix: Water

| Parameters | Results | Units | LOQ | LOD | DF | Prepared | Analyzed | CAS No. | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **6010 MET ICP, Dissolved** | Analytical Method: EPA 6010 Preparation Method: EPA 6010 | | | | | | | | |
| Boron, Dissolved | 369 | ug/L | 100 | 0.36 | 1 | 03/02/09 08:30 | 03/03/09 22:31 | 7440-42-8 | |
| Calcium, Dissolved | 1280000 | ug/L | 2000 | 90.4 | 10 | 03/02/09 08:30 | 03/04/09 10:26 | 7440-70-2 | P6 |
| Chromium, Dissolved | 988 | ug/L | 5.0 | 1.1 | 1 | 03/02/09 08:30 | 03/03/09 22:31 | 7440-47-3 | |
| Potassium, Dissolved | 42300 | ug/L | 2000 | 399 | 10 | 03/02/09 08:30 | 03/05/09 10:35 | 7440-09-7 | P6 |
| Sodium, Dissolved | 144000 | ug/L | 1000 | 12.9 | 1 | 03/02/09 08:30 | 03/03/09 22:31 | 7440-23-5 | P6 |



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## ANALYTICAL RESULTS

Project: 3081.93 DAIRYLAND POWER COOP
Pace Project No.: 4014247

**Sample: CONC. LEACHATE** **Lab ID: 4014247002** Collected: 02/18/09 16:00 Received: 02/20/09 08:30 Matrix: Water

| Parameters | Results | Units | LOQ | LOD | DF | Prepared | Analyzed | CAS No. | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **120.1 Specific Conductance** | Analytical Method: EPA 120.1 | | | | | | | | |
| Specific Conductance | **8380** | umhos/cm | 10.0 | 1.2 | 1 | | 02/24/09 10:00 | | |
| **2540D Total Suspended Solids** | Analytical Method: SM 2540D | | | | | | | | |
| Total Suspended Solids | **6.0J** | mg/L | 10.0 | 3.1 | 1 | | 02/24/09 09:08 | | |
| **300.0 IC Anions 28 Days,Diss** | Analytical Method: EPA 300.0 | | | | | | | | |
| Chloride, Dissolved | **548** | mg/L | 500 | 106 | 100 | | 03/04/09 00:17 | 16887-00-6 | |
| Sulfate, Dissolved | **1260** | mg/L | 400 | 51.0 | 100 | | 03/04/09 00:17 | 14808-79-8 | |



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# ANALYTICAL RESULTS

Project: 3081.93 DAIRYLAND POWER COOP
Pace Project No.: 4014247

**Sample: SHERCO #3 SCRUBBER MAT** **Lab ID: 4014247003** Collected: 02/18/09 16:00 Received: 02/20/09 08:30 Matrix: Solid

***Results reported on a "dry-weight" basis***

| Parameters | Results | Units | LOQ | LOD | DF | Prepared | Analyzed | CAS No. | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **6010 MET ICP** | Analytical Method: EPA 6010 Preparation Method: EPA 3050 | | | | | | | | |
| Aluminum | 69800 | mg/kg | 253 | 6.3 | 10 | 02/25/09 09:45 | 02/26/09 15:43 | 7429-90-5 | |
| Antimony | 0.74J | mg/kg | 10.1 | 0.60 | 10 | 02/25/09 09:45 | 02/26/09 15:43 | 7440-36-0 | D3 |
| Arsenic | 7.7J | mg/kg | 10.1 | 0.60 | 10 | 02/25/09 09:45 | 02/26/09 15:43 | 7440-38-2 | D3 |
| Barium | 123 | mg/kg | 0.25 | 0.053 | 1 | 02/25/09 09:45 | 02/25/09 22:13 | 7440-39-3 | |
| Beryllium | 1.3 | mg/kg | 0.20 | 0.0026 | 1 | 02/25/09 09:45 | 02/25/09 22:13 | 7440-41-7 | |
| Boron | 701 | mg/kg | 10.1 | 0.35 | 2 | 02/25/09 09:45 | 02/26/09 15:48 | 7440-42-8 | |
| Cadmium | 0.34 | mg/kg | 0.25 | 0.0064 | 1 | 02/25/09 09:45 | 02/25/09 22:13 | 7440-43-9 | |
| Calcium | 147000 | mg/kg | 101 | 23.8 | 10 | 02/25/09 09:45 | 02/26/09 15:43 | 7440-70-2 | |
| Chromium | 27.2 | mg/kg | 2.5 | 0.29 | 10 | 02/25/09 09:45 | 02/26/09 15:43 | 7440-47-3 | |
| Cobalt | 2.7 | mg/kg | 0.51 | 0.030 | 2 | 02/25/09 09:45 | 02/26/09 15:48 | 7440-48-4 | |
| Copper | 37.6 | mg/kg | 0.51 | 0.16 | 1 | 02/25/09 09:45 | 02/25/09 22:13 | 7440-50-8 | |
| Iron | 11000 | mg/kg | 5.1 | 0.37 | 1 | 02/25/09 09:45 | 02/25/09 22:13 | 7439-89-6 | |
| Lead | 28.4 | mg/kg | 5.1 | 0.34 | 10 | 02/25/09 09:45 | 02/26/09 15:43 | 7439-92-1 | |
| Magnesium | 7630 | mg/kg | 10.1 | 0.82 | 1 | 02/25/09 09:45 | 02/25/09 22:13 | 7439-95-4 | |
| Manganese | 310 | mg/kg | 0.25 | 0.016 | 1 | 02/25/09 09:45 | 02/25/09 22:13 | 7439-96-5 | |
| Molybdenum | 4.2 | mg/kg | 1.0 | 0.012 | 1 | 02/25/09 09:45 | 02/25/09 22:13 | 7439-98-7 | |
| Nickel | 8.3 | mg/kg | 0.51 | 0.022 | 1 | 02/25/09 09:45 | 02/25/09 22:13 | 7440-02-0 | |
| Selenium | 3.8J | mg/kg | 10.1 | 0.74 | 10 | 02/25/09 09:45 | 02/26/09 15:43 | 7782-49-2 | D3 |
| Silver | 0.63 | mg/kg | 0.51 | 0.011 | 1 | 02/25/09 09:45 | 02/25/09 22:13 | 7440-22-4 | |
| Sodium | 7840 | mg/kg | 101 | 2.2 | 2 | 02/25/09 09:45 | 02/26/09 15:48 | 7440-23-5 | |
| Strontium | 2980 | mg/kg | 2.5 | 0.14 | 10 | 02/25/09 09:45 | 02/26/09 15:43 | 7440-24-6 | |
| Thallium | <1.9 | mg/kg | 20.3 | 1.9 | 10 | 02/25/09 09:45 | 02/26/09 15:43 | 7440-28-0 | D3 |
| Vanadium | 42.8 | mg/kg | 0.51 | 0.046 | 2 | 02/25/09 09:45 | 02/26/09 15:48 | 7440-62-2 | |
| Zinc | 15.6 | mg/kg | 2.0 | 0.22 | 1 | 02/25/09 09:45 | 02/25/09 22:13 | 7440-66-6 | |
| **6010 MET ICP, ASTM** | Analytical Method: EPA 6010 Preparation Method: EPA 3010 | | | | | | | | |
| Aluminum | 0.63 | mg/L | 0.50 | 0.015 | 1 | 02/25/09 09:18 | 02/25/09 16:51 | 7429-90-5 | |
| Antimony | 0.0018J | mg/L | 0.020 | 0.0010 | 1 | 02/25/09 09:18 | 02/25/09 16:51 | 7440-36-0 | |
| Arsenic | 0.0027J | mg/L | 0.020 | 0.0012 | 1 | 02/25/09 09:18 | 02/25/09 16:51 | 7440-38-2 | |
| Barium | 2.6 | mg/L | 0.0050 | 0.00033 | 1 | 02/25/09 09:18 | 02/25/09 16:51 | 7440-39-3 | |
| Beryllium | <0.000040 | mg/L | 0.0040 | 0.000040 | 1 | 02/25/09 09:18 | 02/25/09 16:51 | 7440-41-7 | |
| Boron | 0.40 | mg/L | 0.10 | 0.00036 | 1 | 02/25/09 09:18 | 02/25/09 16:51 | 7440-42-8 | |
| Cadmium | 0.00021J | mg/L | 0.0050 | 0.00013 | 1 | 02/25/09 09:18 | 02/25/09 16:51 | 7440-43-9 | |
| Calcium | 483 | mg/L | 0.40 | 0.018 | 2 | 02/25/09 09:18 | 02/26/09 13:31 | 7440-70-2 | P6 |
| Chromium | 0.11 | mg/L | 0.0050 | 0.0011 | 1 | 02/25/09 09:18 | 02/25/09 16:51 | 7440-47-3 | |
| Copper | 0.0030J | mg/L | 0.010 | 0.00049 | 1 | 02/25/09 09:18 | 02/25/09 16:51 | 7440-50-8 | 2j |
| Iron | <0.0072 | mg/L | 0.10 | 0.0072 | 1 | 02/25/09 09:18 | 02/25/09 16:51 | 7439-89-6 | |
| Lead | 0.0027J | mg/L | 0.010 | 0.0014 | 1 | 02/25/09 09:18 | 02/25/09 16:51 | 7439-92-1 | |
| Magnesium | 0.093J | mg/L | 0.20 | 0.024 | 1 | 02/25/09 09:18 | 02/25/09 16:51 | 7439-95-4 | |
| Manganese | <0.00066 | mg/L | 0.0050 | 0.00066 | 1 | 02/25/09 09:18 | 02/25/09 16:51 | 7439-96-5 | |
| Nickel | 0.00033J | mg/L | 0.010 | 0.00015 | 1 | 02/25/09 09:18 | 02/25/09 16:51 | 7440-02-0 | 3j |
| Selenium | 0.021 | mg/L | 0.020 | 0.0016 | 1 | 02/25/09 09:18 | 02/25/09 16:51 | 7782-49-2 | |
| Silver | <0.00034 | mg/L | 0.010 | 0.00034 | 1 | 02/25/09 09:18 | 02/25/09 16:51 | 7440-22-4 | |
| Sodium | 10.4 | mg/L | 1.0 | 0.013 | 1 | 02/25/09 09:18 | 02/25/09 16:51 | 7440-23-5 | |



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# ANALYTICAL RESULTS

Project: 3081.93 DAIRYLAND POWER COOP
Pace Project No.: 4014247

**Sample: SHERCO #3 SCRUBBER MAT** Lab ID: **4014247003** Collected: 02/18/09 16:00 Received: 02/20/09 08:30 Matrix: Solid

***Results reported on a "dry-weight" basis***

| Parameters | Results | Units | LOQ | LOD | DF | Prepared | Analyzed | CAS No. | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **6010 MET ICP, ASTM** | Analytical Method: EPA 6010 Preparation Method: EPA 3010 | | | | | | | | |
| Thallium | <0.0014 | mg/L | 0.040 | 0.0014 | 1 | 02/25/09 09:18 | 02/25/09 16:51 | 7440-28-0 | |
| Zinc | <0.0026 | mg/L | 0.040 | 0.0026 | 1 | 02/25/09 09:18 | 02/25/09 16:51 | 7440-66-6 | |
| **7470 Mercury, ASTM D3938** | Analytical Method: EPA 7470 Preparation Method: EPA 7470 | | | | | | | | |
| Mercury | <0.10 | ug/L | 0.20 | 0.10 | 1 | 03/04/09 15:41 | 03/05/09 11:30 | 7439-97-6 | |
| **Percent Moisture** | Analytical Method: ASTM D2974-87 | | | | | | | | |
| Percent Moisture | 1.5 | % | 0.10 | 0.10 | 1 | | 02/21/09 08:13 | | |
| **300.0 IC Anions ASTM 28 Days** | Analytical Method: EPA 300.0 | | | | | | | | |
| Sulfate | 784 | mg/L | 200 | 18.0 | 50 | | 03/05/09 18:30 | 14808-79-8 | |



**REPORT OF LABORATORY ANALYSIS**

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## ANALYTICAL RESULTS

Project: 3081.93 DAIRYLAND POWER COOP
Pace Project No.: 4014247

**Sample: SHERCO #3 SCRUBBER MAT** **Lab ID: 4014247004** Collected: 02/18/09 16:00 Received: 02/20/09 08:30 Matrix: Water

| Parameters | Results | Units | LOQ | LOD | DF | Prepared | Analyzed | CAS No. | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **120.1 Specific Conductance** | Analytical Method: EPA 120.1 | | | | | | | | |
| Specific Conductance | **2490** | umhos/cm | 10.0 | 1.2 | 1 | | 04/06/09 10:00 | | |
| **2540C Total Dissolved Solids** | Analytical Method: SM 2540C | | | | | | | | |
| Total Dissolved Solids | **1680** | mg/L | 20.0 | 12.0 | 1 | | 02/25/09 11:30 | | |
| **4500H+ pH, Electrometric** | Analytical Method: SM 4500-H+B | | | | | | | | |
| pH at 25 Degrees C | **12.1** | Std. Units | 0.10 | 0.010 | 1 | | 02/23/09 13:00 | | H6 |



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## QUALITY CONTROL DATA

Project: 3081.93 DAIRYLAND POWER COOP
Pace Project No.: 4014247

QC Batch: PMST/2240
QC Batch Method: ASTM D2974-87
Analysis Method: ASTM D2974-87
Analysis Description: Dry Weight/Percent Moisture
Associated Lab Samples: 4014247003

SAMPLE DUPLICATE: 128622

| Parameter | Units | 4014248001 Result | Dup Result | RPD | Max RPD | Qualifiers |
|---|---|---|---|---|---|---|
| Percent Moisture | % | 21.5 | 19.7 | 9 | 10 | |



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# QUALITY CONTROL DATA

Project: 3081.93 DAIRYLAND POWER COOP
Pace Project No.: 4014247

QC Batch: WET/3123
QC Batch Method: SM 4500-H+B
Analysis Method: SM 4500-H+B
Analysis Description: 4500H+B pH
Associated Lab Samples: 4014247004

SAMPLE DUPLICATE: 129074

| Parameter | Units | 4014247004 Result | Dup Result | RPD | Max RPD | Qualifiers |
|---|---|---|---|---|---|---|
| pH at 25 Degrees C | Std. Units | 12.1 | 12.1 | .2 | 5 | H6 |



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# QUALITY CONTROL DATA

Project: 3081.93 DAIRYLAND POWER COOP
Pace Project No.: 4014247

QC Batch: WET/3126 | Analysis Method: SM 2540D
QC Batch Method: SM 2540D | Analysis Description: 2540D Total Suspended Solids
Associated Lab Samples: 4014247002

METHOD BLANK: 129143 | Matrix: Water
Associated Lab Samples: 4014247002

| Parameter | Units | Blank Result | Reporting Limit | Analyzed | Qualifiers |
|---|---|---|---|---|---|
| Total Suspended Solids | mg/L | <0.31 | 1.0 | 02/24/09 09:08 | |

LABORATORY CONTROL SAMPLE: 129144

| Parameter | Units | Spike Conc. | LCS Result | LCS % Rec | % Rec Limits | Qualifiers |
|---|---|---|---|---|---|---|
| Total Suspended Solids | mg/L | 459 | 424 | 92 | 80-120 | |

SAMPLE DUPLICATE: 129145

| Parameter | Units | 4014301001 Result | Dup Result | RPD | Max RPD | Qualifiers |
|---|---|---|---|---|---|---|
| Total Suspended Solids | mg/L | 144 | 142 | 1 | 10 | |



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# QUALITY CONTROL DATA

Project: 3081.93 DAIRYLAND POWER COOP
Pace Project No.: 4014247

QC Batch: WET/3133
QC Batch Method: EPA 120.1
Analysis Method: EPA 120.1
Analysis Description: 120.1 Specific Conductance
Associated Lab Samples: 4014247002

METHOD BLANK: 129474
Matrix: Water
Associated Lab Samples: 4014247002

| Parameter | Units | Blank Result | Reporting Limit | Analyzed | Qualifiers |
|---|---|---|---|---|---|
| Specific Conductance | umhos/cm | <1.2 | 10.0 | 02/24/09 10:00 | |

LABORATORY CONTROL SAMPLE: 129475

| Parameter | Units | Spike Conc. | LCS Result | LCS % Rec | % Rec Limits | Qualifiers |
|---|---|---|---|---|---|---|
| Specific Conductance | umhos/cm | 345 | 341 | 99 | 80-120 | |

SAMPLE DUPLICATE: 129476

| Parameter | Units | 4014100002 Result | Dup Result | RPD | Max RPD | Qualifiers |
|---|---|---|---|---|---|---|
| Specific Conductance | umhos/cm | 811 | 813 | .2 | 20 | |



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# QUALITY CONTROL DATA

Project: 3081.93 DAIRYLAND POWER COOP
Pace Project No.: 4014247

QC Batch: MPRP/2296
QC Batch Method: EPA 3010
Analysis Method: EPA 6010
Analysis Description: 6010 MET ASTM
Associated Lab Samples: 4014247003

METHOD BLANK: 129558
Matrix: Water
Associated Lab Samples: 4014247003

| Parameter | Units | Blank Result | Reporting Limit | Analyzed | Qualifiers |
|---|---|---|---|---|---|
| Aluminum | mg/L | <0.015 | 0.50 | 02/25/09 16:44 | |
| Antimony | mg/L | <0.0010 | 0.020 | 02/25/09 16:44 | |
| Arsenic | mg/L | <0.0012 | 0.020 | 02/25/09 16:44 | |
| Barium | mg/L | <0.00033 | 0.0050 | 02/25/09 16:44 | |
| Beryllium | mg/L | <0.000040 | 0.0040 | 02/25/09 16:44 | |
| Boron | mg/L | <0.00036 | 0.10 | 02/25/09 16:44 | |
| Cadmium | mg/L | <0.00013 | 0.0050 | 02/25/09 16:44 | |
| Calcium | mg/L | <0.0090 | 0.20 | 02/26/09 13:24 | |
| Chromium | mg/L | <0.0011 | 0.0050 | 02/25/09 16:44 | |
| Copper | mg/L | <0.00049 | 0.010 | 02/25/09 16:44 | |
| Iron | mg/L | 0.0092J | 0.10 | 02/25/09 16:44 | |
| Lead | mg/L | <0.0014 | 0.010 | 02/25/09 16:44 | |
| Magnesium | mg/L | <0.024 | 0.20 | 02/25/09 16:44 | |
| Manganese | mg/L | <0.00066 | 0.0050 | 02/25/09 16:44 | |
| Nickel | mg/L | <0.00015 | 0.010 | 02/25/09 16:44 | |
| Selenium | mg/L | <0.0016 | 0.020 | 02/25/09 16:44 | |
| Silver | mg/L | <0.00034 | 0.010 | 02/25/09 16:44 | |
| Sodium | mg/L | <0.013 | 1.0 | 02/25/09 16:44 | |
| Thallium | mg/L | <0.0014 | 0.040 | 02/25/09 16:44 | |
| Zinc | mg/L | <0.0026 | 0.040 | 02/25/09 16:44 | |

LABORATORY CONTROL SAMPLE: 129559

| Parameter | Units | Spike Conc. | LCS Result | LCS % Rec | % Rec Limits | Qualifiers |
|---|---|---|---|---|---|---|
| Aluminum | mg/L | 5 | 4.8 | 96 | 80-120 | |
| Antimony | mg/L | .5 | 0.49 | 98 | 80-120 | |
| Arsenic | mg/L | .5 | 0.48 | 95 | 80-120 | |
| Barium | mg/L | .5 | 0.48 | 97 | 80-120 | |
| Beryllium | mg/L | .5 | 0.49 | 98 | 80-120 | |
| Boron | mg/L | .5 | 0.49 | 98 | 80-120 | |
| Cadmium | mg/L | .5 | 0.47 | 94 | 80-120 | |
| Calcium | mg/L | 5 | 4.9 | 98 | 80-120 | |
| Chromium | mg/L | .5 | 0.49 | 98 | 80-120 | |
| Copper | mg/L | .5 | 0.48 | 95 | 80-120 | |
| Iron | mg/L | 5 | 5.0 | 100 | 80-120 | |
| Lead | mg/L | .5 | 0.48 | 97 | 80-120 | |
| Magnesium | mg/L | 5 | 4.9 | 97 | 80-120 | |
| Manganese | mg/L | .5 | 0.49 | 97 | 80-120 | |
| Nickel | mg/L | .5 | 0.49 | 98 | 80-120 | |
| Selenium | mg/L | .5 | 0.47 | 94 | 80-120 | |
| Silver | mg/L | .25 | 0.25 | 98 | 80-120 | |



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# QUALITY CONTROL DATA

Project: 3081.93 DAIRYLAND POWER COOP
Pace Project No.: 4014247

LABORATORY CONTROL SAMPLE: 129559

| Parameter | Units | Spike Conc. | LCS Result | LCS % Rec | % Rec Limits | Qualifiers |
|---|---|---|---|---|---|---|
| Sodium | mg/L | 5 | 5.0 | 101 | 80-120 | |
| Thallium | mg/L | .5 | 0.47 | 94 | 80-120 | |
| Zinc | mg/L | .5 | 0.49 | 99 | 80-120 | |

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 129560 129561

| Parameter | Units | 4014247003 Result | MS Spike Conc. | MSD Spike Conc. | MS Result | MSD Result | MS % Rec | MSD % Rec | % Rec Limits | RPD | Max RPD | Qual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Aluminum | mg/L | 0.63 | 5 | 5 | 5.6 | 5.6 | 99 | 100 | 75-125 | .7 | 20 | |
| Antimony | mg/L | 0.0018J | .5 | .5 | 0.53 | 0.53 | 105 | 105 | 75-125 | .4 | 20 | |
| Arsenic | mg/L | 0.0027J | .5 | .5 | 0.51 | 0.51 | 102 | 101 | 75-125 | .4 | 20 | |
| Barium | mg/L | 2.6 | .5 | .5 | 3.0 | 3.0 | 82 | 81 | 75-125 | .2 | 20 | |
| Beryllium | mg/L | <0.000040 | .5 | .5 | 0.49 | 0.49 | 98 | 98 | 75-125 | .06 | 20 | |
| Boron | mg/L | 0.40 | .5 | .5 | 0.90 | 0.90 | 101 | 101 | 75-125 | .09 | 20 | |
| Cadmium | mg/L | 0.00021J | .5 | .5 | 0.49 | 0.49 | 99 | 99 | 75-125 | .1 | 20 | |
| Calcium | mg/L | 483 | 5 | 5 | 470 | 468 | -248 | -288 | 75-125 | .4 | 20 | P6 |
| Chromium | mg/L | 0.11 | .5 | .5 | 0.60 | 0.60 | 97 | 96 | 75-125 | .4 | 20 | |
| Copper | mg/L | 0.0030J | .5 | .5 | 0.50 | 0.50 | 99 | 99 | 75-125 | .3 | 20 | |
| Iron | mg/L | <0.0072 | 5 | 5 | 5.0 | 5.0 | 100 | 101 | 75-125 | .3 | 20 | |
| Lead | mg/L | 0.0027J | .5 | .5 | 0.48 | 0.49 | 96 | 97 | 75-125 | .8 | 20 | |
| Magnesium | mg/L | 0.093J | 5 | 5 | 4.9 | 4.9 | 96 | 97 | 75-125 | .9 | 20 | |
| Manganese | mg/L | <0.00066 | .5 | .5 | 0.49 | 0.49 | 98 | 98 | 75-125 | .1 | 20 | |
| Nickel | mg/L | 0.00033J | .5 | .5 | 0.49 | 0.49 | 98 | 98 | 75-125 | .6 | 20 | |
| Selenium | mg/L | 0.021 | .5 | .5 | 0.53 | 0.53 | 101 | 101 | 75-125 | .5 | 20 | |
| Silver | mg/L | <0.00034 | .25 | .25 | 0.26 | 0.26 | 103 | 103 | 75-125 | .08 | 20 | |
| Sodium | mg/L | 10.4 | 5 | 5 | 15.3 | 15.2 | 98 | 96 | 75-125 | .8 | 20 | |
| Thallium | mg/L | <0.0014 | .5 | .5 | 0.46 | 0.47 | 93 | 93 | 75-125 | .5 | 20 | |
| Zinc | mg/L | <0.0026 | .5 | .5 | 0.48 | 0.48 | 97 | 97 | 75-125 | .1 | 20 | |

MATRIX SPIKE SAMPLE: 129562

| Parameter | Units | 4014288001 Result | Spike Conc. | MS Result | MS % Rec | % Rec Limits | Qualifiers |
|---|---|---|---|---|---|---|---|
| Aluminum | mg/L | 21.97 | 5 | 26.7 | 95 | 75-125 | |
| Antimony | mg/L | 0.00211J | .5 | 0.50 | 99 | 75-125 | |
| Arsenic | mg/L | 0.002528J | .5 | 0.48 | 96 | 75-125 | |
| Barium | mg/L | 0.4721 | .5 | 0.94 | 94 | 75-125 | |
| Beryllium | mg/L | <0.000040 | .5 | 0.49 | 98 | 75-125 | |
| Boron | mg/L | 0.625 | .5 | 1.1 | 97 | 75-125 | |
| Cadmium | mg/L | 0.0001578J | .5 | 0.47 | 95 | 75-125 | |
| Calcium | mg/L | 70.97 | 5 | 75.9 | 99 | 75-125 | |
| Chromium | mg/L | 0.01262 | .5 | 0.49 | 96 | 75-125 | |



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# QUALITY CONTROL DATA

Project: 3081.93 DAIRYLAND POWER COOP
Pace Project No.: 4014247

MATRIX SPIKE SAMPLE: 129562

| Parameter | Units | 4014288001 Result | Spike Conc. | MS Result | MS % Rec | % Rec Limits | Qualifiers |
|---|---|---|---|---|---|---|---|
| Copper | mg/L | 0.002597J | .5 | 0.48 | 96 | 75-125 | |
| Iron | mg/L | <0.0072 | 5 | 5.1 | 101 | 75-125 | |
| Lead | mg/L | 0.002311J | .5 | 0.48 | 95 | 75-125 | |
| Magnesium | mg/L | 0.05902J | 5 | 5.0 | 98 | 75-125 | |
| Manganese | mg/L | <0.00066 | .5 | 0.48 | 96 | 75-125 | |
| Nickel | mg/L | 0.0003864J | .5 | 0.48 | 96 | 75-125 | |
| Selenium | mg/L | 0.003411J | .5 | 0.48 | 95 | 75-125 | |
| Silver | mg/L | <0.00034 | .25 | 0.24 | 98 | 75-125 | |
| Sodium | mg/L | 123.5 | 5 | 125 | 38 | 75-125 | P6 |
| Thallium | mg/L | <0.0014 | .5 | 0.46 | 91 | 75-125 | |
| Zinc | mg/L | <0.0026 | .5 | 0.49 | 97 | 75-125 | |



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# QUALITY CONTROL DATA

Project: 3081.93 DAIRYLAND POWER COOP
Pace Project No.: 4014247

QC Batch: MPRP/2297
QC Batch Method: EPA 3050
Analysis Method: EPA 6010
Analysis Description: 6010 MET
Associated Lab Samples: 4014247003

METHOD BLANK: 129563
Matrix: Solid
Associated Lab Samples: 4014247003

| Parameter | Units | Blank Result | Reporting Limit | Analyzed | Qualifiers |
|---|---|---|---|---|---|
| Aluminum | mg/kg | <0.62 | 25.0 | 02/25/09 21:45 | |
| Antimony | mg/kg | <0.060 | 1.0 | 02/25/09 21:45 | |
| Arsenic | mg/kg | <0.059 | 1.0 | 02/25/09 21:45 | |
| Barium | mg/kg | <0.053 | 0.25 | 02/25/09 21:45 | |
| Beryllium | mg/kg | <0.0026 | 0.20 | 02/25/09 21:45 | |
| Boron | mg/kg | 1.1J | 5.0 | 02/25/09 21:45 | |
| Cadmium | mg/kg | <0.0063 | 0.25 | 02/25/09 21:45 | |
| Calcium | mg/kg | <2.4 | 10.0 | 02/26/09 15:16 | |
| Chromium | mg/kg | <0.028 | 0.25 | 02/25/09 21:45 | |
| Cobalt | mg/kg | <0.015 | 0.25 | 02/25/09 21:45 | |
| Copper | mg/kg | <0.16 | 0.50 | 02/25/09 21:45 | |
| Iron | mg/kg | 1.5J | 5.0 | 02/25/09 21:45 | |
| Lead | mg/kg | 0.048J | 0.50 | 02/25/09 21:45 | |
| Magnesium | mg/kg | <0.81 | 10.0 | 02/26/09 15:16 | |
| Manganese | mg/kg | 0.023J | 0.25 | 02/25/09 21:45 | |
| Molybdenum | mg/kg | <0.012 | 1.0 | 02/25/09 21:45 | |
| Nickel | mg/kg | <0.022 | 0.50 | 02/25/09 21:45 | |
| Selenium | mg/kg | <0.073 | 1.0 | 02/25/09 21:45 | |
| Silver | mg/kg | <0.011 | 0.50 | 02/25/09 21:45 | |
| Sodium | mg/kg | 4.8J | 50.0 | 02/26/09 16:42 | |
| Strontium | mg/kg | <0.014 | 0.25 | 02/25/09 21:45 | |
| Thallium | mg/kg | <0.19 | 2.0 | 02/25/09 21:45 | |
| Vanadium | mg/kg | <0.023 | 0.25 | 02/25/09 21:45 | |
| Zinc | mg/kg | <0.22 | 2.0 | 02/25/09 21:45 | |

LABORATORY CONTROL SAMPLE: 129564

| Parameter | Units | Spike Conc. | LCS Result | LCS % Rec | % Rec Limits | Qualifiers |
|---|---|---|---|---|---|---|
| Aluminum | mg/kg | 250 | 251 | 100 | 80-120 | |
| Antimony | mg/kg | 25 | 24.1 | 96 | 80-120 | |
| Arsenic | mg/kg | 25 | 24.2 | 97 | 80-120 | |
| Barium | mg/kg | 25 | 24.8 | 99 | 80-120 | |
| Beryllium | mg/kg | 25 | 24.6 | 98 | 80-120 | |
| Boron | mg/kg | 25 | 24.9 | 99 | 80-120 | |
| Cadmium | mg/kg | 25 | 23.9 | 96 | 80-120 | |
| Calcium | mg/kg | 250 | 237 | 95 | 80-120 | |
| Chromium | mg/kg | 25 | 24.8 | 99 | 80-120 | |
| Cobalt | mg/kg | 25 | 24.9 | 100 | 80-120 | |
| Copper | mg/kg | 25 | 24.0 | 96 | 80-120 | |
| Iron | mg/kg | 250 | 260 | 104 | 80-120 | |
| Lead | mg/kg | 25 | 24.1 | 96 | 80-120 | |



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# QUALITY CONTROL DATA

Project: 3081.93 DAIRYLAND POWER COOP
Pace Project No.: 4014247

LABORATORY CONTROL SAMPLE: 129564

| Parameter | Units | Spike Conc. | LCS Result | LCS % Rec | % Rec Limits | Qualifiers |
|---|---|---|---|---|---|---|
| Magnesium | mg/kg | 250 | 229 | 92 | 80-120 | |
| Manganese | mg/kg | 25 | 24.3 | 97 | 80-120 | |
| Molybdenum | mg/kg | 25 | 25.3 | 101 | 80-120 | |
| Nickel | mg/kg | 25 | 24.5 | 98 | 80-120 | |
| Selenium | mg/kg | 25 | 23.2 | 93 | 80-120 | |
| Silver | mg/kg | 12.5 | 12.0 | 96 | 80-120 | |
| Sodium | mg/kg | 250 | 270 | 108 | 80-120 | |
| Strontium | mg/kg | 25 | 24.4 | 98 | 80-120 | |
| Thallium | mg/kg | 25 | 23.4 | 93 | 80-120 | |
| Vanadium | mg/kg | 25 | 24.1 | 96 | 80-120 | |
| Zinc | mg/kg | 25 | 25.0 | 100 | 80-120 | |

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 129565 129566

| Parameter | Units | 4014313009 Result | MS Spike Conc. | MSD Spike Conc. | MS Result | MSD Result | MS % Rec | MSD % Rec | % Rec Limits | RPD | Max RPD | Qual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Aluminum | mg/kg | 17900 | 329 | 328 | 16000 | 13800 | -577 | -1250 | 75-125 | 15 | 20 | P6 |
| Antimony | mg/kg | 0.57J | 32.9 | 32.8 | 5.4 | 6.2 | 15 | 17 | 75-125 | 14 | 20 | M0 |
| Arsenic | mg/kg | 9.4 | 32.9 | 32.8 | 36.1 | 35.9 | 81 | 81 | 75-125 | .6 | 20 | |
| Barium | mg/kg | 308 | 32.9 | 32.8 | 299 | 406 | -26 | 300 | 75-125 | 30 | 20 | P6,R1 |
| Beryllium | mg/kg | 0.39 | 32.9 | 32.8 | 27.4 | 27.4 | 82 | 82 | 75-125 | .06 | 20 | |
| Boron | mg/kg | 8.9 | 32.9 | 32.8 | 38.0 | 38.1 | 88 | 89 | 75-125 | .2 | 20 | |
| Cadmium | mg/kg | 4.7 | 32.9 | 32.8 | 31.6 | 30.5 | 82 | 79 | 75-125 | 3 | 20 | |
| Calcium | mg/kg | 77100 | 329 | 328 | 92800 | 85300 | 4790 | 2500 | 75-125 | 8 | 20 | P6 |
| Chromium | mg/kg | 23.1 | 32.9 | 32.8 | 43.9 | 40.5 | 63 | 53 | 75-125 | 8 | 20 | M0 |
| Cobalt | mg/kg | 3.2 | 32.9 | 32.8 | 29.5 | 28.9 | 80 | 78 | 75-125 | 2 | 20 | |
| Copper | mg/kg | 28.6 | 32.9 | 32.8 | 43.9 | 40.0 | 47 | 35 | 75-125 | 9 | 20 | M0 |
| Iron | mg/kg | 14000 | 329 | 328 | 20300 | 19000 | 1910 | 1530 | 75-125 | 6 | 20 | P6 |
| Lead | mg/kg | 154 | 32.9 | 32.8 | 93.7 | 68.5 | -184 | -261 | 75-125 | 31 | 20 | P6,R1 |
| Magnesium | mg/kg | 29900 | 329 | 328 | 34800 | 31700 | 1510 | 544 | 75-125 | 10 | 20 | P6 |
| Manganese | mg/kg | 232 | 32.9 | 32.8 | 300 | 244 | 206 | 37 | 75-125 | 20 | 20 | P6,R1 |
| Molybdenum | mg/kg | 1.0J | 32.9 | 32.8 | 28.5 | 28.5 | 84 | 84 | 75-125 | .2 | 20 | |
| Nickel | mg/kg | 10.2 | 32.9 | 32.8 | 34.4 | 32.5 | 74 | 68 | 75-125 | 6 | 20 | M0 |
| Selenium | mg/kg | <0.096 | 32.9 | 32.8 | 27.9 | 27.9 | 85 | 85 | 75-125 | .08 | 20 | |
| Silver | mg/kg | 0.21J | 16.5 | 16.5 | 15.8 | 15.7 | 95 | 94 | 75-125 | .7 | 20 | |
| Sodium | mg/kg | 2030 | 329 | 328 | 2000 | 1550 | -8 | -146 | 75-125 | 25 | 20 | P6,R1 |
| Strontium | mg/kg | 83.8 | 32.9 | 32.8 | 112 | 98.9 | 86 | 46 | 75-125 | 12 | 20 | M0 |
| Thallium | mg/kg | <0.25 | 32.9 | 32.8 | 24.1 | 24.1 | 73 | 73 | 75-125 | .3 | 20 | M0 |
| Vanadium | mg/kg | 27.5 | 32.9 | 32.8 | 50.9 | 47.9 | 71 | 62 | 75-125 | 6 | 20 | M0 |
| Zinc | mg/kg | 203 | 32.9 | 32.8 | 211 | 270 | 23 | 206 | 75-125 | 25 | 20 | P6,R1 |



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# QUALITY CONTROL DATA

Project: 3081.93 DAIRYLAND POWER COOP
Pace Project No.: 4014247

QC Batch: WET/3135 | Analysis Method: SM 2540C
QC Batch Method: SM 2540C | Analysis Description: 2540C Total Dissolved Solids
Associated Lab Samples: 4014247004

METHOD BLANK: 129593 | Matrix: Water
Associated Lab Samples: 4014247004

| Parameter | Units | Blank Result | Reporting Limit | Analyzed | Qualifiers |
|---|---|---|---|---|---|
| Total Dissolved Solids | mg/L | <12.0 | 20.0 | 02/25/09 11:28 | |

LABORATORY CONTROL SAMPLE: 129594

| Parameter | Units | Spike Conc. | LCS Result | LCS % Rec | % Rec Limits | Qualifiers |
|---|---|---|---|---|---|---|
| Total Dissolved Solids | mg/L | 741 | 768 | 104 | 80-120 | |

SAMPLE DUPLICATE: 129595

| Parameter | Units | 4014247004 Result | Dup Result | RPD | Max RPD | Qualifiers |
|---|---|---|---|---|---|---|
| Total Dissolved Solids | mg/L | 1680 | 1710 | 2 | 10 | |



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# QUALITY CONTROL DATA

Project: 3081.93 DAIRYLAND POWER COOP
Pace Project No.: 4014247

QC Batch: WET/3138
QC Batch Method: EPA 120.1
Analysis Method: EPA 120.1
Analysis Description: 120.1 Specific Conductance
Associated Lab Samples: 4014247004

METHOD BLANK: 129717
Matrix: Water
Associated Lab Samples: 4014247004

| Parameter | Units | Blank Result | Reporting Limit | Analyzed | Qualifiers |
|---|---|---|---|---|---|
| Specific Conductance | umhos/cm | <1.2 | 10.0 | 02/25/09 10:00 | |

LABORATORY CONTROL SAMPLE: 129718

| Parameter | Units | Spike Conc. | LCS Result | LCS % Rec | % Rec Limits | Qualifiers |
|---|---|---|---|---|---|---|
| Specific Conductance | umhos/cm | 345 | 332 | 96 | 80-120 | |

SAMPLE DUPLICATE: 129719

| Parameter | Units | 4014247004 Result | Dup Result | RPD | Max RPD | Qualifiers |
|---|---|---|---|---|---|---|
| Specific Conductance | umhos/cm | 2.8J | 2.8J | | 20 | |



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# QUALITY CONTROL DATA

Project: 3081.93 DAIRYLAND POWER COOP
Pace Project No.: 4014247

QC Batch: MPRP/2312
QC Batch Method: EPA 6010
Analysis Method: EPA 6010
Analysis Description: 6010 MET Dissolved
Associated Lab Samples: 4014247001

METHOD BLANK: 131035
Matrix: Water
Associated Lab Samples: 4014247001

| Parameter | Units | Blank Result | Reporting Limit | Analyzed | Qualifiers |
|---|---|---|---|---|---|
| Boron, Dissolved | ug/L | 0.85J | 100 | 03/03/09 22:24 | |
| Calcium, Dissolved | ug/L | 9.5J | 200 | 03/03/09 22:24 | |
| Chromium, Dissolved | ug/L | <1.1 | 5.0 | 03/03/09 22:24 | |
| Potassium, Dissolved | ug/L | <39.9 | 200 | 03/03/09 22:24 | |
| Sodium, Dissolved | ug/L | <12.9 | 1000 | 03/03/09 22:24 | |

LABORATORY CONTROL SAMPLE: 131036

| Parameter | Units | Spike Conc. | LCS Result | LCS % Rec | % Rec Limits | Qualifiers |
|---|---|---|---|---|---|---|
| Boron, Dissolved | ug/L | 500 | 512 | 102 | 80-120 | |
| Calcium, Dissolved | ug/L | 5000 | 4900 | 98 | 80-120 | |
| Chromium, Dissolved | ug/L | 500 | 492 | 98 | 80-120 | |
| Potassium, Dissolved | ug/L | 5000 | 4970 | 99 | 80-120 | |
| Sodium, Dissolved | ug/L | 5000 | 5070 | 101 | 80-120 | |

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 131037 131038

| Parameter | Units | 4014247001 Result | MS Spike Conc. | MSD Spike Conc. | MS Result | MSD Result | MS % Rec | MSD % Rec | % Rec Limits | RPD | Max RPD | Qual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boron, Dissolved | ug/L | 369 | 500 | 500 | 904 | 890 | 107 | 104 | 75-125 | 2 | 20 | |
| Calcium, Dissolved | ug/L | 1280000 | 5000 | 5000 | 1260000 | 1230000 | -320 | -900 | 75-125 | 2 | 20 | P6 |
| Chromium, Dissolved | ug/L | 988 | 500 | 500 | 1450 | 1430 | 93 | 89 | 75-125 | 1 | 20 | |
| Potassium, Dissolved | ug/L | 42300 | 5000 | 5000 | 47100 | 45700 | 97 | 68 | 75-125 | 3 | 20 | P6 |
| Sodium, Dissolved | ug/L | 144000 | 5000 | 5000 | 146000 | 143000 | 32 | -20 | 75-125 | 2 | 20 | P6 |



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# QUALITY CONTROL DATA

Project: 3081.93 DAIRYLAND POWER COOP
Pace Project No.: 4014247

QC Batch: WETA/3319 | Analysis Method: EPA 300.0
QC Batch Method: EPA 300.0 | Analysis Description: 300.0 IC Anions,Dissolved
Associated Lab Samples: 4014247002

METHOD BLANK: 131508 | Matrix: Water
Associated Lab Samples: 4014247002

| Parameter | Units | Blank Result | Reporting Limit | Analyzed | Qualifiers |
|---|---|---|---|---|---|
| Chloride | mg/L | <1.1 | 5.0 | 03/03/09 18:36 | |
| Sulfate | mg/L | <0.51 | 4.0 | 03/03/09 18:36 | |

LABORATORY CONTROL SAMPLE: 131509

| Parameter | Units | Spike Conc. | LCS Result | LCS % Rec | % Rec Limits | Qualifiers |
|---|---|---|---|---|---|---|
| Chloride | mg/L | 20 | 19.3 | 97 | 90-110 | |
| Sulfate | mg/L | 20 | 18.9 | 95 | 90-110 | |

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 131510 131511

| Parameter | Units | 1088653001 Result | MS Spike Conc. | MSD Spike Conc. | MS Result | MSD Result | MS % Rec | MSD % Rec | % Rec Limits | RPD | Max RPD | Qual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Chloride | mg/L | | 20 | 20 | 27.1 | 27.2 | 97 | 98 | 90-110 | .5 | 20 | |
| Sulfate | mg/L | | 20 | 20 | 28.2 | 28.3 | 92 | 93 | 90-110 | .5 | 20 | |

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 131512 131513

| Parameter | Units | 4014209001 Result | MS Spike Conc. | MSD Spike Conc. | MS Result | MSD Result | MS % Rec | MSD % Rec | % Rec Limits | RPD | Max RPD | Qual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Chloride | mg/L | 940 | 400 | 400 | 1360 | 1360 | 105 | 105 | 90-110 | .2 | 20 | |
| Sulfate | mg/L | 51.3 | | | 73.1 | 73.3 | | | | .2 | 20 | |



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# QUALITY CONTROL DATA

Project: 3081.93 DAIRYLAND POWER COOP
Pace Project No.: 4014247

QC Batch: MERP/1452
QC Batch Method: EPA 7470
Analysis Method: EPA 7470
Analysis Description: 7470 Mercury ASTM
Associated Lab Samples: 4014247003

METHOD BLANK: 131948
Matrix: Water
Associated Lab Samples: 4014247003

| Parameter | Units | Blank Result | Reporting Limit | Analyzed | Qualifiers |
|---|---|---|---|---|---|
| Mercury | ug/L | <0.10 | 0.20 | 03/05/09 11:22 | |

LABORATORY CONTROL SAMPLE: 131949

| Parameter | Units | Spike Conc. | LCS Result | LCS % Rec | % Rec Limits | Qualifiers |
|---|---|---|---|---|---|---|
| Mercury | ug/L | 5 | 4.9 | 98 | 85-115 | |

MATRIX SPIKE SAMPLE: 131950

| Parameter | Units | 4014247003 Result | Spike Conc. | MS Result | MS % Rec | % Rec Limits | Qualifiers |
|---|---|---|---|---|---|---|---|
| Mercury | ug/L | <0.10 | 5 | 4.8 | 97 | 85-115 | |

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 131951 131952

| Parameter | Units | 4014288001 Result | MS Spike Conc. | MSD Spike Conc. | MS Result | MSD Result | MS % Rec | MSD % Rec | % Rec Limits | RPD | Max RPD | Qual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mercury | ug/L | <0.10 | 5 | 5 | 4.9 | 4.8 | 98 | 97 | 85-115 | 1 | 20 | |



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# QUALITY CONTROL DATA

Project: 3081.93 DAIRYLAND POWER COOP
Pace Project No.: 4014247

QC Batch: WETA/3344
QC Batch Method: EPA 300.0
Analysis Method: EPA 300.0
Analysis Description: 300.0 IC Anions ASTM
Associated Lab Samples: 4014247003

METHOD BLANK: 132275
Matrix: Water
Associated Lab Samples: 4014247003

| Parameter | Units | Blank Result | Reporting Limit | Analyzed | Qualifiers |
|---|---|---|---|---|---|
| Sulfate | mg/L | <0.36 | 4.0 | 03/05/09 18:06 | |

LABORATORY CONTROL SAMPLE: 132276

| Parameter | Units | Spike Conc. | LCS Result | LCS % Rec | % Rec Limits | Qualifiers |
|---|---|---|---|---|---|---|
| Sulfate | mg/L | 20 | 18.8 | 94 | 90-110 | |

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 132277 132278

| Parameter | Units | 4014247003 Result | MS Spike Conc. | MSD Spike Conc. | MS Result | MSD Result | MS % Rec | MSD % Rec | % Rec Limits | RPD | Max RPD | Qual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sulfate | mg/L | 784 | 1000 | 1000 | 1720 | 1720 | 94 | 93 | 80-120 | .09 | 20 | |



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# QUALIFIERS

Project: 3081.93 DAIRYLAND POWER COOP
Pace Project No.: 4014247

## DEFINITIONS

DF - Dilution Factor, if reported, represents the factor applied to the reported data due to changes in sample preparation, dilution of the sample aliquot, or moisture content.

ND - Not Detected at or above adjusted reporting limit.

J - Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit.

MDL - Adjusted Method Detection Limit.

S - Surrogate

1,2-Diphenylhydrazine (8270 listed analyte) decomposes to Azobenzene.

Consistent with EPA guidelines, unrounded data are displayed and have been used to calculate % recovery and RPD values.

LCS(D) - Laboratory Control Sample (Duplicate)

MS(D) - Matrix Spike (Duplicate)

DUP - Sample Duplicate

RPD - Relative Percent Difference

NC - Not Calculable.

Pace Analytical is NELAP accredited. Contact your Pace PM for the current list of accredited analytes.

U - Indicates the compound was analyzed for, but not detected.

## ANALYTE QUALIFIERS

| | |
|---|---|
| 1j | Analyte was detected in the associated ASTM blank at 1.51umho/cm. |
| 2j | Analyte was detected in the associated extraction blank at 0.0026 mg/L. |
| 3j | Analyte was detected in the associated extraction blank at 0.21 mg/L. |
| D3 | Sample was diluted due to the presence of high levels of non-target analytes or other matrix interference. |
| H6 | Analysis initiated more than 15 minutes after sample collection. |
| M0 | Matrix spike recovery was outside laboratory control limits. |
| P6 | Matrix spike recovery was outside laboratory control limits due to a parent sample concentration notably higher than the spike level. |
| R1 | RPD value was outside control limits. |



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# CHAIN OF CUSTODY RECORD

√4 № 063214

RMT

744 Heartland Trail, P.O. Box 8923 • Madison, WI 53708-8923 • Phone (608) 831-4444 • FAX (608) 831-3334

Project No. 3081.93

Project/Client: Dairyland Power Coop

Project Manager/Contact Person: Curt Madsen

Filtered (Yes/No): Y Y Y

Preserved (Code): B A A

Analyses Requested: B, Ca, Cr, K, Na; Chloride, Specific cond.; Sulfate, TSS; Al, Sb, As, Ba, Be, B, Cd; Ca, Cr, Co, Cu, Fe, Pb; Mg, Mn, Mo, Ni, Se, Ag; Na, Sr, Tl, V, Zn; ASTM D3987-85, pH, Hg and TDS, Sulfate, Specific Cond.

PRESERVED CODES: A - NONE; B - $HNO_3$; C - $H_2SO_4$; D - NaOH; E - HCl; F - METHANOL; G - _____

| Lab No. | Yr. 09 Date | Time | Sample Station ID | Total Number Of Containers | MATRIX | B, Ca, Cr, K, Na | Chloride, Specific cond. | Sulfate, TSS | Al, Sb, As, Ba, Be, B, Cd | Ca, Cr, Co, Cu, Fe, Pb | Mg, Mn, Mo, Ni, Se, Ag | Na, Sr, Tl, V, Zn | ASTM D3987-85, pH, Hg and TDS, Sulfate, Specific Cond. | Comments: |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 001 | 2/18 | 4:00PM | Conc. Leachate - Preserved 500ml | 1 | Aq | X | | | | | | | | Preserved to pH <2 w/ $HNO_3$ |
| 002 | 2/18 | 4:00PM | Conc. Leachate ↓ | 1 | Aq | | X | X | | | | | | |
| 003 | 2/18 | 4:00PM | Sherco #3 Scrubber Mat. 32oz | 1 | S | | | | X | X | X | X | X | Use this sample for both total metals and Water leach test. Plenty of solid is provided. Comp Metals use this list, ASTM Water leach, use same metals list, but omit Co, Mo, Sr and V. Please measure pH After Water leach and also analyze Hg and TDS, Sulfate and specific Conductor |

SPECIAL INSTRUCTIONS: The analyte list for these may be confusing. See attached Memo.

| SAMPLER Relinquished by (Sig.) | Date/Time | Received by (Sig.) | Date/Time |
|---|---|---|---|
| [signature] | 2/19/09 7:00 AM | D. Fenwick | 2/19/9 0850 |
| Relinquished by (Sig.) D. Fenwick | Date/Time 2/19/9 1700 | Received by (Sig.) Walto | Date/Time |
| Relinquished by (Sig.) Walto | Date/Time 2/20/09 8:30 | Received by (Sig.) L. Mann | Date/Time 2/20/09 8:30 |

HAZARDS ASSOCIATED WITH SAMPLES: [ ] Flammable [ ] Corrosive [ ] Highly Toxic [ ] Other (list) _____

Turn Around (circle one): Normal Rush

Report Due _____

(For Lab Use Only) #4014247

Receipt Temp: Temp Blank Y N ROI

Receipt pH (Wet/Metals) OK

Custody Seal: Present/Absent Intact/Not Intact Seal #'s

F-268 (R6/95)

WHITE - LABORATORY COPY YELLOW - REPORT APPENDIX PINK - SAMPLER/SUBMITTER

# Sample Condition Upon Receipt

Pace Analytical

Client Name: LMT Project # 4014247

Courier: ☐ Fed Ex ☐ UPS ☐ USPS ☐ Client ☒ Commercial ☐ Pace Other _____

Tracking #: _____

Custody Seal on Cooler/Box Present: ☐ yes ☒ no Seals intact: ☐ yes ☐ no

Packing Material: ☐ Bubble Wrap ☐ Bubble Bags ☒ None ☐ Other _____

Thermometer Used NA Type of Ice: Wet Blue None ☐ Samples on ice, cooling process has begun

Cooler Temperature NOE Biological Tissue is Frozen: Yes No

Date and Initials of person examining contents: 2/20/09

Temp should be above freezing to 6°C

| | | Comments: |
|---|---|---|
| Chain of Custody Present: | ☒Yes ☐No ☐N/A | 1. |
| Chain of Custody Filled Out: | ☒Yes ☐No ☐N/A | 2. |
| Chain of Custody Relinquished: | ☒Yes ☐No ☐N/A | 3. |
| Sampler Name & Signature on COC: | ☒Yes ☐No ☐N/A | 4. |
| Samples Arrived within Hold Time: | ☒Yes ☐No ☐N/A | 5. |
| **Short Hold Time Analysis (<72hr):** | ☐Yes ☒No ☐N/A | 6. |
| **Rush Turn Around Time Requested:** | ☐Yes ☒No ☐N/A | 7. |
| Sufficient Volume: | ☒Yes ☐No ☐N/A | 8. |
| Correct Containers Used: | ☒Yes ☐No ☐N/A | 9. |
| -Pace Containers Used: 2/20 | ☒Yes ☐No ☐N/A | |
| Containers Intact: | ☒Yes ☐No ☐N/A | 10. |
| Filtered volume received for Dissolved tests | ☐Yes ☐No ☒N/A | 11. |
| Sample Labels match COC: | ☒Yes ☐No ☐N/A | 12. |
| -Includes date/time/ID/Analysis Matrix: W/S | | |
| All containers needing preservation have been checked. | ☒Yes ☐No ☐N/A | 13. |
| All containers needing preservation are found to be in compliance with EPA recommendation. | ☒Yes ☐No ☐N/A | |
| exceptions: VOA, coliform, TOC, O&G, WI-DRO (water) | ☐Yes ☐No | Initial when completed CI / Lot # of added preservative |
| Samples checked for dechlorination: | ☐Yes ☐No ☒N/A | 14. |
| Headspace in VOA Vials ( >6mm): | ☐Yes ☐No ☒N/A | 15. |
| Trip Blank Present: | ☐Yes ☐No ☒N/A | 16. |
| Trip Blank Custody Seals Present | ☐Yes ☐No ☒N/A | |
| Pace Trip Blank Lot # (if purchased): _____ | | |

**Client Notification/ Resolution:** Field Data Required? Y / N

Person Contacted: _____ Date/Time: _____

Comments/ Resolution: _____

Project Manager Review: DAT Date: 2/26/09

Note: Whenever there is a discrepancy affecting North Carolina compliance samples, a copy of this form will be sent to the North Carolina DEHNR Certification Office ( i.e out of hold, incorrect preservative, out of temp, incorrect containers)

F-ALL-C003rev.3, 11September2006

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## TABLE 1
## BULK CHEMICAL ANALYSIS
## RESULTS FOR GENOA FLY ASH

| | | | |
|---|---|---|---|
| Sample No. | | | # 44641 |
| Sample Site | | | DPC Genoa Fly Ash |
| PARAMETER: | METHOD: | MDL: | RESULT: |
| Chloride as Cl(1:2) | EPA 325.2 | 0.6 ppm | 22.1 mg/kg |
| Fluoride as F | EPA 340.2 | 0.002 ppm | 1.48 mg/kg |
| Nitrate+Nitrite as NO3+NO2-N | EPA 353.1 | 0.01 ppm | 0.24 mg/kg |
| Total Phosphorus as P | EPA 365.4 | 50 ppm | 1,880 ppm |
| Moisture, % | EPA 160.3 | --- | 0.0 % |
| Loss on Ignition | --- | --- | 0.26 % |
| Total Organic Carbon | EPA 9060 | 0.01 | 2.0 % |
| Aluminum-Total | EPA 7020 | 200 ppm | 32,600 mg/kg * |
| Antimony-Total | EPA 7041 | 0.015 ppm | 0.157 mg/kg * |
| Arsenic-Total | EPA 7060 | 3.2 ppm | 109 mg/kg * |
| Barium-Total | EPA 7080 | 0.6 ppm | 73.1 mg/kg * |
| Beryllium-Total | EPA 7091 | 0.280 ppm | 5.07 mg/kg * |
| Boron-Total | Jackson | 6 ppm | 127 mg/kg * |
| Cadmium-Total | EPA 7130 | 0.03 ppm | 1.80 mg/kg * |
| Calcium -Total | EPA 7140 | 190 ppm | 26,900 mg/kg * |
| Chromium-Total | EPA 7190 | 0.12 ppm | 60.7 mg/kg * |
| Cobalt-Total | EPA 7201 | 0.1 ppm | 9.0 mg/kg * |
| Copper-Total | EPA 7210 | 0.35 ppm | 73.8 mg/kg * |
| Iron-Total | EPA 7380 | 540 ppm | 41,300 mg/kg * |
| Lead-Total | EPA 7420 | 0.3 ppm | 95.3 mg/kg * |
| Magnesium-Total | EPA 7450 | 20 ppm | 6,080 mg/kg * |
| Manganese-Total | EPA 7460 | 0.6 ppm | 87.0 mg/kg * |
| Mercury-Total | EPA 7471 | 0.018 ppm | 0.305 mg/kg * |
| Molybdenum-Total | EPA 7481 | 0.260 ppm | 12.1 mg/kg * |
| Nickel-Total | EPA 7520 | 0.38 ppm | 47.3 mg/kg * |
| Potassium-Total | EPA 7610 | 105 ppm | 3,070 mg/kg * |
| Selenium-Total | EPA 7740 | 0.248 ppm | 1.82 mg/kg * |
| Silica-Total | SM 3111D | 4.2 ppm | 102 mg/kg * |
| Silver-Total | EPA 272.2 | 0.003 ppm | 0.234 mg/kg * |
| Sodium-Total | EPA 7770 | 22 ppm | 2,060 mg/kg * |
| Thallium-Total | EPA 7841 | 0.047 ppm | 2.07 mg/kg * |
| Zinc-Total | EPA 7950 | 1.6 ppm | 101 mg/kg * |
| Vanadium-Total | EPA 7910 | 2 ppm | 155 mg/kg * |
| Strontium-Total | SM 3113 | 15.5 ppm | 558 mg/kg * |
| Tin-Total | EPA 282.2 | 0.273 ppm | 3.40 mg/kg * |

MDL = Minimum Detection Level
* Calculated on a 'dry weight' basis

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## TABLE 1
## BULK CHEMICAL ANALYSIS
## RESULTS FOR ALMA FLY ASH

| | | | |
|---|---|---|---|
| Sample No. | | | # 44638 |
| Sample Site | | | DPC Alma Fly Ash |
| PARAMETER: | METHOD: | MDL: | RESULT: |
| Chloride as Cl(1:2) | EPA 325.2 | 0.6 ppm | 47.4 mg/kg |
| Fluoride as F | EPA 340.2 | 0.002 ppm | 2.75 mg/kg |
| Nitrate+Nitrite as NO3+NO2-N | EPA 353.1 | 0.01 ppm | 0.24 mg/kg |
| Total Phosphorus as P | EPA 365.4 | 20 ppm | 1,850 ppm |
| Moisture, % | EPA 160.3 | --- | 0.0 % |
| Loss on Ignition | --- | --- | 6.04 % |
| Total Organic Carbon | EPA 9060 | 0.01 | 6.1 % |
| Aluminum-Total | EPA 7020 | 200 ppm | 37,000 mg/kg * |
| Antimony-Total | EPA 7041 | 0.146 ppm | <0.146 mg/kg * |
| ✓Arsenic-Total | EPA 7060 | 1.28 ppm | 76.2 mg/kg * |
| ✓Barium-Total | EPA 7080 | 6 ppm | 11 mg/kg * |
| Beryllium-Total | EPA 7091 | 0.280 ppm | 5.00 mg/kg * |
| Boron-Total | Jackson | 6 ppm | 110 mg/kg * |
| ✓Cadmium-Total | EPA 7130 | 0.03 ppm | 2.09 mg/kg * |
| Calcium -Total | EPA 7140 | 380 ppm | 69,200 mg/kg * |
| Chromium-Total | EPA 7190 | 0.12 ppm | 49.5 mg/kg * |
| Cobalt-Total | EPA 7201 | 0.1 ppm | 10.1 mg/kg * |
| Copper-Total | EPA 7210 | 0.14 ppm | 88.3 mg/kg * |
| Iron-Total | EPA 7380 | 270 ppm | 18,500 mg/kg * |
| Lead-Total | EPA 7420 | 0.3 ppm | 53.8 mg/kg * |
| Magnesium-Total | EPA 7450 | 60 ppm | 10,700 mg/kg * |
| Manganese-Total | EPA 7460 | 0.6 ppm | 148 mg/kg * |
| ✓Mercury-Total | EPA 7471 | 0.018 ppm | 0.390 mg/kg * |
| Molybdenum-Total | EPA 7481 | 260 ppm | 15.0 mg/kg * |
| Nickel-Total | EPA 7520 | 0.19 ppm | 52.6 mg/kg * |
| Potassium-Total | EPA 7610 | 105 ppm | 3,680 mg/kg * |
| ✓Selenium-Total | EPA 7740 | 0.248 ppm | 5.55 mg/kg * |
| Silica-Total | SM 3111D | 4.2 ppm | 36.4 mg/kg * |
| ✓Silver-Total | EPA 272.2 | 0.001 ppm | 0.062 mg/kg * |
| Sodium-Total | EPA 7770 | 110 ppm | 5,300 mg/kg * |
| Thallium-Total | EPA 7841 | 0.047 ppm | 1.65 mg/kg * |
| Zinc-Total | EPA 7950 | 1.6 ppm | 156 mg/kg * |
| Vanadium-Total | EPA 7910 | 10 ppm | 206 mg/kg * |
| Strontium-Total | SM 3113 | 78 ppm | 1,500 mg/kg * |
| Tin-Total | EPA 282.2 | 0.273 ppm | 6.06 mg/kg * |

MDL = Minimum Detection Level
* Calculated on a 'dry weight' basis

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## TABLE 1
## BULK CHEMICAL ANALYSIS RESULTS FOR JPM FLY ASH

Sample No. # 44640
Sample Site DPC JPM Fly Ash

| PARAMETER: | METHOD: | MDL: | RESULT: |
|---|---|---|---|
| Chloride as Cl(1:2) | EPA 325.2 | 0.6 ppm | 3.0 mg/kg |
| Fluoride as F | EPA 340.2 | 0.002 ppm | 7.88 mg/kg |
| Nitrate+Nitrite as NO3+NO2-N | EPA 353.1 | 0.01 ppm | 0.24 mg/kg |
| Total Phosphorus as P | EPA 365.4 | 20 ppm | 3,490 ppm |
| Moisture, % | EPA 160.3 | --- | 0.0 % |
| Loss on Ignition | --- | --- | 0.41 % |
| Total Organic Carbon | EPA 9060 | 0.01 | 0.41 % |
| Aluminum-Total | EPA 7020 | 400 ppm | 59,200 mg/kg |
| Antimony-Total | EPA 7041 | 0.015 ppm | 0.078 mg/kg * |
| Arsenic-Total | EPA 7060 | 3.2 ppm | 56.0 mg/kg * |
| Barium-Total | EPA 7080 | 6 ppm | 113 mg/kg * |
| Beryllium-Total | EPA 7091 | 0.066 ppm | 1.60 mg/kg * |
| Boron-Total | Jackson | 6 ppm | 63 mg/kg * |
| Cadmium-Total | EPA 7130 | 0.03 ppm | 2.29 mg/kg * |
| Calcium -Total | EPA 7140 | 380 ppm | 98,800 mg/kg * |
| Chromium-Total | EPA 7190 | 0.12 ppm | 69.2 mg/kg * |
| Cobalt-Total | EPA 7201 | 0.1 ppm | 7.9 mg/kg * |
| Copper-Total | EPA 7210 | 0.35 ppm | 156 mg/kg * |
| Iron-Total | EPA 7380 | 540 ppm | 22,700 mg/kg * |
| Lead-Total | EPA 7420 | 0.3 ppm | 31.4 mg/kg * |
| Magnesium-Total | EPA 7450 | 100 ppm | 23,900 mg/kg * |
| Manganese-Total | EPA 7460 | 1.2 ppm | 311 mg/kg * |
| Mercury-Total | EPA 7471 | 0.018 ppm | <0.018 mg/kg * |
| Molybdenum-Total | EPA 7481 | 0.065 ppm | 1.46 mg/kg * |
| Nickel-Total | EPA 7520 | 0.19 ppm | 33.3 mg/kg * |
| Potassium-Total | EPA 7610 | 21 ppm | 942 mg/kg * |
| Selenium-Total | EPA 7740 | 0.248 ppm | 1.02 mg/kg * |
| Silica-Total | SM 3111D | 21 ppm | 355 mg/kg * |
| Silver-Total | EPA 272.2 | 0.003 ppm | 0.251 mg/kg * |
| Sodium-Total | EPA 7770 | 110 ppm | 5,710 mg/kg * |
| Thallium-Total | EPA 7841 | 0.005 ppm | 0.086 mg/kg * |
| Zinc-Total | EPA 7950 | 0.4 ppm | 30.7 mg/kg * |
| Vanadium-Total | EPA 7910 | 2 ppm | 24 mg/kg * |
| Strontium-Total | SM 3113 | 155 ppm | 1,960 mg/kg * |
| Tin-Total | EPA 282.2 | 0.273 ppm | <0.273 mg/kg * |

MDL = Minimum Detection Level
* Calculated on a 'dry weight' basis

APPENDIX B

DPC Leachate Generation Procedure
(Revised August 4, 2008)

DPC Leachate Generation Procedure (revised 8/04/08)

This procedure is intended to simulate a high solid to liquid ratio leaching scenario. Use a ratio of 150 percent moisture to fly ash for leachate generation (e.g., 1000 grams fly ash/1500 mL $H_2O$) and concentrate the leachate through 5 iterations. Quarterly fly ash samples will be homogenized together to create one fly ash composite sample for leachate generation and testing.

1. Homogenize the quarterly samples in their individual buckets.

2. Create a fly ash composite using equal amounts of each quarterly sample and homogenize together.

3. Place 1,000 grams fly ash composite in a 2-liter bottle.

4. Add 1.5 liters deionized water to the bottle, and seal using an air/water-tight lid.

5. Perform the extraction by placing the bottle in a TCLP tumbler. Agitate the sample for a period of 14 – 18 hours in the tumbler end-over-end at a rate of 30 rotations per minute.

6. After the tumbling period, let the mixture settle for at least four hours and decant the supernatant by carefully pouring or using a peristaltic pump if available. Do not allow any solid material in the supernatant (leachate).

7. Measure and record the volume of the leachate.

8. Bring the volume of the leachate up to 1.5 liters with deionized water and place in a 2-liter bottle.

9. Add 1,000 grams of new fly ash composite (created in step 2) to the bottle with the re-used leachate (from step 8).

10. Repeat steps above as appropriate (i.e., reusing the leachate each time) until five iterations have been completed.

11. After the fifth iteration is complete, let the mixture sit for >24 hours to allow for maximum settling. After settling, decant the supernatant and measure volume. Pass leachate through a 0.45 μm filter using a vacuum filtration apparatus. Split the final leachate into two bottles appropriate for shipment. One bottle will remained unpreserved. Preserve the other sample according to method specifications (e.g., acidify to pH <2 for metals). Refrigerate samples and ship to laboratory for analysis.

| Date | Volume of Leachate (mL) | Notes |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | Final Volume: | |

APPENDIX C

Hydraulic Conductivity and Swell of Nonprehydrated Geosyntehtic Clay Liners Permeated with Multispecies Inorganic Solutions

Dale C. Kolstad; et. al.

# Hydraulic Conductivity and Swell of Nonprehydrated Geosynthetic Clay Liners Permeated with Multispecies Inorganic Solutions

Dale C. Kolstad, M.ASCE[1]; Craig H. Benson, M.ASCE[2]; and Tuncer B. Edil, M.ASCE[3]

**Abstract:** The influence of multispecies inorganic solutions on swelling and hydraulic conductivity of non-prehydrated geosynthetic clay liners (GCLs) containing sodium bentonite was examined. Ionic strength and the relative abundance of monovalent and divalent cations (RMD) in the permeant solution were found to influence swell of the bentonite, and the hydraulic conductivity of GCLs. Swell is directly related to RMD and inversely related to ionic strength, whereas hydraulic conductivity is directly related to ionic strength and inversely related to RMD. RMD has a greater influence for solutions with low ionic strength (e.g., 0.05 M), whereas concentration effects dominate at high ionic strength (e.g., 0.5 M). No discernable effect of cation species of similar valence was observed in the swell or hydraulic conductivity data for test solutions with similar ionic strength and RMD. A strong relationship between hydraulic conductivity and free swell was found, but the relationship must be defined empirically for a particular bentonite. A regression model relating hydraulic conductivity of the GCL to ionic strength and RMD of the permeant solution was developed. Predictions made with the model indicate that high hydraulic conductivities (i.e., $>10^{-7}$ cm/s) are not likely for GCLs in base liners in many solid waste containment facilities. However, for wastes with stronger leachates or leachates dominated by polyvalent cations, high hydraulic conductivities may occur.

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**CE Database subject headings:** Hydraulic conductivity; Swelling; Inorganic chemicals; Clay liners; Bentonite.

## Introduction

Geosynthetic clay liners (GCLs) are factory-manufactured clay liners consisting of a layer of bentonite clay encased by geotextiles or glued to a geomembrane. GCLs have become a popular alternative to compacted clay liners in waste containment applications because of their relatively low cost, ease of installation, perceived resistance to environmental distress (e.g. freeze–thaw and wet–dry cycling), smaller air–space requirements, and low hydraulic conductivity to water ($<10^{-8}$ cm/s). For GCLs that do not contain a geomembrane, bentonite is responsible for the low hydraulic conductivity. Sodium (Na) montmorillonite mineral is the primary component of bentonite, and largely controls the hydraulic conductivity of GCLs (Shackelford et al. 2000).

A variety of studies have shown that the hydraulic conductivity and swelling of bentonite can be affected by inorganic permeant solutions (Alther et al. 1985; Shan and Daniel 1991; Egloffstein 1997, 2001; Quaranta et al. 1997; Ruhl and Daniel 1997; Petrov and Rowe 1997; Shackelford et al. 2000; Jo et al. 2001; Vasko et al. 2001; Ashmawy et al. 2002; Katsumi et al. 2002, 2003; Shan and Lai 2002). The general conclusion of these studies is that the hydraulic conductivity and swelling of GCLs is sensitive to the concentration of the permeant solution and the cation valence. In general, higher hydraulic conductivity and lower swell are obtained in more concentrated solutions or solutions with a preponderance of divalent cations. However, no systematic study has been made regarding how the concentration and relative proportions of monovalent and polyvalent cations in a multispecies (i.e., more than one cation species) solution affect swelling and hydraulic conductivity of bentonite and GCLs.

Several studies have been conducted in soil science regarding the effect of multispecies solutions on the hydraulic conductivity of montmorillonitic soils (Reeve and Bower 1960; McNeal and Coleman 1966; McNeal et al. 1966; Mustafa and Hamid 1975; Malik et al. 1992). However, these studies have focused on increasing the hydraulic conductivity of montmorillonitic soils for land drainage and agricultural applications rather than maintaining low hydraulic conductivity for containment applications. Moreover, none of these studies has focused on clay soils very rich in montmorillonite, such as the Na-bentonites used for GCLs.

This paper discusses how the ionic strength and relative amounts of monovalent and divalent cations in multispecies solutions affect swelling and hydraulic conductivity of nonprehydrated GCLs containing Na-bentonite. The focus is on applications where inorganic solutes are the primary factor affecting hydraulic conductivity (e.g., conventional solid waste containment facilities for municipal, hazardous, or mining wastes) and where complete prehydration (i.e., prehydration by permeation with distilled, deionized, or potable water) is unlikely. The effects of complete prehydration and organic compounds are discussed

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Note. Discussion open until May 1, 2005. Separate discussions must be submitted for individual papers. To extend the closing date by one month, a written request must be filed with the ASCE Managing Editor. The manuscript for this paper was submitted for review and possible publication on July 23, 2003; approved on April 6, 2004. This paper is part of the *Journal of Geotechnical and Geoenvironmental Engineering*, Vol. 130, No. 12, December 1, 2004. ©ASCE, ISSN 1090-0241/2004/12-1236–1249/$18.00.

by others (e.g., Shan and Daniel 1991; Petrov and Rowe 1997; Ruhl and Daniel 1997; Shackelford et al. 2000).

## Background

### *Exchangeable Cations, Mobility of Water, and Hydration of Bentonite*

A weak interlayer bond allows the montmorillonite crystal layers to separate during hydration as water molecules enter the interlayer space (Grim 1968; van Olphen 1977). Consequently, cations on the interlayer surfaces become exchangeable, which renders the physical properties of Na-montmorillonite susceptible to interactions with the permeant liquid. The degree of exchange depends on the valence, relative abundance, and size of the cations. Generally, cations of greater valence and smaller size replace cations of lower valence and larger size. The preference for replacement is the lyotropic series, which is $Li^+ < Na^+ < K^+ < Rb^+ < Cs^+ < Mg^{2+} < Ca^{2+} < Ba^{2+} < Cu^{2+} < Al^{3+} < Fe^{3+}$ (Sposito 1981; 1989; McBride 1994). Because $Na^+$ is at the lower end of the lyotropic series, Na-bentonites are prone to cation exchange when permeated with solutions containing divalent or trivalent ions (Sposito 1981).

Water in the pores of bentonite can be considered mobile or immobile. Mobile water is bulk pore water that is free to move under a hydraulic gradient. Immobile water is bound to the external and internal (i.e., interlayer) mineral surfaces by strong electrical forces, and is believed to act as an extension of the solid surface. When the amount of immobile water in the system increases, the hydraulic conductivity of bentonite decreases because the interparticle flow paths for mobile water become more constricted and tortuous. This is especially true in bentonites where swell is constrained (e.g., needle-punched GCLs or GCLs under confining pressure) (Reeve and Ramaddoni 1965; McNeal and Coleman 1966; McNeal et al. 1966; Lagerwerff et al. 1969; Mesri and Olson 1971; Petrov and Rowe 1997; Shackelford et al. 2000; Jo et al. 2001). Changes in the volume of immobile water also cause volume changes in the bentonite (swell occurs as the volume of immobile water increases). Thus swell and hydraulic conductivity are generally inversely related for bentonites (Shackelford et al. 2000; Jo et al. 2001; Ashmawy et al. 2002; Katsumi et al. 2002).

The fraction of the pore water that is immobile is proportional to the number of layers of water molecules hydrating the interlayer surfaces of the montmorillonite particles (McBride 1994). Hydration of montmorillonite in electrolyte solutions occurs in two phases: the crystalline phase and the osmotic phase (Norrish and Quirk 1954; McBride 1994, Zhang et al. 1995; Prost et al. 1998). The crystalline phase occurs first as several molecular layers of water hydrate the interlayer and outer surfaces from the completely dry state. Osmotic hydration occurs when additional water molecules hydrate the interlayer surfaces, resulting in large interlayer distances (McBride 1994). Crystalline hydration generally results in a small expansion of the interlayer space and a limited amount of immobile water, which is manifested at the macroscale as a small amount of swelling (referred to as "crystalline swell") and higher hydraulic conductivity. Osmotic hydration can result in appreciable expansion of the interlayer space, a large fraction of the pore water being bound, and is responsible for the large amount of swelling (referred to as "osmotic swell") and low hydraulic conductivity often associated with Na-bentonites.

When the interlayer cations are monovalent, both crystalline and osmotic hydration occur, allowing the interlayer spacings to become large. However, only crystalline swelling occurs when the interlayer cations are divalent or trivalent, limiting expansion of the interlayer region to approximately 1.96 nm (four layers of water molecules). Strong electrostatic attraction between the montmorillonite sheets and the interlayer cations prevent osmotic swelling when the cations are polyvalent, despite the larger hydration energy associated with polyvalent cations (McBride 1994; 1997; Quirk and Marčelja 1997). Thus, appreciable swelling and lower hydraulic conductivity occur when the interlayer cations are monovalent, whereas very little swelling and higher hydraulic conductivity occur when the cations are divalent or trivalent (Norrish and Quirk 1954; McBride 1994; Wu et al. 1994; Egloffstein 1997, 2001; Onikata et al. 1999; Jo et al. 2001; Ashmawy et al. 2002). In monovalent solutions, the volume of swelling and spacing of the interlayer region is inversely proportional to the square root of the concentration of the solution (Norrish and Quirk 1954; McBride 1994; Zhang et al. 1995; Onikata et al. 1999).

### *Hydraulic Conductivity to Single-Species Inorganic Solutions*

Mesri and Olson (1971) studied the mechanisms controlling the hydraulic conductivity of bentonite when the interlayer cation was sodium or calcium. At similar void ratios, the hydraulic conductivity of Na-bentonite was approximately five times lower than that of the Ca-bentonite. Mesri and Olson (1971) attributed the lower hydraulic conductivity of the Na-bentonite to the presence of immobile water, which resulted in smaller and more tortuous flow paths for mobile water.

Petrov and Rowe (1997) investigated how NaCl solutions of varying concentration affected the hydraulic conductivity of a GCL containing Na-bentonite. Tests were conducted with distilled (DI) water and NaCl solutions having concentrations between 0.1–2.0 M. Hydraulic conductivity of the GCL generally increased as the NaCl concentration increased. At 2.0 M, the hydraulic conductivity was as much as 800 times higher than that with distilled water. For concentrations less than 0.1 M, the hydraulic conductivity was comparable to that obtained with distilled water. Prehydration with at least one pore volume of distilled water tempered the sensitivity of hydraulic conductivity to salt concentration. For 2.0 M NaCl, prehydration with distilled water resulted in a hydraulic conductivity 25 times lower than that obtained by direct permeation with 2.0 M NaCl. Tests conducted over a range of confining stresses (3 to 118 kPa) showed that, at a given concentration, the hydraulic conductivity can vary by a factor of 10 to 50 depending on the effective stress.

Jo et al. (2001) investigated how cation valence and concentration of single-species salt solutions affect free swell and hydraulic conductivity of nonprehydrated GCLs containing Na-bentonite. Salt solutions with cation valences of 1, 2, and 3 and concentrations between 0.005 and 1.0 M were used. All tests were conducted until the physical and chemical termination criteria in ASTM D 6766 were achieved. Permeation with salt solutions having concentrations less than 0.1 M (monovalent) or 0.01 M (divalent or trivalent) yielded hydraulic conductivities similar to those with DI water ($\approx 10^{-9}$ cm/s), regardless of cation valence. For higher concentrations, swell decreased and hydraulic conductivity increased as the concentration or valence increased. Swelling in the presence of monovalent cations followed the order of the hydrated radius ($r_h$) and the lyotropic series, with Li ($r_h \approx 0.6$ nm) solutions yielding the greatest swell and K ($r_h$

≈0.3 nm) solutions yielding the lowest swell at a given concentration. In contrast, hydraulic conductivity to the monovalent solutions was insensitive to cation species. No dependence on species was observed for swell or hydraulic conductivity when the solutions contained divalent or trivalent cations. In addition, solutions with trivalent cations resulted in swell and hydraulic conductivity essentially identical to those obtained with solutions having divalent cations at the same concentration.

Jo et al. (2001) conclude that swell and hydraulic conductivity depend more on valence at intermediate concentrations (0.025 M to 0.1 M), whereas concentration dominates at low (0.005 M) and high (1 M) concentrations. They also conclude that hydraulic conductivity and swelling have a strong inverse relationship, and suggest that swell tests can be used as an indicator of adverse chemical interactions that affect the hydraulic conductivity of GCLs.

### *Hydraulic Conductivity to Multispecies Inorganic Solutions*

Reeve and Bower (1960) investigated how sodium adsorption ratio (SAR) of the permeant solution and electrolyte concentration affected the hydraulic conductivity of a sodic (sodium rich) soil with a montmorillonitic clay fraction. SAR is a ratio describing the relative amounts of sodium, calcium, and magnesium in the pore water equilibrated with the soil, and can be written as (McBride 1994):

$$\mathrm{SAR} = \left[\frac{\mathrm{Na}^{+}}{[(\mathrm{Ca}^{2+} + \mathrm{Mg}^{2+})/2]^{1/2}}\right]_e \tag{1}$$

where the cation ($Na^+$, $Ca^{2+}$, $Mg^{2+}$) concentrations are expressed in meq/L (note: 1 meq/L=1 mN). The soil had a cation exchange capacity (CEC)=8.9 meq/100 g. The permeant solutions were Salton sea water (SAR=57) and diluted Salton sea water with SAR=40, 27.2, 18.2, and 2.2. Reeve and Bower (1960) found that the rate of monovalent for divalent exchange is a function of the divalent cation concentration and SAR of the permeant solution. At a given SAR, solutions with higher ionic strength resulted in more rapid exchange and higher hydraulic conductivity.

McNeal and Coleman (1966) and McNeal et al. (1966) used Na–Ca solutions to investigate how concentration and SAR affect swelling and hydraulic conductivity of Gila clay from New Mexico, USA, which has CEC=41.2 meq/100 g and consists of 29% montmorillonite. Swelling was quantified as the mass of "bound" solution per mass of clay. Test solutions were prepared with NaCl and $CaCl_2$ salts at concentrations of 0.8, 0.2, 0.05, 0.012, and 0.003 mN with SAR=0, 15, 25, 50, 100, and ∞. Specimens for hydraulic conductivity testing were initially equilibrated by permeation with 10 pore volumes of a 0.8 N solution having the same SAR as the test solution, and then were sequentially permeated with test solutions of decreasing concentration.

McNeal et al. (1966) found no appreciable swell in solutions with SAR=0 (all divalent) regardless of concentration, which is consistent with the lack of an osmotic swelling phase when the interlayer contains polyvalent cations (Norrish and Quirk 1954). Measurable swelling began at 0.012 N and SAR=25, and increased as the SAR of the solution increased. Decreases in hydraulic conductivity occurred with decreasing concentration and increasing SAR of the permeant solution. For example, the hydraulic conductivity was $1.5\times10^{-5}$ cm/s for a 0.8 N solution with SAR=0, $5.9\times10^{-6}$ cm/s for a 0.050 N solution with SAR=100, and $1.5\times10^{-7}$ cm/s for a 0.012 N solution with SAR=∞ (all sodium).

McNeal et al. (1966) concluded that salt concentration and SAR affect swelling and hydraulic conductivity of Gila clay in an inverse manner, which was also reported by Jo et al. (2001) for GCLs permeated with single-species solutions. Increasing the concentration or relative abundance of divalent cations (lower SAR) results in less swell and higher hydraulic conductivity. McNeal et al. (1966) postulate that swelling of montmorillonite is the dominant mechanism affecting its hydraulic conductivity because it affects the opening and closing of pores.

Mustafa and Hamid (1975) investigated how electrolyte concentration and SAR of the permeant solution affected the hydraulic conductivity of two montmorillonitic soils, one containing 32% montmorillonite and the other 14% montmorillonite. The hydraulic conductivity of both soils exhibited the same trends with concentration and SAR as reported by McNeal et al. (1966). However, Mustafa and Hamid (1975) indicate that the relationships between swell, hydraulic conductivity, and characteristics of the permeant solution are unique for each soil.

Malik et al. (1992) investigated how mixed Na–Ca solutions of various concentrations affect swelling, dispersion, and flow in two unsaturated clays reported to be montmorillonitic (the montmorillonite content was not reported). NaCl and $CaCl_2$ solutions with SAR=0, 5, 15, 25, and 50 and concentrations of 3.1, 12.5, 50, 200, and 500 mM were used. Their results were also similar to those reported by McNeal et al. (1966); swell of both soils increased and the hydraulic conductivity decreased as the concentration decreased or the SAR increased.

## Materials and Methods

### *Geosynthetic Clay Liner*

The GCL used in this study contains granular sodium bentonite encapsulated between a 170 g/m$^2$ slit-film monofilament woven geotextile and a 206 g/m$^2$ staple-fiber nonwoven geotextile. The geotextiles are bonded by needle-punching fibers that are thermally fused to the geotextiles. The specific gravity of the bentonite is 2.65, and the average mass of bentonite per area is 4.3 kg/m$^2$. The initial thickness of the GCL ranges from 5.5 to 6.5 mm, and the average initial gravimetric water content of the bentonite was 9%.

X-ray diffraction showed that the bentonite contains 86% montmorillonite, 3% quartz, 5% tridymite, 3% plagioclase feldspar, 1% K-feldspar, 1% aragonite, 1% illite/mica, and trace amounts of calcite, siderite, clinoptilolite, rutile, and gypsum. The granule size distribution for the GCL (determined by mechanical sieve analysis on the air-dry bentonite) is shown in Fig. 1 along with the granule size distribution for the GCL used by Jo et al. (2001). Both GCLs contain sand-size bentonite granules, but the GCL used in this study has smaller granules.

The CEC and composition of the exchange complex (Ca, Mg, Na, and K) were measured on two samples of bentonite from the GCL using the procedures in *Methods of Soil Analysis* (Spark 1996). Soluble salts were extracted with DI water and exchangeable metals were extracted with ammonium acetate. These replicate measurements yielded CECs of 65.2 and 73.5 meq/100 g and the following exchange complex: Na—56.1 and 40.0 meq/100 g, K—0.6 and 0.8 meq/100 g, Ca—12.0 and 15.7 meq/100 g, Mg—4.0 and 4.8 meq/100 g. Thus, the bentonite used in this study is predominantly Na-montmorillonite.

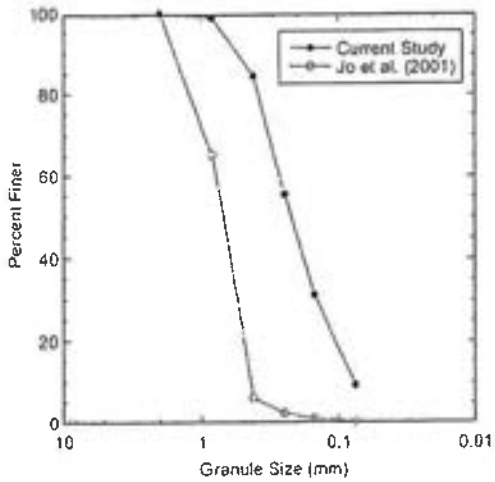


Fig. 1. Granule size distributions for geosynthetic clay liner used in this study and by Jo et al. (2001)

### Permeant Liquids

The multispecies salt solutions were prepared with anhydrous inorganic salts (>96% purity) dissociated in DI water. LiCl and NaCl salts were used to investigate the effects of monovalent cations, and $CaCl_2$ and $MgCl_2$ salts were used to investigate the effects of divalent cations. The anionic background ($Cl^-$) was held constant for all permeant solutions. Type II DI water was used to prepare the solutions and as the reference solution.

A summary of the solutions used in this study is in Table 1. All of the solutions have near neutral pH (6.6 to 8.5). The parameter RMD in Table 1 represents a ratio of the concentrations of monovalent and divalent cations in the permeant solution. RMD is defined as

$$\mathrm{RMD} = \frac{M_M}{\sqrt{M_D}} \tag{2}$$

where $M_M$=total molarity of monovalent cations; and $M_D$=total total molarity of divalent cations in the solution. RMD is slightly different from SAR in that RMD characterizes the permeant solution introduced to the soil, whereas SAR generally describes pore water equilibrated with the soil (although SAR has been used to describe solutions by some investigators). RMD also is in terms of molar concentrations (rather than normality), includes all monovalent and divalent cations (SAR is limited to Na, Mg, and Ca) in solution, and does not include a factor of 2 in the denominator (because more than two cations can contribute to $M_D$).

Solutions having ionic strength (I) ranging from 0.05 to 0.5 M and RMD from 0 to ∞ (all divalent to all monovalent) were used as permeant liquids. These solutions were selected to represent the range of ionic strengths and RMDs expected in leachate from modern disposal facilities for municipal solid waste, hazardous wastes, construction and demolition wastes, fly ash, paper sludge, and mine waste. A review of literature pertaining to the composition of leachates from these wastes is included in Kolstad (2000), and is summarized later in this paper. Most of the solutions were Li–Ca mixtures. However, tests were also conducted with Na–Mg and Li–Na–Ca–Mg mixtures to investigate how cation species affected swell and hydraulic conductivity of the GCL.

### Free Swell Tests

Free swell tests were conducted in accordance with ASTM D 5890. Bentonite from the GCL was ground to a fine powder using a mortar and pestle and dry sieved through a No. 200 U.S. standard sieve. The sieved bentonite was air dried for 24 h, and then stored in an airtight container prior to testing. A 100 mL graduated cylinder, accurate to ±0.5 mL, was filled to the 90 mL mark with the test solution. Two grams of sieved bentonite were added to the graduated cylinder in 0.1 g increments. Test solution was then added to the cylinder to reach a final volume of 100 mL by flowing the solution along the cylinder wall so that any particles adhered to the wall would be washed into solution. Swell volume (mL/2 g) was recorded after 24 h, which Jo et al. (2001) report is adequate to establish equilibrium.

### Hydraulic Conductivity Tests

Falling head hydraulic conductivity tests with constant tailwater elevation were conducted on the GCL specimens using flexible-wall permeameters in general accordance with ASTM D 5084 and D 6766. An average hydraulic gradient of 100 and effective stress of 20 kPa were applied. Hydraulic gradients this large are uncommon when testing clay soils, but are common when testing GCLs. Large gradients are acceptable when testing GCLs because the differential in effective stress across a thin specimen is not very sensitive to the hydraulic gradient (Shackelford et al. 2000). Aqueous solutions of the inorganic salts (Table 1) were used as the permeant solutions. Backpressure was not used to permit convenient collection of effluent samples for pH and electrical conductivity (EC) testing.

GCL test specimens were prepared by cutting a sample from a GCL panel using a steel cutting ring (105 mm in diameter) and a sharp utility knife following the method described in Daniel et al. (1997). A small amount of test solution was applied along the inner circumference of the ring using a squirt bottle to prevent bentonite loss when removing the specimen from the trimming ring. Excess geotextile fibers were removed from the edge of the specimen with sharp scissors to eliminate potential preferential flow paths between the GCL and flexible membrane (Petrov et al. 1997). Paste prepared with the test solution and bentonite trimmings was delicately placed along the perimeter of the specimen with a small spatula to minimize the potential for sidewall leakage during permeation.

The initial thickness of the GCL specimen was measured to the nearest 0.1 mm with a caliper. Four measurements were made and the average thickness was recorded. The initial weight of the specimen was measured to the nearest 0.01 g. On completion of the hydraulic conductivity test, the specimen was removed from the permeameter and the final thickness and weight were measured in the same manner.

Sidewall leakage and preferential flow paths along the needle-punched fibers are of concern when permeating GCLs with solutions that alter the hydraulic conductivity of bentonite. When relatively high hydraulic conductivities ($>10^{-6}$ cm/s) were obtained, the influent solution was spiked with Rhodamine WT dye (5 mg/L) to stain the flow paths bright red. For all tests that were conducted, the dye tests showed that preferential flow along the needle-punching fibers and the sidewalls did not occur. Jo et al. (2001) report similar findings in their single-species tests on GCLs.

Table 1. Summary of Permeant Solutions

| Type of solution | Ionic strength (M) | Monovalent concentration $10^{-2}$ (M) | Divalent concentration $10^{-2}$ (M) | RMD ($mM^{1/2}$) | pH | EC (S/m) |
|---|---|---|---|---|---|---|
| Li–Ca | 0.05 | 5.00 | 0.00 | ∞ | 7.4 | 0.50 |
| | | 4.35 | 0.22 | 0.93 | 7.6 | 0.48 |
| | | 3.33 | 0.56 | 0.45 | 7.7 | 0.43 |
| | | 2.00 | 1.00 | 0.20 | 7.2 | 0.42 |
| | | 0.00 | 1.67 | 0.00 | 7.8 | 0.36 |
| Na–Mg | | 3.33 | 0.56 | 0.45 | 7.4 | 0.43 |
| Li–Na | | 3.33 | 0.56 | 0.45 | 7.2 | 0.43 |
| Ca–Mg | | Li(1):Na(3)[a] | Ca(1):Mg(3)[b] | | | |
| Li–Ca | 0.1 | 10.0 | 0.00 | ∞ | 6.8 | 0.88 |
| | | 8.70 | 0.44 | 1.32 | 7.9 | 0.87 |
| | | 8.33 | 0.56 | 1.12 | 8.5 | 0.88 |
| | | 7.77 | 0.77 | 0.88 | 8.1 | 0.87 |
| | | 6.67 | 1.11 | 0.64 | 7.7 | 0.86 |
| | | 5.00 | 1.67 | 0.38 | 7.3 | 0.80 |
| | | 2.50 | 2.50 | 0.16 | 7.5 | 0.77 |
| | | 1.00 | 3.00 | 0.06 | 7.4 | 0.72 |
| | | 0.00 | 3.33 | 0.00 | 7.9 | 0.70 |
| Na–Mg | | 8.70 | 4.35 | 1.32 | 6.8 | 0.87 |
| | | 6.67 | 1.11 | 0.64 | 6.6 | 0.86 |
| | | 1.00 | 3.00 | 0.06 | 7.2 | 0.73 |
| Li–Na | | 8.33 | 0.56 | 1.12 | 7.1 | 0.88 |
| Ca–Mg | | Li(3):Na(1)[a] | Ca(3):Mg(1)[b] | | | |
| Li–Na | | 2.50 | 2.50 | 0.16 | 6.5 | 0.77 |
| Ca–Mg | | Li(1):Na(1)[a] | Ca(1):Mg(1)[b] | | | |
| Li–Ca | 0.2 | 20.0 | 0.00 | ∞ | 8.1 | 1.86 |
| | | 16.7 | 1.11 | 1.58 | 7.2 | 1.72 |
| | | 13.3 | 2.22 | 0.89 | 7.1 | 1.62 |
| | | 8.00 | 4.00 | 0.40 | 7.2 | 1.50 |
| | | 0.00 | 6.67 | 0.00 | 7.2 | 1.29 |
| Na–Mg | | 13.3 | 2.22 | 0.89 | 6.7 | 1.61 |
| Li–Na | | 8.00 | 4.00 | 0.40 | 7.2 | 1.50 |
| Ca–Mg | | Li(1):Na(3)[a] | Ca(3):Mg(1)[b] | | | |
| Li–Ca | 0.5 | 50.0 | 0.00 | ∞ | 8.1 | 3.45 |
| | | 38.5 | 3.85 | 1.97 | 7.3 | 3.46 |
| | | 31.3 | 6.25 | 1.24 | 8.2 | 3.29 |
| | | 20.0 | 10.0 | 0.64 | 8.1 | 3.03 |
| | | 0.0 | 16.7 | 0.00 | 7.6 | 2.74 |
| Na–Mg | | 31.3 | 6.25 | 1.24 | 7.2 | 3.30 |
| Li–Na | | 38.5 | 3.85 | 1.97 | 6.6 | 3.46 |
| Ca–Mg | | Li(3):Na(1)[a] | Ca(1):Mg(3)[b] | | | |
| Li–Na | | 20.0 | 10.0 | 0.64 | 6.9 | 3.02 |
| Ca–Mg | | Li(2):Na(1)[a] | Ca(1):Mg(2)[b] | | | |

Note: RMD=Relative abundance of monovalent and divalent cations; EC=Exchange capacity.

[a]Molar ratio of monovalent cations when two species are present.

[b]Molar ratio of divalent cations when two species are present

The hydraulic conductivity tests were terminated when the termination criteria in ASTM D 5084 and D 6766 were satisfied. The hydraulic conductivity was required to be steady (±25% of the mean with no statistically significant trend for at least four values), the ratio of outflow to inflow was between 0.75 and 1.25 for four consecutive values, and the pH and EC of the influent and effluent deviated less than 10%. A minimum of 2 pore volumes of flow (PVF) was also stipulated, although all tests required more than 2 PVF to satisfy all of the termination criteria (some tests required more than 150 PVF). A pH meter and a portable electrical conductivity probe were used to measure the pH and EC.

Table 2. Summary of Free Swell Data

| Ionic strength (M) | RMD $mM^{1/2}$ | Free swell (mL/2 g) Li–Ca solutions | Na–Mg solutions | Li–Na–Ca–Mg solutions |
|---|---|---|---|---|
| 0.05 | 0.93 | 30.5 | — | — |
| | 0.45 | 24.5 | 24.5 | — |
| | 0.20 | 22.0 | — | — |
| | 0.00 | 19.0 | — | — |
| 0.1 | 1.32 | 21.5 | 21.0 | — |
| | 1.12 | 21.0 | — | 21.0 |
| | 0.88 | 19.0 | — | — |
| | 0.64 | 17.5 | 17.5 | — |
| | 0.38 | 14.0 | — | — |
| | 0.16 | 13.5 | — | 13.0 |
| | 0.06 | 11.5 | 12.0 | — |
| | 0.00 | 11.0 | — | — |
| 0.2 | 1.67 | 19.0 | — | — |
| | 0.89 | 15.0 | 15.5 | — |
| | 0.40 | 12.0 | — | 12.5 |
| | 0.00 | 9.5 | — | — |
| 0.5 | 1.97 | 11.5 | — | 12.0 |
| | 1.24 | 10.5 | 10.0 | — |
| | 0.64 | 8.5 | — | 8.5 |
| | 0.00 | 6.5 | — | — |

Note: Free Swell in distilled water=36.5 mL/2 g; RMD=Relative abundance of monovalent and divalent cations.

## Results of Free Swell Tests

### *Effect of Concentration and Relative Abundance of Monovalent and Divalent Cations*

Free swell tests were conducted using solutions with ionic strengths ranging from 0.05 M to 0.5 M and RMD ranging from 0 to 1.97 $mM^{1/2}$. The multispecies solutions were prepared with Li and Ca, Na, and Mg, or Li, Na, Ca, and Mg. Results of the tests are summarized in Table 2.

Free swell is shown as a function of ionic strength in Fig. 2 for the Li–Ca solutions. The data are segregated by solutions that are predominantly divalent (RMD < 0.35 $mM^{1/2}$), solutions with comparable fractions of monovalent and divalent cations (0.35 $mM^{1/2}$ < RMD < 0.90 $mM^{1/2}$), and solutions that are predominantly monovalent (RMD > 0.90 $mM^{1/2}$). Free swell of the bentonite decreases with increasing concentration for each range of RMD. Lower free swell also occurs as the RMD decreases because the presence of more divalent cations suppresses the osmotic component of swelling. RMD also affects the sensitivity to concentration. For the predominantly monovalent solutions (RMD > 0.90 $mM^{1/2}$), the free swell decreases 19 mL/2 g, on average, as the ionic strength is varied between 0.05 to 0.5 M. For the predominantly divalent solutions (RMD < 0.35 $mM^{1/2}$), the free swell decreases 14 mL/2 g, on average, over the same range of ionic strengths.

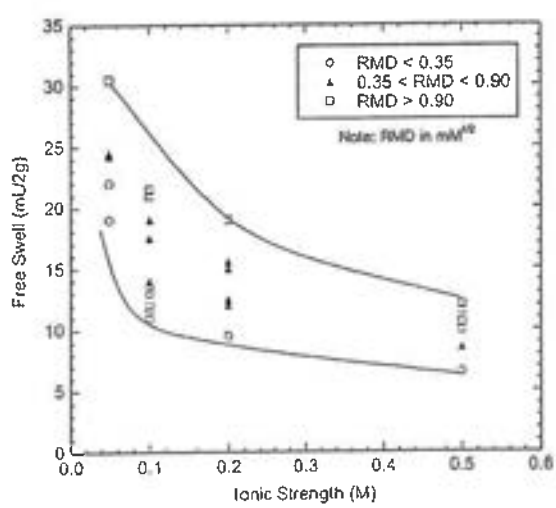


Fig. 2. Free swell of geosynthetic clay liner bentonite as a function of ionic strength for low, intermediate, and high relative abundance of monovalent and divalent cation

The influence of RMD on swell at constant ionic strength is shown in Fig. 3. The relationships are approximately linear, with trend lines fitted to the data using least-squares linear regression. The slope of each trend line reflects the sensitivity of swell to RMD; the intercept is the free swell when the solution only contains divalent cations. When the ionic strength is lower, the trend lines have a larger slope (e.g., slope=12.1 for $I$=0.05 M and 2.6 for $I$=0.5 M), which indicates that RMD has a stronger influence on swelling at low ionic strength and less effect at high ionic strength.

The trends in the free swell tests are consistent with those reported by McNeal et al. (1966) for swelling of Gila clay in mixed Na–Ca solutions. They found a unique relationship between swell and SAR when the concentration was fixed, and that the sensitivity to SAR diminished as the concentration increased. Jo et al. (2001) report similar findings for single species solutions. They found that concentration has a greater effect on free swell for monovalent solutions than divalent solutions.

The sensitivity of free swell to concentration and RMD is

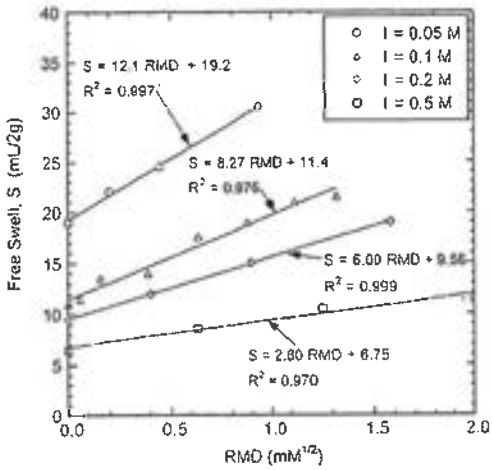


Fig. 3. Free swell of GCL bentonite as a function of RMD for ionic strengths of 0.05, 0.1, 0.2 and 0.5 M

caused by expansion and contraction of the interlayer space as a result of crystalline and osmotic swelling. This effect is illustrated in Fig. 4, which shows basal spacing (i.e., sum of interlayer separation distance and thickness of one montmorillonite layer, also referred to as $d_{001}$) as a function of ionic strength. The basal spacing was computed using the method in Smalley (1994), which is based on particle geometry, free swell of the bentonite, the thickness of a montmorillonite layer ($\approx$0.9 nm), the basal spacing of Ca-montmorillonite in water ($\approx$1.96 nm), and the free swell of Ca-montmorillonite in water ($\approx$8.0 mL/2 g). The symbol size in Fig. 4 is proportional to RMD (larger symbols for larger RMD). At high ionic strength (0.5 M), the basal spacing ($d_{001}$) ranges between 1.5 and 2.9 nm, indicating that the swelling is in the crystalline phase ($d_{001} \leq 1.96$ nm) or the low end of the osmotic phase ($d_{001} > 1.96$ nm). In contrast, the basal spacing ranges between 4.5 and 8.6 nm at lower concentration ($I \leq 0.05$ M), which corresponds to crystalline and osmotic swelling ($d_{001} > 1.96$ nm). Moreover, the smallest symbols (lowest RMD)

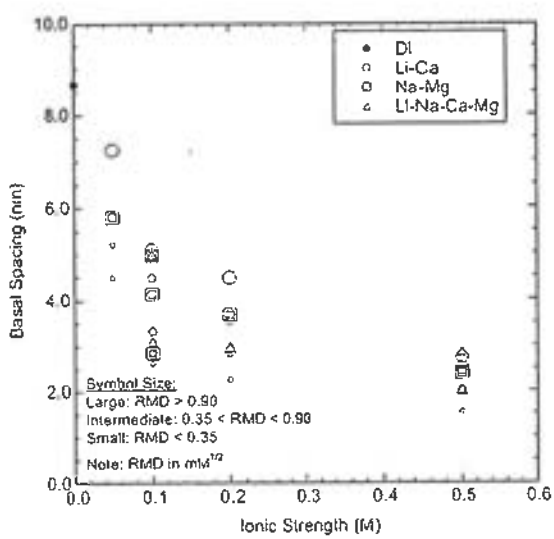


Fig. 4. Free swell of GCL bentonite as a function of computed basal spacing of montmorillonite

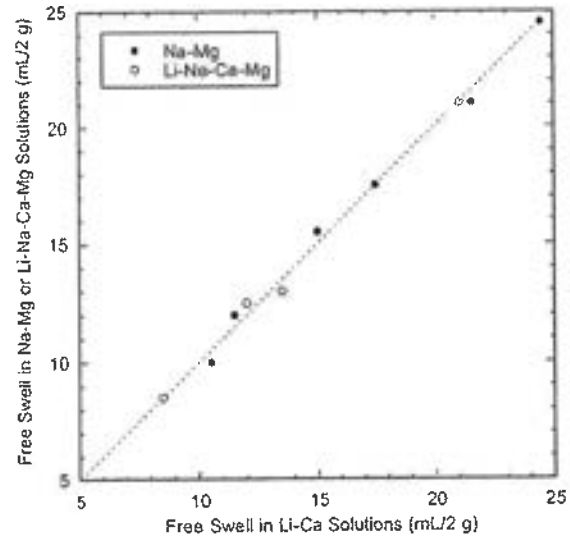


Fig. 5. Comparison of free swell of bentonite in Na–Mg and Li–Na–Ca–Mg solutions to free swell in Li–Ca solutions for solutions prepared with the same ionic strength and RMD

often correspond to the lowest $d_{001}$ for each ionic strength, reflecting suppression of osmotic swelling due to the preponderance of divalent cations.

### *Effect of Cation Species*

The influence of cation species on free swell is illustrated in Fig. 5 using data from the Li–Ca, Na–Mg, and Li–Na–Ca–Mg solutions. Swell in the Na–Mg and Li–Na–Ca–Mg solutions is essentially equal to the swell in the Li–Ca solutions at the same ionic strength and RMD. No discernable effect of cation species is evident. The tendency of divalent cations to suppress osmotic swelling, combined with the insensitivity of free swell to type of divalent cation species (i.e., as in Jo et al. 2001), probably muted any sensitivity to species for the monovalent cations. The single-species tests by Jo et al. (2001) also show that free swell in monovalent solutions is only slightly sensitive to cations species. Thus, free swell is likely to be insensitive to cation species for most monovalent–divalent cation mixtures.

## Results of Hydraulic Conductivity Tests

### *Effect of Concentration and Relative Abundance of Monovalent and Divalent Cations*

Hydraulic conductivity tests were conducted using multispecies aqueous solutions listed in Table 1. The ionic strength of the test solutions ranged from 0.05 M to 0.5 M, and the RMD ranged from 0 to 1.97 mM$^{1/2}$. Hydraulic conductivities obtained from these tests are summarized in Table 3.

Hydraulic conductivity is shown in Fig. 6 as a function of ionic strength (I). As in Fig. 2, the solutions have been characterized as primarily divalent (RMD$<$0.35 mM$^{1/2}$), comparable mixtures (0.35 mM$^{1/2}$$<$RMD$<$0.90 mM$^{1/2}$), and primarily monovalent (RMD$>$0.90 mM$^{1/2}$). The hydraulic conductivity is sensitive to the composition of the permeant solution, ranging from 5.6 $\times 10^{-10}$ cm/s ($I$=0.05 M and RMD=0.66 mM$^{1/2}$) to 1.0 $\times 10^{-5}$ cm/s ($I$=0.5 M and RMD=0), and varies exponentially

Table 3. Summary of Hydraulic Conductivities

| Ionic strength (M) | RMD ($mM^{1/2}$) | Hydraulic conductivity (cm/s) | | |
|---|---|---|---|---|
| | | Li–Ca solutions | Na–Mg solutions | Li–Na–Ca–Mg solutions |
| 0.05 | 0.93 | $5.6\times10^{-10}$ | — | — |
| | 0.45 | $1.1\times10^{-9}$ | $2.1\times10^{-9}$ | — |
| | 0.20 | $3.0\times10^{-9}$ | — | — |
| | 0.00 | $9.2\times10^{-9}$ | — | — |
| 0.1 | 1.32 | $2.4\times10^{-9}$ | $8.9\times10^{-10}$ | — |
| | 1.12 | $2.3\times10^{-9}$ | — | $4.8\times10^{-9}$ |
| | 0.88 | $3.3\times10^{-9}$ | — | — |
| | 0.64 | $5.2\times10^{-9}$ | $6.5\times10^{-9}$ | — |
| | 0.38 | $9.3\times10^{-9}$ | — | — |
| | 0.16 | $9.5\times10^{-9}$ | — | $2.1\times10^{-8}$ |
| | 0.06 | $1.1\times10^{-8}$ | $8.5\times10^{-9}$ | — |
| | 0.00 | $1.3\times10^{-8}$ | — | — |
| 0.2 | 1.67 | $2.8\times10^{-9}$ | — | — |
| | 0.89 | $2.5\times10^{-8}$ | $3.4\times10^{-8}$ | — |
| | 0.40 | $4.9\times10^{-8}$ | — | $5.2\times10^{-8}$ |
| | 0.00 | $1.0\times10^{-7}$ | — | — |
| 0.5 | 1.97 | $2.4\times10^{-7}$ | — | $9.1\times10^{-8}$ |
| 1.24 | | $8.5\times10^{-7}$ | $4.2\times10^{-7}$ | — |
| 0.64 | | $5.0\times10^{-6}$ | — | $8.5\times10^{-6}$ |
| 0.00 | | $1.0\times10^{-5}$ | — | — |

Note: Hydraulic conductivity to distilled water $=9.0\times10^{-10}$ cm/s; RMD = Relative abundance of monovalent and divalent cations.

with ionic strength (linearly on a semilogarithmic graph). The highest hydraulic conductivities at any ionic strength were obtained using the primarily divalent (RMD < 0.35 $mM^{1/2}$) solutions, and the lowest for the primarily monovalent (RMD > 0.90 $mM^{1/2}$) solutions.

The effect of RMD at constant ionic strength is shown in Fig. 7. The base-10 logarithm of hydraulic conductivity ($\log_{10}K$) is approximately linearly related to RMD. The trend lines relating

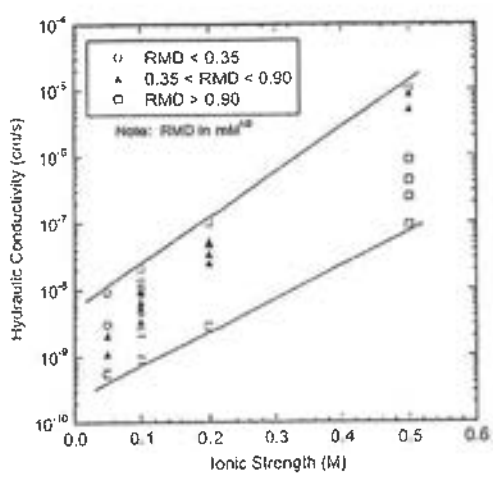


Fig. 6. Hydraulic conductivity of GCL as a function of solution ionic strength for low, intermediate, and high RMD

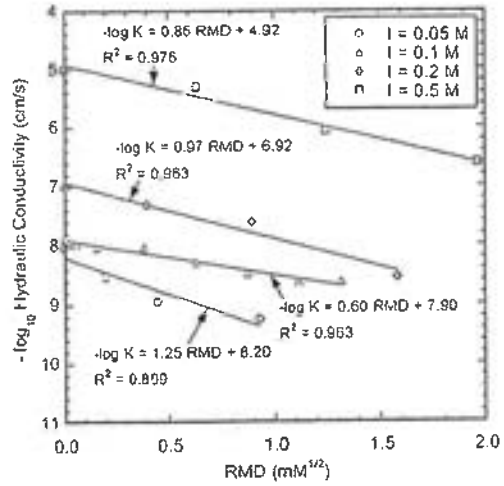


Fig. 7. Hydraulic conductivity of GCL as a function of RMD for ionic strengths of 0.05, 0.1, 0.2, and 0.5 M

$\log_{10}K$ and RMD in Fig. 7 were fit using least-squares linear regression. Their slope describes the sensitivity of hydraulic conductivity to RMD, and the intercept is the hydraulic conductivity to the divalent solution. The hydraulic conductivity exhibits greater sensitivity to RMD at lower ionic strength (i.e., slope = 1.25 at $I=0.05$ M and 0.86 at $I=0.5$ M). The data for the tests conducted at an ionic strength of 0.1 M are an exception to the trend. The reason for this deviation is unknown.

The trends in Figs. 6 and 7 are comparable to the trends reported by McNeal and Coleman (1966) for Gila clay. They found that the hydraulic conductivity increases with increasing concentration and decreasing SAR, and distinct curves relating hydraulic conductivity to SAR exists when the concentration is fixed. McNeal and Coleman (1966) report that SAR has a stronger influence on hydraulic conductivity at low concentrations, and that the effect of SAR diminishes at high concentrations. Jo et al. (2001) also report similar sensitivity to ionic strength and cation valence for single species solutions. At a given ionic strength, the highest hydraulic conductivities were obtained with divalent or trivalent solutions, and the lowest with monovalent solutions.

A diminished effect of ionic strength and RMD probably would have been observed had much lower or much higher ionic strengths been used. For example, DI water is the limiting case for dilute solutions (in this study, the hydraulic conductivity of the GCL to DI water was $9.0\times10^{-10}$ cm/s). In addition, Jo et al. (2001) report that the hydraulic conductivity of the GCL they tested leveled off between $10^{-5}$ to $10^{-4}$ cm/s for ionic strengths greater than 1 M. When the ionic strength is high, osmotic swelling becomes negligible, and the basal spacing is reduced to its smallest value in the hydrated state (≈2 nm). Once this compressed condition is reached, no further increase in hydraulic conductivity can occur. In fact, a decrease in hydraulic conductivity is possible due to the higher viscosity of concentrated solutions (Fernandez and Quigley 1988).

### *Effect of Cation Species*

Li–Ca, Na–Mg, and Li–Na–Ca–Mg solutions having various RMD and ionic strengths were used to investigate how differences in cation species affect the hydraulic conductivity of GCLs

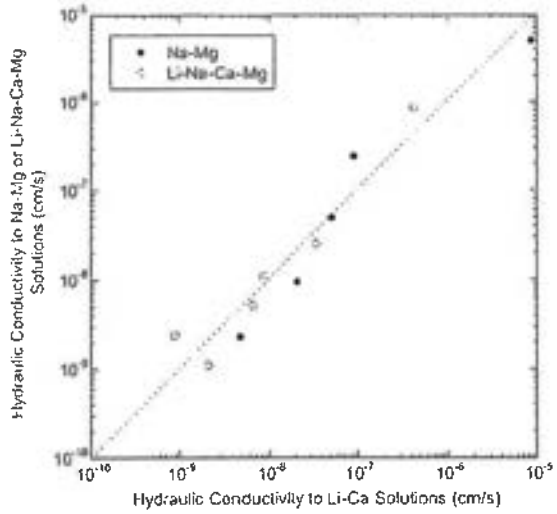


Fig. 8. Comparison of hydraulic conductivities of GCL obtained with Na–Mg and Li–Na–Ca–Mg solutions to hydraulic conductivities obtained with Li–Ca solutions for solutions prepared with the same ionic strength and RMD

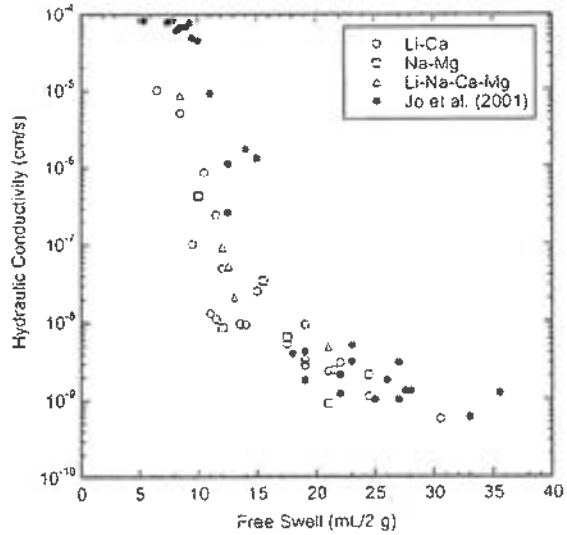


Fig. 9. Hydraulic conductivity of GCL as a function of free swell of bentonite. Test data are from this study and from Jo et al. (2001)

permeated with mixed solutions. Composition of each solution is summarized in Table 1 and the hydraulic conductivities are in Table 3.

Hydraulic conductivities obtained using the Li–Ca solutions are compared with those obtained from the Na–Mg and Li–Na–Ca–Mg solutions in Fig. 8. At comparable ionic strengths and RMD, essentially the same hydraulic conductivities were obtained with the Na–Mg and Li–Na–Ca–Mg solutions as with the Li–Ca solutions. No discernable effect of cation species is apparent. The insensitivity of hydraulic conductivity to cation species is analogous to the insensitivity of free swell to cation species. Differences in preference of the montmorillonite for Ca over Mg and Na over Li appear to have a small effect compared to the effects of RMD and concentration. In addition, Jo et al. (2001) found that the hydraulic conductivity was insensitive to cation species for a given valence.

The insensitivity to cation species evident in Fig. 8, combined with the insensitivity to cation species observed by Jo et al. (2001) for single-species solutions, suggests that the hydraulic conductivity at fixed RMD is likely to be insensitive to cation species in most monovalent–divalent mixtures. Moreover, Jo et al. (2001) found that permeation with single-species solutions containing divalent and trivalent cations yielded essentially the same hydraulic conductivity at a given concentration. Thus, the insensitivity to cation species may extend to multispecies solutions in general, with ionic strength and RMD being the dominant variables controlling hydraulic conductivity. In this case, the denominator of RMD would include the total normality of the polyvalent (valence $\geq +2$) cations in the solution. While this hypothesis is plausible, more testing is needed to confirm its validity.

## Practical Implications

### *Free Swell and Hydraulic Conductivity*

Jo et al. (2001) show that a strong relationship exists between free swell of bentonite and the hydraulic conductivity of GCLs exposed to single-species solutions. A similar relationship could be expected for multispecies solutions as well because Figs. 2, 3, 6, and 7 show that ionic strength and RMD affect swell and hydraulic conductivity in a consistent and similar manner. McNeal et al. (1966) also report a strong correlation between swelling and hydraulic conductivity for Gila clay permeated with solutions having different ionic strengths and SAR.

Hydraulic conductivity of the GCL specimens permeated with the multispecies solutions is shown in Fig. 9 as a function of free swell along with the single-species data from Jo et al. (2001). A strong relationship exists between hydraulic conductivity and free swell for both data sets. The slight offset in the two data sets at lower swell volumes (and higher hydraulic conductivities) is most likely due to differences in the granule size distributions of the bentonites and not the use of multispecies versus single species solutions. The GCLs used in both studies were essentially identical, except the bentonite in the GCL used in this study has smaller granules than the bentonite in the GCL used by Jo et al. (2001) (Fig. 1). Mesri and Olson (1971) and McNeal et al. (1966) indicate that bentonites with larger "domains" (quasi-crystals) permit larger flow paths and higher hydraulic conductivity. In addition, Katsumi et al. (2002) show that nonprehydrated GCLs containing bentonite with larger granules are more permeable than GCLs with smaller granules when permeated using stronger ($\geq$0.2 M) salt solutions. Because the granules do not swell appreciably in strong solutions, bentonites with larger granules have larger intergranular pores, and higher hydraulic conductivity. That is, the hydraulic conductivity of granular bentonite permeated with strong solutions follows a similar relationship with particle size as do granular soils; i.e., the hydraulic conductivity increases as the particle size increases, all factors being equal (e.g., Lambe and Whitman 1969; Terzaghi et al. 1996). In contrast, granule size has no effect on free swell, because the bentonite is crushed to pass the No. 200 sieve prior to free swell testing.

McNeal et al. (1966) conclude that swelling of expansive minerals such as montmorillonite is the dominant mechanism affecting the hydraulic conductivity. The results of this study, as well as those in Jo et al. (2001), support this conclusion. The trends shown in Fig. 9 also indicate that free swell tests can be a relatively simple and quick screening method to evaluate the compat-

ibility of GCLs permeated with inorganic salt solutions containing mixtures of cations. Although not a surrogate for chemical compatibility testing (direct testing is needed to demonstrate that a GCL is compatible with a liquid), free swell testing can be used to identify liquids that are incompatible with GCLs. The data in Fig. 9 also illustrate that the relationship between hydraulic conductivity and free swell is bentonite specific, and needs to be identified empirically.

### Estimating Hydraulic Conductivity

The approximately linear trends shown in Figs. 6 and 7 suggest that a relatively simple empirical model can be used to estimate hydraulic conductivity of GCLs as a function of ionic strength and RMD. A model relating these parameters was developed using stepwise regression (Draper and Smith 1998) using a significance level of 0.05:

$$\frac{\log K_c}{\log K_{DI}} = 1.085 - 1.097I + 0.0398I^2\,\mathrm{RMD} \qquad (3)$$

In Eq. 3, $K_c$ = hydraulic conductivity to the inorganic chemical solution and $K_{DI}$ = hydraulic conductivity to deionized water. The $R^2$ for Eq. (3) is 0.967 and the $p$ statistic is less than 0.0001. Eq. (3) is linear in both $I$ and RMD, and the product $I^2 \times$ RMD reflects that the sensitivity to RMD varies nonlinearly with ionic strength (e.g., as in Fig. 7). Eq. (3) is valid for $I = 0.05-0.5$ M and RMD $< 2.0$ mM$^{1/2}$.

Eq. (3) is based on data from the GCL tested in this study under the state of stress that was employed (effective stress = 20 kPa). However, Eq. (3) can be used to *estimate* how inorganic solutions may affect the hydraulic conductivity of other GCLs provided they employ granular Na-bentonite consisting of approximately 80% montmorillonite. Many of the GCLs used in North America today fit this description. Even if the granule size or montmorillonite content differs from those in this study, the relative effects of ionic strength and RMD should be approximately correct. In addition, Petrov and Rowe (1997) show that the hydraulic conductivity of GCLs exhibits similar sensitivity to effective stress regardless of whether DI water or a salt solution is used as the permeant liquid. Thus, Eq. (3) can be used to *estimate* the hydraulic conductivity at different effective stresses if the hydraulic conductivity to DI water at these stresses is known.

A comparison of $K_c$ predicted with Eq. (3) and the measured hydraulic conductivity is shown in Fig. 10(a). The contour lines in Fig. 10 correspond to Eq. (3), whereas the data points correspond to the $I$ and RMD for the tests conducted in this study. Eq. (3) captures the data reasonably well. Hydraulic conductivities predicted with Eq. (3) are also shown as contours in Fig. 10(b) along with points corresponding to $I$ and RMD for actual leachates from a variety of wastes and solid waste disposal facilities reviewed by Kolstad (2000). The ionic strength and RMD of each leachate is summarized in Table 4, along with the data source (literature and regulatory agency reports) and the type of containment facility. The points and contour lines in Fig. 10(b) illustrate what hydraulic conductivity likely would have been had the GCL used in this study been tested with these leachates.

Of the 50 points shown in Fig. 10(b), 37 fall below $10^{-7}$ cm/s (74%) and 24 fall below $10^{-8}$ cm/s (48%). Thus, GCLs with high hydraulic conductivities ($>10^{-7}$ cm/s) should not be common in bottom liners where leachates similar to those in Table 4 are likely to be found. Moreover, many of the points in Fig. 10(b) associated with high hydraulic conductivities correspond to "young" (landfill age < 5 yr) municipal solid waste (MSW)

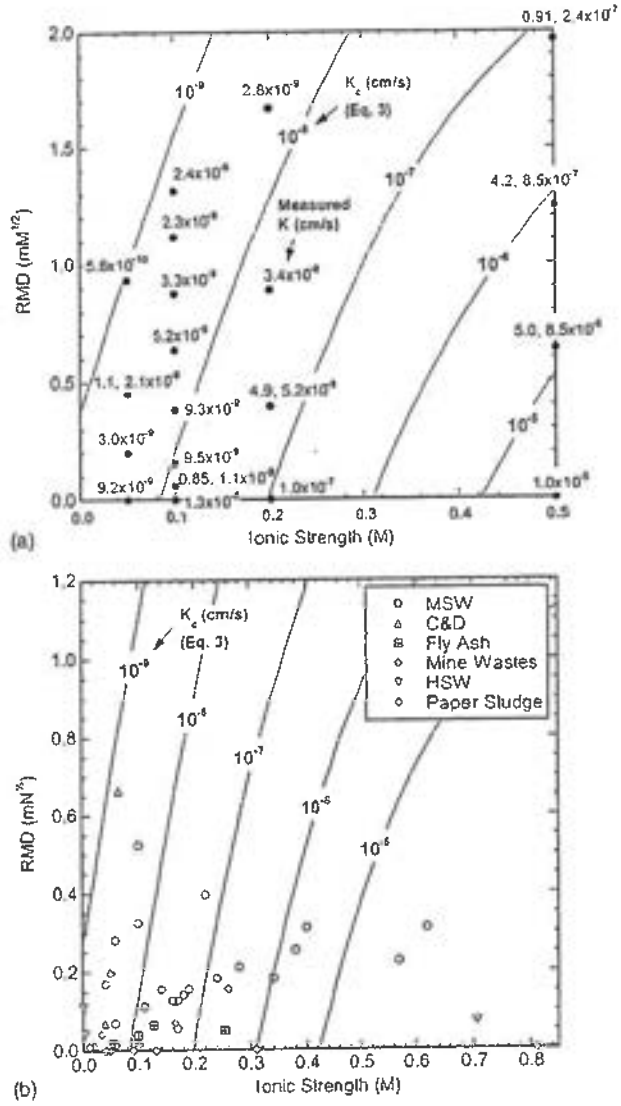


Fig. 10. Contours of hydraulic conductivity as a function of RMD and ionic strength predicted with Eq. (3) along with (a) measured hydraulic conductivities as solid circles and (b) points corresponding to ionic strength and RMD of various leachates. Data from Williams (1975) ($I$ = 1.87 M and RMD = 0) and Kolstad (2000) ($I$ = 1.37 M and RMD = 2.52 mM$^{1/2}$) are off the scale in (b).

leachates (Table 4). The composition of MSW leachate changes over time, and thus high hydraulic conductivities may not be realized because of the relatively long time required for a GCL and leachate to reach equilibrium under field conditions (Jo 2003). However, some of the points for mine waste, paper sludge, and fly ash disposal facilities are associated with high hydraulic conductivities, and the composition of leachates from these wastes can be persistent.

### Effect of Prehydration

The results of this study pertain specifically to nonprehydrated GCLs. Different results may have been obtained had the GCLs been completely prehydrated by permeation with DI or potable water for several pore volumes of flow. Comparisons between hydraulic conductivities of nonprehydrated and completely prehy-

Table 4. Summary of Ionic Strength and RMD of Various Leachates

| Source | Leachate type | Ionic strength (M) | RMD ($mM^{1/2}$) |
|---|---|---|---|
| Ehrig (1983) | Young MSW leachate (<5 yr) | 0.28 | 0.21 |
| Pohland (1980) | | 0.38 | 0.25 |
| Tchbanoglous et al. (1993) | | 0.14 | 0.16 |
| Chian and DeWalle (1976) | | 0.17 | 0.13 |
| Cheremisinoff (1983) | | 0.22 | 0.40 |
| Alker et al. (1995) | | 0.16 | 0.13 |
| Chian and DeWalle (1975) | | 0.57 | 0.23 |
| Chian and DeWalle (1975) | | 0.62 | 0.31 |
| Chian and DeWalle (1975) | | 0.34 | 0.18 |
| Farquhar (1989) | | 0.40 | 0.31 |
| Shams et al. (1994) | | 0.24 | 0.18 |
| Ehrig (1983) | Intermediate MSW leachate (5–10 yr) | 0.10 | 0.52 |
| Pohland (1980) | | 0.10 | 0.33 |
| Chian and DeWalle (1975) | | 0.17 | 0.06 |
| Chian and DeWalle (1975) | | 0.11 | 0.11 |
| Farquhar (1989) | | 0.18 | 0.14 |
| Chian and DeWalle (1975) | Old MSW leachate (>10 yr) | 0.06 | 0.01 |
| Chian and DeWalle (1975) | | 0.06 | 0.28 |
| Farquhar (1989) | | 0.06 | 0.07 |
| Alker et al. (1995) | | 0.04 | 0.17 |
| Kmet and McGinley (1982) | MSW leachate | 0.19 | 0.16 |
| Ruhl and Daniel (1997) | | 0.04 | 0.17 |
| Kolstad (2000) | C and D leachate | 0.05 | 0.01 |
| Kolstad (2000) | | 0.02 | 0.01 |
| WMNA (1993) | | 0.04 | 0.07 |
| Weber et al. (2002) | | 0.066 | 0.66 |
| Kolstad (2000) | Fly ash leachate | 0.03 | 0.25 |
| Kolstad (2000) | | 0.03 | 0.06 |
| Kolstad (2000) | | 0.02 | 0.10 |
| Kolstad (2000) | | 0.05 | 0.23 |
| Kolstad (2000) | | 0.06 | 0.13 |
| Kolstad (2000) | | 0.07 | 0.20 |
| Kolstad (2000) | | 0.37 | 2.52 |
| Kolstad (2000) | | 0.76 | 0.71 |
| Al et al. (1994) | Mine process water | 0.05 | 0.00 |
| Shackelford (1998) | | 0.04 | 0.00 |
| Jordan et al. (1998) | | 0.05 | 0.20 |

Table 4. (*Continued.*)

| Source | Leachate type | Ionic strength (M) | RMD ($mM^{1/2}$) |
|---|---|---|---|
| Williams (1975) | Acidic mine waste drainage | 1.87 | 0.00 |
| Christensen and Laake (1996) | | 0.13 | 0.00 |
| Christensen and Laake (1996) | | 0.09 | 0.00 |
| Al et al. (1994) | | 0.81 | 0.00 |
| Shackelford (1998) | | 0.31 | 0.00 |
| Williams (1975) | Pyritic tailings leachate | 0.26 | 0.16 |
| Pettit and Scharer (1999) | Ur rock drainage | 0.10 | 0.01 |
| Kolstad (2000) | Hazardous waste leachate | 0.001 | 0.11 |
| | | 0.70 | 0.07 |
| | | 0.003 | 0.04 |
| Kolstad (2000) | Paper mill landfill leachate | 0.17 | 0.07 |
| | | 0.01 | 0.01 |
| | | 0.03 | 0.04 |

Note: RMD=Relative abundance of monovalent and divalent cations; MSW=Municipal solid waste.

drated GCLs that have been permeated long enough to establish chemical equilibrium between the bentonite solid and the solution show that prehydration by permeation with DI water results in hydraulic conductivities an order of magnitude lower than those obtained without prehydration, even if cation exchange between the mineral surface and the permeant liquid is complete (Petrov and Rowe 1997; Jo et al. 2004).

Although the effect of complete prehydration is significant, complete prehydration is unlikely to occur in the field. Most GCLs in field applications hydrate as water is drawn to the bentonite from an underlying subgrade via vapor diffusion or gradients in matric potential (Daniel et al. 1993, 1998; Katsumi et al. 2003). The prehydration afforded by these processes does not appear to have the same effect as complete prehydration by direct permeation. Vasko et al. (2001) found that the hydraulic conductivity of GCLs prehydrated with DI water via capillary wetting and vapor diffusion and permeated with $CaCl_2$ solutions had essentially the same hydraulic conductivity as nonprehydrated GCLs unless the solution was very strong (concentration >0.1 M). Comparable findings are reported by Katsumi et al. (2003). These observations suggest that hydraulic conductivities reported in this study are likely to be more representative of most field conditions than hydraulic conductivities of completely prehydrated GCLs.

## Summary and Conclusions

This study dealt with the influence of multispecies inorganic salt solutions on swelling and hydraulic conductivity of nonprehydrated GCLs. Free swell and hydraulic conductivity tests were conducted on nonprehydrated specimens of a commercially available GCL using DI water and aqueous solutions of LiCl, NaCl, $CaCl_2$, and $MgCl_2$ salts. The relative amounts of monovalent and divalent cations in solution were quantified with the parameter RMD, which is the ratio of the total molarity of monovalent cations to the square root of the total molarity of divalent cations.

Results of the free swell tests show that swell is directly related to RMD and inversely related to ionic strength. RMD has a strong effect on swell in weaker solutions, and a modest effect in strong solutions. Similar findings were obtained from the hydraulic conductivity tests. Hydraulic conductivity was found to be directly related to ionic strength and inversely related to RMD, with RMD having a greater effect on hydraulic conductivity in weaker solutions. Tests were also conducted to determine if cation species affects swell or hydraulic conductivity. No discernable effect of cation species was evident in the free swell or hydraulic conductivity for tests conducted at a given ionic strength and RMD.

A strong relationship between hydraulic conductivity and free swell was found that is analogous to the relationship reported by Jo et al. (2001) for tests conducted using single-species salt solutions. However, the hydraulic conductivity-free swell relationship is not unique, and must be defined empirically for a particular bentonite if free swell tests are to be used for chemical compatibility screening.

The hydraulic conductivity data were also used to develop a regression model relating hydraulic conductivity of the GCL to ionic strength and RMD of the permeant solution. Predictions made with the model indicate that high hydraulic conductivities (i.e., $>10^{-7}$ cm/s) are unlikely for nonprehydrated GCLs in base liners in many solid waste containment facilities. However, for some wastes that transmit stronger leachates or leachates that are dominated by polyvalent cations (e.g., fly ash, paper sludge, and mine wastes), high hydraulic conductivities may be realized provided adequate time exists for the bentonite and leachate to reach chemical equilibrium.

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*Erratum note for*

Hydraulic Conductivity and Swell of Nonprehydrated Geosynthetic Clay Liners Permeated with Multispecies Inorganic Solutions, by Kolstad, Benson, and Edil.

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By Craig H. Benson[1]

The units for RMD in the text and graphs in this paper should be $M^{1/2}$ rather than the units of $mM^{1/2}$ shown in the published version. In addition, the plotting positions for the fly ash leachates were reversed in Fig. 10b (i.e., the fly ash leachate data were plotted as RMD vs. I instead of I vs. RMD). A correct version of Fig. 10b is presented here. This error does not affect any of the conclusions or inferences in the paper.

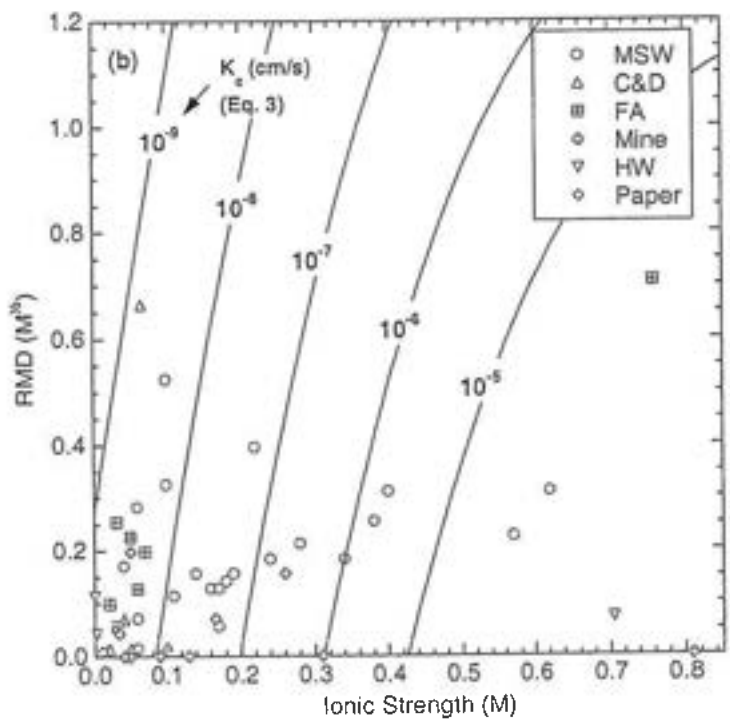


Fig. 10b. Contours of hydraulic conductivity as a function of RMD and ionic strength predicted with Eq. 3 along points corresponding to ionic strength and RMD of various leachates. Data from Williams (1975) (I = 1.87 M and RMD = 0) and Kolstad (2000) (I = 1.37 M and RMD = 2.52 $mM^{1/2}$) are off the scale in (b).

[1]Professor and Kellet Fellow, Dept. of Civil and Environmental Engineering, 1415 Engineering Drive, Madison, WI 53706, USA, benson@engr.wisc.edu

# H.2.2
# 2013 Plan of Operation Modification

708 Heartland Trail
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Madison, WI 53717

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November 4, 2013

Mr. Martin Herrick, P.E.
Wisconsin Department of Natural Resources
3500 Mormon Coulee Road
La Crosse, WI 54601

Subject: Plan Modification
Phase IV Disposal Area, License #4126
Dairyland Power Cooperative

Dear Mr. Herrick:

On behalf of Dairyland Power Cooperative (DPC) TRC Environmental Corporation (TRC) is submitting two copies of a Plan Modification to accept new waste streams that will be generated at the J. P. Madgett Power Plant in Alma, WI (JPM) and at the Genoa Unit 3 Power Plant in Genoa, WI (G-3) and disposed of in the Alma Off-Site Ash Disposal Facility, Phase IV Disposal Area in Alma, WI (AOS Phase IV Disposal Area), License #4126. We request that the Wisconsin Department of Natural Resources (WDNR) review and approve this plan modification request in accordance with NR 514.09. To support this request detailed information on the waste types, characteristics and quantities; anticipated schedule of when the waste types will begin to be generated; and how it will be managed within the landfill is presented in the following text and accompanying attachments.

## Background

New waste streams will be generated at JPM and at G-3 and disposed in the AOS Phase IV Disposal Area. The wastes generated are in response to federal regulations on the control of sulfur dioxide ($SO_2$) and mercury in the plant air emissions. The wastes are from dry sorbent injection (DSI) for the control of $SO_2$ at JPM and activated carbon injection (ACI) at both JPM and G-3 for the removal of mercury. The modifications presented in this request will pose low potential risk of adverse impacts on public health or the environment.

## Schedule

The schedule for start-up and testing of the various processes to be implemented at the two plants is as follows:

- JPM – dry sorbent injection and activated carbon injection — December 2013
- G-3 – activated carbon injection — August 2014

In addition, $NO_x$ control systems using selective catalytic reduction (at JPM) and selective non-catalytic reduction (at G-3) are planned to be implemented in the near future (late 2014 to early 2015). Although these are gas-phase reactions that consume the ammonia or urea that is injected, there will be some minor ammonia carry-over into the fly ash requiring landfill disposal.

Rather than submit multiple plan modification requests to the WDNR as the different processes are brought on-line at different dates, DPC is requesting a plan modification to incorporate the three waste streams.

## Waste Characterization

In accordance with NR 506.09 the WDNR requests the following information for wastes proposed for disposal.

(a) Detailed physical and chemical characteristics including percent solids, material safety data sheets where appropriate and the results of the paint filter test.

(b) The volume of waste to be disposed of on a daily and yearly basis.

(c) The source of the waste and a description of the processes which generated the waste.

(d) The duration of disposal.

(e) Special handling and disposal procedures.

(f) Based on a preliminary review of the above information, the department may require additional information to determine the compatibility of the waste with the existing design and operation of the landfill.

Information for above items (a), (b) and (d) is summarized in Table 1. More detailed information is provided below.

Schematics for the air pollution control systems at both plants are provided in Figures 1 and 2. The systems are slightly different at the two plants.

- At JPM, the gas stream passes through an electrostatic precipitator to remove fly ash, which is followed by ammonia injection to convert $NO_x$ to $N_2$ gas and water. Activated carbon is then injected for mercury removal, followed by sodium bicarbonate injection for $SO_2$ removal. The activated carbon, DSI residual material, and fly ash are collected in a baghouse prior to exhaust gas emission from the stack. See Figure 1 (attached).

- At G-3, urea is injected into the boiler for $NO_x$ removal. Activated carbon is then injected into the exhaust gas from the boiler, followed by an electrostatic precipitator to remove fly ash. Lime (CaO) is then injected for $SO_2$ removal, and the residual activated carbon (referred to as flue gas desulfurization material or FGD) and fly ash are collected in a baghouse. Disposal of the FGD residual material that is removed from the baghouse in the AOS Phase IV Disposal Area was the subject of a previous WDNR approval associated with a plan modification dated May 4, 2009. See Figure 2.

**Dry Scrubber Injection for Sulfur Dioxide Removal**

Sodium bicarbonate can be injected into the gas stream from a coal-fired power plant to remove sulfur dioxide ($SO_2$), and in the process generate a residual material containing sodium sulfite, sodium sulfate, and residual injected material. DPC evaluated sodium bicarbonate injection (DSI) in field trials conducted in July and August 2011. The DSI residual material is similar to the FGD residual material generated at G-3, except that there is a higher sodium and lower calcium content.

One of the characteristics of both the DSI and FGD residual materials (removed with the fly ash from the baghouses) noted in the testing was the ability to absorb water and over time to harden into a monolithic material. This ability was evaluated by adding different amounts of water to the DSI material, allowing the wet material to sit for several days and then running a paint filter test on the material. The results, shown in Table 2 and Figure 3, indicate that the DSI material can absorb approximately its own weight in water before releasing any free water. The annual precipitation in the area is approximately 30 inches per year. Thus, a layer of DSI residual and fly ash material, approximately 3-feet thick, would be sufficient to absorb all the annual precipitation. The combined annual production of DSI and FGD residual material and fly ash from both the G-3 and JPM baghouse facilities will be in excess of 200,000 cubic yards, which correlates to an area of approximately 40-acres covered with a layer of DSI/FGD/fly ash material 3-feet thick per year. Since the total area of the landfill open at any time will likely range from 10 to 15-acres, it is clear that the depth of DSI/FGD/fly ash material will be much greater than 3-feet per year. Therefore, the apparent absorption capacity of the DSI/FGD/fly ash material placed in the landfill is greater than the annual precipitation. This does not mean that there will be no leachate generated from the landfill, but rather that the leachate comes predominantly from surface runoff and flow through fractures in the solidified material rather than uniform percolation through the DSI/FGD/fly ash material.

### Activated Carbon for Mercury Control

Activated carbon can be used for mercury removal from coal-fired power plant exhaust gases. The carbon is amended with sulfur species to enhance mercury removal. No test runs have been done using the activated carbon, so no samples from the facility are available for testing. Some formulations of the mercury-removal carbon contain bromine to assist in the removal process. The decision as to whether to use the bromine spiked carbon or not has not been made, nor has a selection been made as to which supplier of activated carbon to use. Typical MSDS publications for both activated carbons – one bromine containing, one not – are provided in Attachment 1. The activated carbon will remove mercury and perhaps trace amounts of other contaminants from the gas stream, but the bulk physical and chemical characteristics of the carbon are not anticipated to change during the scrubbing process. The characteristics of the waste will be more thoroughly evaluated once the system is on-line, and the information will be provided to the WDNR.

### Handling

The DSI and ACI residual material collected in the baghouse at JPM will increase the annual tonnage of ash waste residual material to be landfilled by approximately 15,000 tons and 1,230 tons, respectively. The ACI residual material collected in the baghouse at G-3 will increase the annual tonnage of ash waste residual material to be landfilled by approximately 1,610 tons. Since the DSI and/or ACI is injected into the flue gas stream it will be uniformly mixed with the fly ash material removed from the baghouses. Thus, it will present and behave in a similar manner to the material currently removed from the baghouses (i.e., dry, powdery material). Residual material removed from the baghouses will continue to be managed using current practices. The current practice at G-3 is to remove the material from the baghouse using a pneumatic tanker truck, which then transports the material to the AOS Phase IV Disposal Area, where it is pneumatically off-loaded into a temporary storage silo prior to moisture conditioning to approximately 10 to 15 percent (for dust control), and hauled and placed in the landfill (followed by grading and compaction). The baghouse material at JPM can be managed in a similar manner as at G-3. The JPM facility also has the ability to transfer the baghouse material directly into an adjacent pin-mixer to moisture condition, and then direct haul by dump truck to the active face of the AOS Phase IV Disposal Area for placement, grading and compaction.

## Regulatory Considerations

Condition 29 of the Conditional Plan of Operation Approval for the Dairyland Power Cooperative Phase IV Disposal Area, dated May 15, 2001, requires that DPC analyze the ash for compatibility with the Geosynthetic Clay Liner (GCL) in the event of a major

process change or coal source change. The purpose of the compatibility testing is to assess the impact of the ash leachate on the bentonite minerals of the GCL, particularly concerning geochemical changes and subsequent permeability changes. In consideration of the results from previous compatibility testing performed annually (from 2003 through 2007); the more recent laboratory testing performed on the sodium bicarbonate residual samples from the JPM baghouse; and the type of product and limited quantity that will be used for ACI, we do not anticipate any significant increase in permeability of the GCL based on the similarity in leaching characteristics between the lime-based and sodium bicarbonate-based material.

Please invoice DPC directly (to the attention of Bill Kowalski) for the applicable review fee. If you have any questions regarding this information, please contact Curt Madsen, at (608) 826-3640.

Sincerely,

TRC Environmental Corporation

Robert Stanforth

Robert Stanforth, Ph.D.
Senior Applied Chemist

Curtis D. Madsen, P.E.
Senior Project Manager

Attachments:
- Table 1 – Summary of Required Information of Three Coal Combustion Residuals
- Table 2 – Moisture Holding Capacity of Sodium Bicarbonate-treated (JPM) and Lime-treated (Genoa) FGD Residual Material
- Figure 1 – Schematic of the Air Pollution Control System for the JPM Facility
- Figure 2 – Schematic of the Air Pollution Control System for the G-3 Facility
- Figure 3 – Moisture Holding Capacity of JPM (sodium bicarbonate treated) and G-3 (lime treated) Material
- Attachment 1 – Material Safety Data Sheets

cc: Bill Kowalski – DPC



TRC
Results you can rely on

**Report Certification**

I, _____, hereby certify that I am a registered professional engineer in the State of Wisconsin, registered in accordance with the requirements of Chapter A-E4, Wis. Adm. Code; that this document has been prepared in accordance with the Rules of Professional Conduct in Chapter A-E8, Wis. Adm. Code; and that, to the best of my knowledge, all information contained in this document was prepared in compliance with all applicable requirements in Chapters NR 500 to 538, Wis. Adm. Code.

WISCONSIN
CURTIS D. MADSEN
E-22619
MADISON, WI
PROFESSIONAL ENGINEER

11-4-2013

Curtis D. Madsen, P.E.
Senior Project Manager

**Table 1**
**Summary of Required Information of Three Coal Combustion Residuals**

| INFORMATION | DRY SCRUBBER WASTE JPM | ACTIVATED CARBON | |
|---|---|---|---|
| | | JPM | GENOA |
| ***Physical and Chemical Characteristics*** | | | |
| Solids Content | 100% | 100% | 100% |
| MSDS | NA | See attached | |
| Paint Filter Test | No free liquid – waste generated from a high temperature combustion process | | |
| ***Volume and Duration of Waste Disposed*** | | | |
| Monthly | 1,250 tons/mo | 103 tons/mo | 134 tons/mo |
| Yearly | 15,000 tons/yr | 1,231 tons/yr | 1,607 tons/yr |
| Duration | Through lifespan of landfill | | |
| ***Source of Wastes and Special Handling*** – in text | | | |

**Table 2**
**Moisture Holding Capacity of Sodium Bicarbonate-treated (JPM) and Lime-treated (G-3) FGD Residual Material**

| ADDITIVE/WASTE | WATER (mL/kg) | | |
|---|---|---|---|
| | ADDED | RECOVERED | ABSORBED |
| Sodium Bicarbonate/ JPM | 250 | 0 | 250 |
| | 500 | 0 | 500 |
| | 1,000 | 167 | 833 |
| | 1,500 | 325 | 1,175 |
| | 2,000 | 760 | 1,240 |
| | 3,000 | 1,680 | 1,320 |
| Lime/ G-3 | 500 | 0 | 500 |
| | 1,000 | 0 | 1,000 |
| | 1,500 | 0 | 1,500 |
| | 2,000 | 665 | 1,335 |
| | 3,000 | 1,670 | 1,330 |
| | 4,000 | 2,250 | 1,750 |

Figure 1
Schematic of the Air Pollution Control
System for the JPM Facility

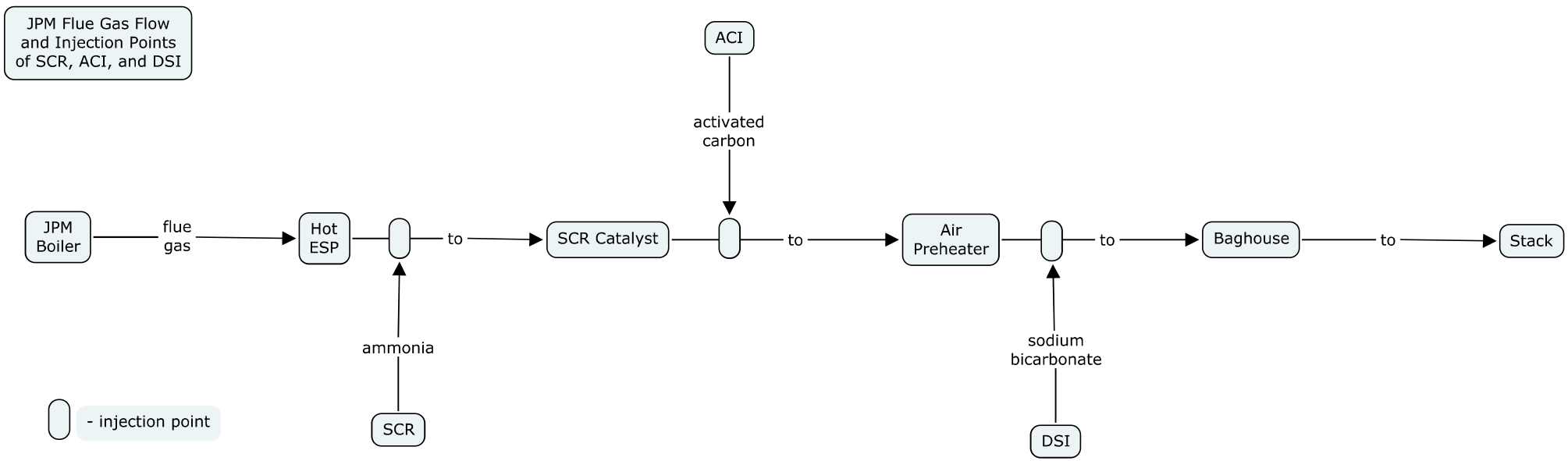


Figure 2
Schematic of the Air Pollution Control
System for the G-3 Facility

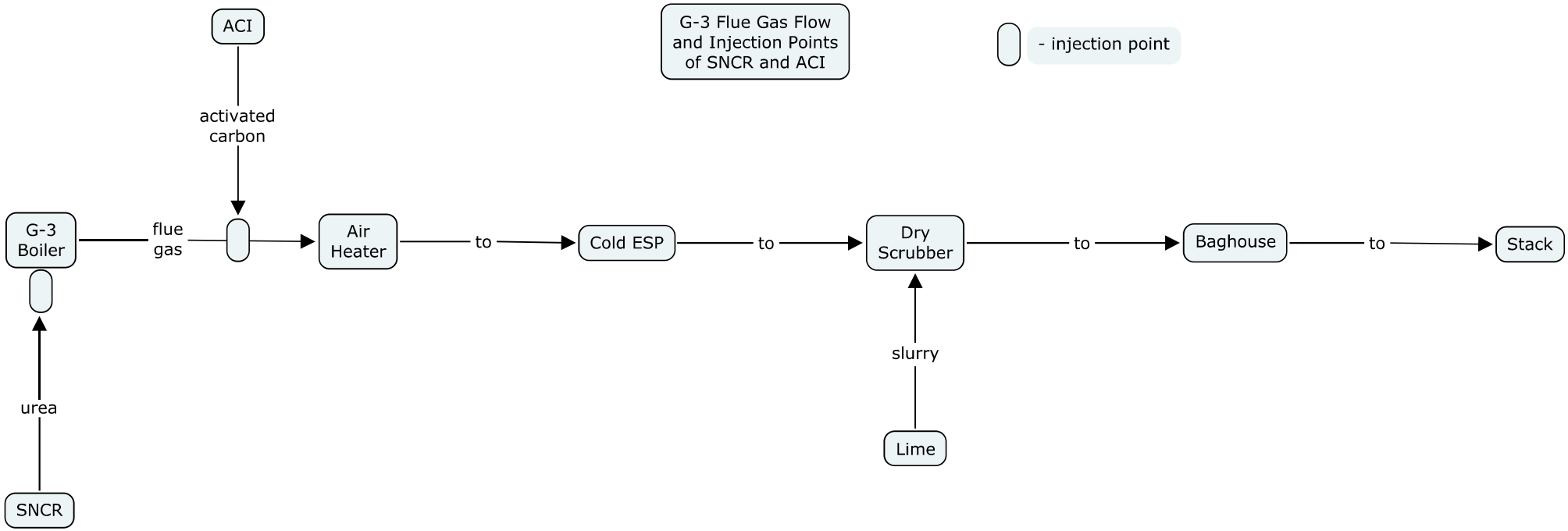
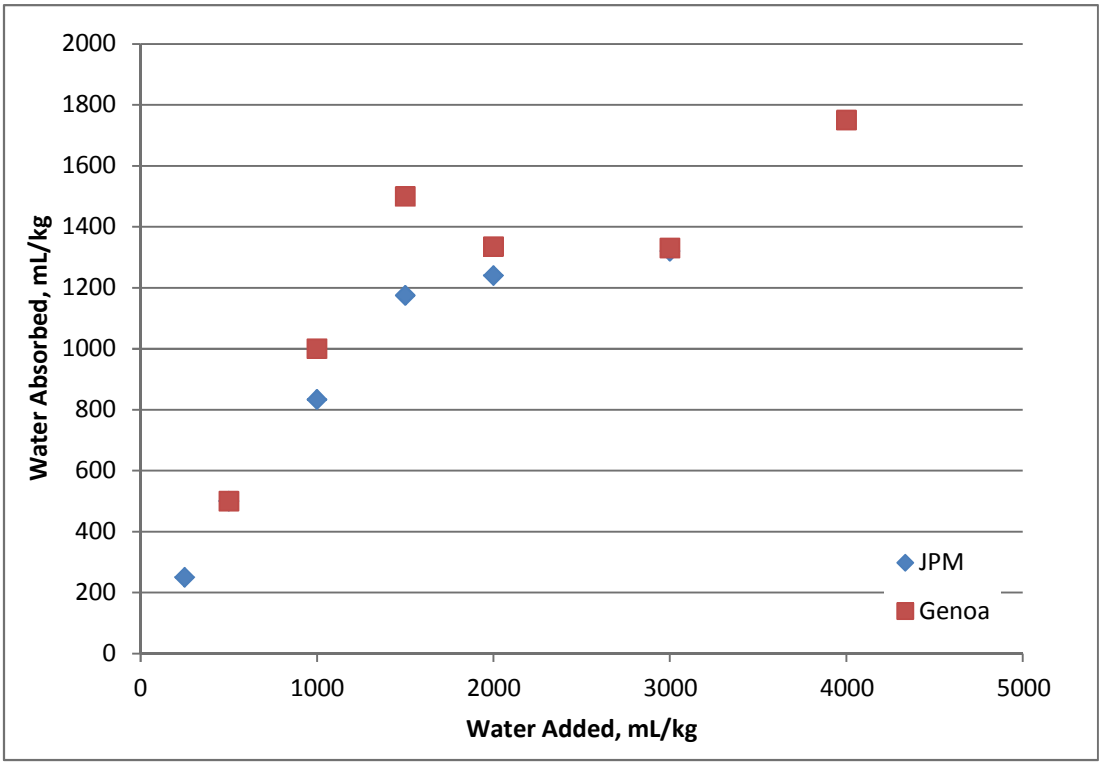


**Figure 3**
**Moisture Holding Capacity of JPM (sodium bicarbonate treated) and G-3 (lime treated) Material**



## Attachment 1

## Material Data Safety Sheets

- Material Safety Data Sheets for Activated Carbon from ADA Carbon Solutions, LLC
- Material Safety Data Sheets for Activated Carbon from Albemarle Corp.

# MATERIAL SAFETY DATA SHEET



PowerPAC™ Emission Control Treatment Series

## 1. Product and Company Identification

| Supplier | Manufacturer |
|---|---|
| **ADA Carbon Solutions, LLC**<br>**8100 SouthPark Way, Unit A-2**<br>**Littleton, CO 80120-4527**<br><br>**Telephone Number:** 888-843-8416<br>**FAX Number:** 303-962-1970 | **ADA Carbon Solutions, LLC**<br>**8100 SouthPark Way, Unit A-2**<br>**Littleton, CO 80120-4527**<br><br>**Telephone Number:** 888-843-8416<br>**FAX Number:** 303-962-1970 |
| **Supplier Emergency Contacts & Phone Number**<br>**CHEMTREC: 800-424-9300** | **Manufacturer Emergency Contacts & Phone Number**<br>**CHEMTREC: 800-424-9300** |

**Issue Date:** 06/2011

**Product Name:** Power PAC™, Power PAC LF™
**CAS Number:** N/A

**Product/Material Uses**
Powdered carbon sorbent of vapor-phase mercury in flue gas, primarily in coal-fired power plants.

## 2. Composition/Information On Ingredients

| Ingredient Name | CAS Number | | Percent of Total Weight |
|---|---|---|---|
| Carbon, activated | 7440-44-0 | | 0–100 |

This product contains no hazardous ingredients when evaluated by criteria established in the OSHA Hazard Communication Standard (29 CFR 1910.1200).

## EMERGENCY OVERVIEW

Wet activated carbon removes oxygen from air and can lower the concentration of oxygen inside vessels and other confined spaces. During combustion, toxic and irritating gases including high levels of carbon monoxide may be produced.

## 3. Hazards Identification

**Primary Routes of Entry**
Inhalation, skin contact, eye contact

**Eye Hazards**
Dust may cause mild mechanical irritation.

**Skin Hazards**
Prolonged or repeated skin contact may cause irritation, drying, and redness.

**Ingestion Hazards**
May cause mild gastrointestinal tract irritation.

**Inhalation Hazards**
High airborne concentrations of low-toxicity dusts may cause coughing, sneezing, and mild temporary irritation.

Avoid use in confined spaces. Wet activated carbon can absorb and deplete oxygen from the air, causing a severe hazard to workers.

**Chronic/Carcinogenicity Effects**
Activated carbons may contain crystalline silica, which is classified as a potential human carcinogen. Prolonged

inhalation of excessive dust may cause pulmonary disorders.

## 4. First Aid Measures

**Eye**

Hold eyelids apart and flush eyes with plenty of water for at least 15 minutes. Get medical attention if irritation develops.

**Skin**

Wash affect areas with soap and water. Get medical attention immediately if irritation develops.

**Ingestion**

If person is fully conscious, give one or two cups of water or milk to drink. Get medical attention immediately if large quantities are ingested.

**Inhalation**

Remove person from source of exposure and into fresh air. Get medical attention if irritation or breathing difficulties develop.

## 5. Fire-Fighting Measures

**Lower Explosive Limit:** N/A
**Upper Explosive Limit:** N/A

**Fire and Explosion Hazards**

High dust concentrations may form explosive mixtures with air, which can be ignited by spark or flame. Dusts may accumulate a static discharge. Keep dust concentrations low.

Fire is possible at elevated temperatures or by self-heating when exposed to strong oxidizers. Activated carbon tends to burn slowly without producing smoke or flame. Material allowed to smolder for long periods in enclosed spaces may produce carbon monoxide, which may reach a lower explosive limit for carbon monoxide (12.5%) in air. Wet activated carbon depletes oxygen from the air.

**Warning**: Electrostatic precipitator and baghouse hoppers containing powdered activated carbon or fly ash with activated carbon can autoignite and present a smoldering fire hazard when exposed to elevated temperature and other sources of heat, such as heaters. If activated carbon is present, hoppers should be emptied frequently and particular care should be exercised when hopper heaters are in use. Cutting or welding operations should not be used near this material due to potential for smoldering combustion. This material is not a self-heating material as classified for transportation.

**Extinguishing Media**

In case of fire, use water spray, dry chemical, or $CO_2$. Use water to cool fire-exposed containers.

**Fire-Fighting Instructions**

Firefighters should wear self-contained breathing apparatus and full protective gear. Remove product from building to a non-hazardous area, preferably outdoors, if safe to do so.

## 6. Accidental Release Measures

Provide maximum dilution or explosion-proof exhaust ventilation. Avoid generating dust. Pick up released product with appropriate implements and return to original container if reusable, or dispose.

## 7. Handling and Storage

**Handling Precautions**

Follow good handling and housekeeping practices. Avoid spills and accumulations of dust, or generation of airborne dust. Do not enter places where bulk material is used or stored until adequately ventilated to prevent asphyxiation.

As with all finely divided materials, precautions should be taken to avoid inhalation and eye contact. Ground all transfer, blending, and dust collecting equipment to prevent static discharge in accordance with NFPA 70, National Electric Code," NFPA 499, "Recommended Practice for the Classification of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas," NFPA 654, Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids," and OSHA Combustible Dust standards. Remove all ignition sources from material handling, transfer, and processing areas where dust may be present.

**Storage Precautions**

Store in sealed containers in a clean cool, dry, well-ventilated area away from strong oxidizers, ignition sources, combustible materials, and heat. Do not store near, or allow contact with, moisture or strong oxidizers.

**Warning:** Wet activated carbon depletes oxygen, creating oxygen-deficient atmospheres in confined spaces.

**Work/Hygienic Practices**

Wash thoroughly with soap and water after handling.

## 8. Exposure Controls/Personal Protection

**Engineering Controls**

Use with adequate general and local exhaust ventilation to prevent excessive airborne dust concentrations. Local exhaust ventilation should be provided, to maintain exposures below recommended occupational exposure limits. Confined spaces where activated carbon is present should be well ventilated and monitored for oxygen content.

**Eye/Face Protection**

Safety glasses with side shields are recommended as minimum industrial eye protection when handling bulk product or performing spill cleanup.

**Skin Protection**

Protective gloves are recommended to minimize skin contact. Use a lab coat or disposable coveralls to prevent excessive contamination to personal clothing.

**Respiratory Protection**

In case of inadequate ventilation to control dust, use NOISH-approved respirator for particulates (e.g., N95). Supplied air respirators may be needed for entering confined spaces where product is stored or handled to protect against oxygen deficiency.

**Ingredients – Exposure Limits**

Carbon, activated.

OSHA PEL-TWA: 15 $mg/m^3$, total dust, as particulates not otherwise specified
OSHA PEL-TWA: 5 $mg/m^3$, respirable dust, as particulates not otherwise specified

## 9. Physical and Chemical Properties

**Appearance**
Grey to black, free-flowing powder

**Odor**
Odorless

**Chemical Type:** Mixture
**Physical State:** Solid
**Specific Gravity:** > 1*
**Packing Density:** 0.5 to 0.65
**Vapor Pressure:** N/A
**Solubility:** Slightly soluble
**Evaporation Rate:** N/A

* - Skeletal density (true density without pores)

## 10. Stability and Reactivity

**Stability:** Stable under ordinary conditions of shipment, storage, and use.
**Hazardous Polymerization:** Will not occur.

**Incompatible Materials**
Avoid contact with strong oxidizing agents such as ozone, liquid oxygen, chlorine, permanganate, sulfuric acid, and nitric acid.

**Hazardous Decomposition Products**
Thermal decomposition ("burning") may produce irritating and toxic fumes of carbon (carbon dioxide, carbon monoxide), formaldehyde, ethylene, and acrylic acid. The exact chemicals formed depend on many factors including temperature and heating rate.

## 11. Toxicological Information

**Chronic/Carcinogenicity**
The product is not listed as potentially carcinogenic by NTP, IARC, OSHA, or ACGIH.

May contain trace concentrations of bound silica. Crystalline silica is considered to be a probable human carcinogen.

**Ingredients – Toxicological Data**
Carbon, activated.
LC50 (inhal, rat): > 64,400 $mg/m^3$
LD50 (oral, rat): > 10,000 mg/kg

## 12. Ecological Information

**Ecotoxicological Information**
No information available for the product. However, ecotoxicity is expected to be minimal.

This material will increase the conductivity of water by increasing dissolved solids. Used activated carbon may exhibit characteristics of the absorbed material.

**Environmental Fate Information**
No information available.

## 13. Disposal Considerations

Activated carbon in pure form is not a hazardous material but spent carbon could potentially be a hazardous waste depending on the application. Dispose in accordance with applicable federal, state, and local government regulations.

## 14. Transport Information

**Additional Shipping Paper Description**

Shipping name: Activated Carbon.

This product is NOT considered spontaneously combustible under the "Self-Heating Test for Carbon" protocol listed in the United Nations Manual of Tests and Criteria [33.3.1].

## 15. Regulatory Information

**U.S. Regulatory Information**

Toxic Substance Control Act (TSCA): All ingredients of the product are listed on the TSCA 8(b) Chemical Substance Inventory or are exempt.

Product is not classifiable under any of the five SARA Title III hazard ratings.

Product does not have a CERCLA RQ.

**SARA Section 313 Notification**

This product does not contain any ingredients regulated under Section 313 of the Emergency Planning and Community Right-To-Know Act of 1986 or 40 CFR 372.

**Canadian Regulatory Information**

Product is not regulated or controlled under WHMIS (Canada). This product is not classifiable as hazardous under the Canadian Hazardous Products Act (HPA).

DSL: 6798

## 16. Other Information

**NFPA Rating**
**Health:** 1
**Fire:** 1
**Reactivity:** 0

**HMIS Rating**
**Health:** 0
**Fire:** 0
**Reactivity:** 0
**Personal Protection:** B

**Disclaimer**

This information relates to the product designated herein and does not relate to its use in combination with any other material or in any other process. To the best of ADA Carbon Solutions' knowledge, the information contained herein is reliable and accurate as of this date; however, accuracy, suitability, and completeness are not guaranteed. Users are responsible to verify this data for their own particular use and they assume all risks of their reliance upon information contained herein. ADA Carbon Solutions, LLC, shall under no circumstances be liable for incidental or consequential damages as a result of reliance upon information contained herein.

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ADA Carbon Solutions, LLC

ALBEMARLE®

# B-PAC™

# Material Safety Data Sheet

**Revision Date:** 23-Dec-2009
**Supersedes** New

## 1. PRODUCT AND COMPANY IDENTIFICATION

**Product Name** B-PAC™
**Chemical Name** Mixture.
**CAS-No** Mixture
**Recommended use** Not available

**Emergency Telephone Numbers** 225-344-7147

**For Non-Emergency** 800-535-3030

| | NFPA | HMIS |
|---|---|---|
| **Health** | 1 | 1 |
| **Flammability** | 1 | 1 |
| **Physical Hazards** | 0 | 0 |

## 2. HAZARDS IDENTIFICATION

**Caution**

**Emergency Overview**
Product dust may be irritating to the eyes and respiratory system.

**Potential Health Effects**

**Eyes** Irritating to eyes.
**Skin** Not expected to be an irritant.
**Inhalation** Irritating to respiratory system.
**Ingestion** Not expected to be acutely toxic.

See Section 11 for additional Toxicological information.

**Occupational Exposure Limit** See Section 8

## 3. COMPOSITION/INFORMATION ON INGREDIENTS

| Component | CAS-No | Weight % |
|---|---|---|
| Carbon | 7440-44-0 | 90-95 |
| Bromine | 7726-95-6 | 5-10 |

## 4. FIRST AID MEASURES

| | |
|---|---|
| **Eye contact** | In the case of contact with eyes, rinse immediately with plenty of water and seek medical advice |
| **Skin Contact** | Wash off immediately with soap and plenty of water removing all contaminated clothes and shoes. |
| **Inhalation** | Move to fresh air If not breathing, give artificial respiration, preferably mouth to mouth. If breathing is difficult, give oxygen. Seek immediate medical attention/advice. |
| **Ingestion** | Drink plenty of water. |

## 5. FIRE-FIGHTING MEASURES

| | |
|---|---|
| **Combustion/explosion hazards** | Contact with combustible material may cause fire. |
| **Suitable Extinguishing Media** | Carbon dioxide, dry chemicals, foam, water spray (mist). |
| **Hazardous Combustion Products** | Carbon monoxide. |
| **Protective Equipment and Precautions for Firefighters** | Wear self contained breathing apparatus for fire fighting if necessary. |

## 6. ACCIDENTAL RELEASE MEASURES

| | |
|---|---|
| **Personal Precautions** | Evacuate unnecessary personnel. Do not breathe dust.. |
| **Environmental precautions** | Sweep up and shovel into suitable containers for disposal. |
| **Methods for Clean-up** | Avoid dust formation. Sweep up and shovel into suitable containers for disposal.. |

## 7. HANDLING AND STORAGE

| | |
|---|---|
| **Handling** | Avoid dust formation. Avoid breathing dust. Wash thoroughly after handling. Wet activated carbon removes oxygen from air causing a severe hazard to workers inside carbon vessels and enclosed or confined spaces. Before entering such an area, sampling and work procedures for low oxygen levels should be taken to ensure ample oxygen availability, observing all local, state, federal or national regulations. |
| **Storage** | Keep containers tightly closed in a dry, cool and well-ventilated place. |

## 8. EXPOSURE CONTROLS / PERSONAL PROTECTION

| Component | CAS-No | Weight % | ACGIH TLV (TWA) | ACGIH (STEL or Ceiling) | OSHA PEL (TWA) | OSHA (STEL or Ceiling) |
|---|---|---|---|---|---|---|
| Carbon | 7440-44-0 | 90-95 | spirable fraction. | | 15MPPCF 5mg/m$^3$ Respirable fraction. 15mg/m$^3$ Total dust. 2.5mg/m$^3$ Respirable dust. 10mg/m$^3$ Total dust. | |
| Bromine | 7726-95-6 | 5-10 | 0.1PPM | 0.2PPM (STEL) | 0.7mg/m$^3$; 0.1PPM 0.1PPM | 2mg/m$^3$; 0.3PPM (STEL) |

**Engineering Controls** Ensure adequate ventilation, especially in confined areas.

**Personal Protective Equipment**

**Eye/face Protection** Safety glasses or goggles recommended.

**Skin Protection** Wear protective gloves/clothing.

**Hand protection** Gloves resistant to chemical permeation.

**Respiratory protection** NIOSH approved particulate filter respirator is recommended if excessive dust is generated.

## 9. PHYSICAL AND CHEMICAL PROPERTIES

**Flash point** Not applicable.
**Form** Powder/Particulate
**Color** Black.
**Odor** Unknown.
**Water Solubility** Negligible.
**Melting/freezing point** Not applicable
**Viscosity, kinematic** No data available
**Flammable limits (LEL, UEL)** No data available
**Vapour pressure** No data available
**Density** 0.4-0.7g/cc
**Vapor density** No data available
**Boiling Point** Not applicable
**Viscosity, dynamic** No data available

## 10. STABILITY AND REACTIVITY

**Stability** Stable.

**Materials to avoid** Avoid strong oxidizing agents. Avoid strong reducing agents.

**Hazardous decomposition products** Carbon monoxide.

**Hazardous Polymerization** None under normal processing.

## 11. TOXICOLOGICAL INFORMATION

**Acute Effects**

| | |
|---|---|
| **Eye contact** | Irritant. |
| **Skin contact** | Not irritating |
| **Ingestion** | Not expected to be acutely toxic. |
| **Inhalation** | May irritate the nose, throat, and lungs. |
| **LD50 Oral:** | >2000 mg/kg (rat) |

## 12. ECOLOGICAL INFORMATION

**Ecotoxicity**

| | |
|---|---|
| **Ecotoxicity effects** | No information available. |

## 13. DISPOSAL CONSIDERATIONS

| | |
|---|---|
| **Waste Disposal Method** | Dispose in a safe manner in accordance with local/national regulations. |

## 14. TRANSPORT INFORMATION

**DOT**

| | |
|---|---|
| **Proper Shipping Name** | NOT REGULATED FOR TRANSPORTATION |
| **Hazard Class** | Not regulated |
| **UN No.** | Not regulated |
| **Packing Group** | Not regulated |
| **Description** | Not regulated |

**IMDG/IMO**

| | |
|---|---|
| **IMO Class** | Not regulated |
| **Packing Group** | Not regulated |
| **UN-No** | Not regulated |
| **IMO Labelling and Marking** | Not regulated |
| **Proper Shipping Name** | Not regulated |
| **EmS** | Not regulated |
| **Marpol - Annex II** | Not regulated |
| **Marpol - Annex III** | Not regulated |
| **Transport Description** | Not regulated |

**IATA/ICAO**

| | |
|---|---|
| **IATA/ICAO Class** | Not regulated |
| **Packing Group** | Not regulated |
| **UN-No** | Not regulated |
| **IATA/ICAO Labelling** | Not regulated |
| **Passenger Aircraft** | Not regulated |
| **Cargo aircraft only** | Not regulated |
| **Proper shipping name** | Not regulated |
| **Transport Description** | Not regulated |

## 15. REGULATORY INFORMATION

| International Inventories | TSCA | DSL | NDSL | AICS | EINECS | ELINCS | ENCS | KECL | PICCS | CHINA | NZIoC |
|---|---|---|---|---|---|---|---|---|---|---|---|
| B-PAC™ | X | X | - | X | X | - | X | X | X | X | X |

(X) Complies (-) Does not Comply

**SARA 313**

Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA). This product contains a chemical or chemicals which are subject to the reporting requirements of the Act and and Title 40 of the Code of Federal Regulations, Part 372:

| Component | CAS-No | Weight % |
|---|---|---|
| Bromine | 7726-95-6 | 5-10 |

**SARA 311/312 Hazardous Categorization**

| | |
|---|---|
| **Chronic Health Hazard** | No |
| **Acute Health Hazard** | Yes |
| **Fire Hazard** | No |
| **Sudden Release of Pressure Hazard** | No |
| **Reactive Hazard** | No |

**Reportable and Threshold Planning Quantities**

The following components have RQs and/or TPQs under SARA and/or CERCLA

| Component | CAS-No | Weight % | SARA 302 RQ, lbs | CERCLA RQ, lbs | SARA 302 TPQ, lbs |
|---|---|---|---|---|---|
| Bromine | 7726-95-6 | 5-10 | 500 | | 500 |

**State Regulations**
This product contains the following chemicals regulated in the states listed below.

| Component | CAS-No | California Prop. 65 | Massachusetts | New Jersey | Pennsylvania |
|---|---|---|---|---|---|
| Carbon | 7440-44-0 | | Listed. | | Listed. |
| Bromine | 7726-95-6 | | Listed. | Listed. | Listed. |

**This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all the information required by the CPR.**

**WHMIS Hazards**
D2B Toxic materials

## 16. OTHER INFORMATION

**Prepared By**

Health & Environment Department
Albemarle Corporation

FOR ADDITIONAL NONEMERGENCY PRODUCT INFORMATION, CONTACT:

HEALTH AND ENVIRONMENT DEPARTMENT
ALBEMARLE CORPORATION
451 FLORIDA ST.
BATON ROUGE, LA. 70801
(800) 535-3030

The information contained herein is accurate to the best of our knowledge. The Company makes no warranty of any kind, express or implied, concerning the safe use of this material in your process or in combination with other substances.

# Appendix I: Supplemental Leachate Collection System Design Demonstrations

- I.1: Cell 3A Liner Construction Documentation Report – Piping and Permeability Calculation
- I.2: Cell 3B Liner Construction Documentation Report – Piping and Permeability Calculation
- I.3: Ineos's Chemical Resistance Guide

# I.1
# Cell 3A Liner Construction Documentation Report
# Piping and Permeability Calculation

# Phase IV, Cell 3A Liner
# Construction Documentation Report

## Dairyland Power Cooperative
## Alma Off-Site Ash Disposal Facility

**January 2013**

WISCONSIN
1/17/13
KIM D.
PAWLISCH
E-28175
Madison,
WI
PROFESSIONAL ENGINEER


Kim D. Pawlisch, P.E.
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Project Manager

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Resident Project Representative





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# Appendix Q
# Piping and Permeability Calculations

| | | |
|---|---|---|
| PROJECT/LOCATION: Dairyland Power Phase IV, Cell 3A Liner Construction | | PROJECT / PROPOSAL NO. |
| SUBJECT: Piping and Perm Calcs (SP1) | | 187576.0000.0000 |
| PREPARED BY: K. Pawlisch | DATE: 8/23/2012 | FINAL X |
| CHECKED BY: T. Martin | DATE: 8/23/2012 | REVISION |

# Piping and Permeability Calculation

## Base Material / Filter Material / Collection Pipe

### Input

**Base** (Select Granular Fill pt. 697)

| | | | | | |
|---|---|---|---|---|---|
| $D15_B$ | 0.46 | mm | = | 0.02 | inches |
| $D50_B$ | 0.85 | mm | = | 0.03 | inches |
| $D85_B$ | 1.80 | mm | = | 0.07 | inches |
| $Cu^{2,3}$ | 2.57 | mm | = | 0.10 | inches |

**Filter** (3/4" River Rock SP1)

| | | | | | |
|---|---|---|---|---|---|
| $D15_F$ | 6.35 | mm | = | 0.25 | inches |
| $D50_F$ | 9.90 | mm | = | 0.39 | inches |
| $D85_F$ | 15.51 | mm | = | 0.61 | inches |

**Collection Pipe**

Pipe Hole Diameter 0.50 inches or Slot Width n/a inch

### Results

**Head Loss (Permeability Criteria)**

| | Actual | | Required | Results |
|---|---|---|---|---|
| $D15_F / D15_B$ | 13.9 | > | 4.0 | OK |

**Perforation Size Results (Piping Criteria)**

| | Actual | | Required | Results |
|---|---|---|---|---|
| $D85_F / _{HOLE}$ | 1.2 | > | 1.2 | OK |
| or | | | | |
| $D85_F / _{SLOT}$ | n/a | > | 1.4 | n/a |

**Particle Migration (Piping Criteria)**

| | Actual | | Required | Results |
|---|---|---|---|---|
| $D15_F / D85_B$ | 3.5 | < | 5.0 | OK |
| $D50_F / D50_B$ | 11.7 | < | 25.0 | OK |
| $D15_F / D15_B$ | 13.9 | < | 20.0 | OK |

Notes:

1. To avoid segregation, filter material should contain no sizes larger than 3 inches.
2. To avoid internal movement of fines, filter material should have no more than 5% passing No. 200 sieve (NAVFAC, 1986).

| | | |
|---|---|---|
| PROJECT/LOCATION: Dairyland Power Phase IV, Cell 3A Liner Construction | | PROJECT / PROPOSAL NO. |
| SUBJECT: Piping and Perm Calcs (SP2) | | 187576.0000.0000 |
| PREPARED BY: K. Pawlisch | DATE: 8/23/2012 | FINAL X |
| CHECKED BY: T. Martin | DATE: 8/23/2012 | REVISION |

# Piping and Permeability Calculation

## Base Material / Filter Material / Collection Pipe

### Input

**Base (Select Granular Fill pt. 697)**

| | | | | | |
|---|---|---|---|---|---|
| $D15_B$ | 0.46 | mm | = | 0.02 | inches |
| $D50_B$ | 0.85 | mm | = | 0.03 | inches |
| $D85_B$ | 1.80 | mm | = | 0.07 | inches |
| $Cu^{2,3}$ | 2.57 | mm | = | 0.10 | inches |

**Filter (3/4" River Rock SP2)**

| | | | | | |
|---|---|---|---|---|---|
| $D15_F$ | 6.71 | mm | = | 0.26 | inches |
| $D50_F$ | 10.88 | mm | = | 0.43 | inches |
| $D85_F$ | 16.03 | mm | = | 0.63 | inches |

**Collection Pipe**

Pipe Hole Diameter 0.50 inches or Slot Width n/a inch

### Results

**Head Loss (Permeability Criteria)**

| | Actual | | Required | Results |
|---|---|---|---|---|
| $D15_F / D15_B$ | 14.7 | > | 4.0 | OK |

**Perforation Size Results (Piping Criteria)**

| | Actual | | Required | Results |
|---|---|---|---|---|
| $D85_F / _{HOLE}$ | 1.3 | > | 1.2 | OK |
| or | | | | |
| $D85_F / _{SLOT}$ | n/a | > | 1.4 | n/a |

**Particle Migration (Piping Criteria)**

| | Actual | | Required | Results |
|---|---|---|---|---|
| $D15_F / D85_B$ | 3.7 | < | 5.0 | OK |
| $D50_F / D50_B$ | 12.8 | < | 25.0 | OK |
| $D15_F / D15_B$ | 14.7 | < | 20.0 | OK |

Notes:

1. To avoid segregation, filter material should contain no sizes larger than 3 inches.
2. To avoid internal movement of fines, filter material should have no more than 5% passing No. 200 sieve (NAVFAC, 1986).

# COMPUTATION SHEET



744 Heartland Trail P.O. Box 8923 Madison, WI 53708-8923 (608) 831-4444 FAX: (608) 831-3334 VOICE: (608) 831-1989

| PROJECT/PROPOSAL NAME | PREPARED | | CHECKED | | PROJECT/PROPOSAL NO. |
|---|---|---|---|---|---|
| *DPC* | By: *MJD* | Date: 6/18/01 | By: BJK | Date: 6/18/01 | 3081.44 |

## *Piping and Permeability Calculation*

### *Input*

| *Fly Ash* | | *Drainage Layer* | |
|---|---|---|---|
| $D15_B$ | 0.02 | $D15_F$ | 0.21 |
| $D50_B$ | 0.03 | $D50_F$ | 0.29 |
| $D85_B$ | 0.05 | | |

### *Results*

*Permeability Results*

| | Actual | Required |
|---|---|---|
| $D15_F/D15_B$ | 8.2 | NA |

*Piping Results*

| | Actual | Required |
|---|---|---|
| $D15_F/D85_B$ | 4.6 | < 6 |
| $D50_F/D50_B$ | 9.5 | < 25 |
| $D15_F/D15_B$ | 8.2 | < 20 |

### *NOTES*

1. All units are in millimeters unless specified.
2. For very uniform base material (Cu<1.5): $D15_F/D85_B$ may be increased to 6.
3. For broadly graded base material (Cu>4): $D15_F/D15_B$ may be increased to 40 (Piping equation only).
4. To avoid segregation, filter material should contain no sizes larger than 3 inches.
5. To avoid internal movement of fines, filter material should have no more than 5% passing No. 200 sieve. (NAVFAC, 1986)
6. NA = Not Applicable

# COMPUTATION SHEET



744 Heartland Trail P.O. Box 8923 Madison, WI 53708-8923 (608) 831-4444 FAX: (608) 831-3334 VOICE: (608) 831-1989

| PROJECT/PROPOSAL NAME | PREPARED | | CHECKED | | PROJECT/PROPOSAL NO. |
|---|---|---|---|---|---|
| *DPC* | By: *MJD* | Date: 6/18/01 | By: BJK | Date: 6/18/01 | 3081.44 |

## *Piping and Permeability Calculation*

### *Input*

| *Bottom Ash* | | *Drainage Layer* | |
|---|---|---|---|
| $D15_B$ | 0.09 | $D15_F$ | 0.21 |
| $D50_B$ | 0.25 | $D50_F$ | 0.29 |
| $D85_B$ | 3.00 | | |

### *Results*

*Permeability Results*

| | Actual | Required |
|---|---|---|
| $D15_F/D15_B$ | 2.3 | NA |

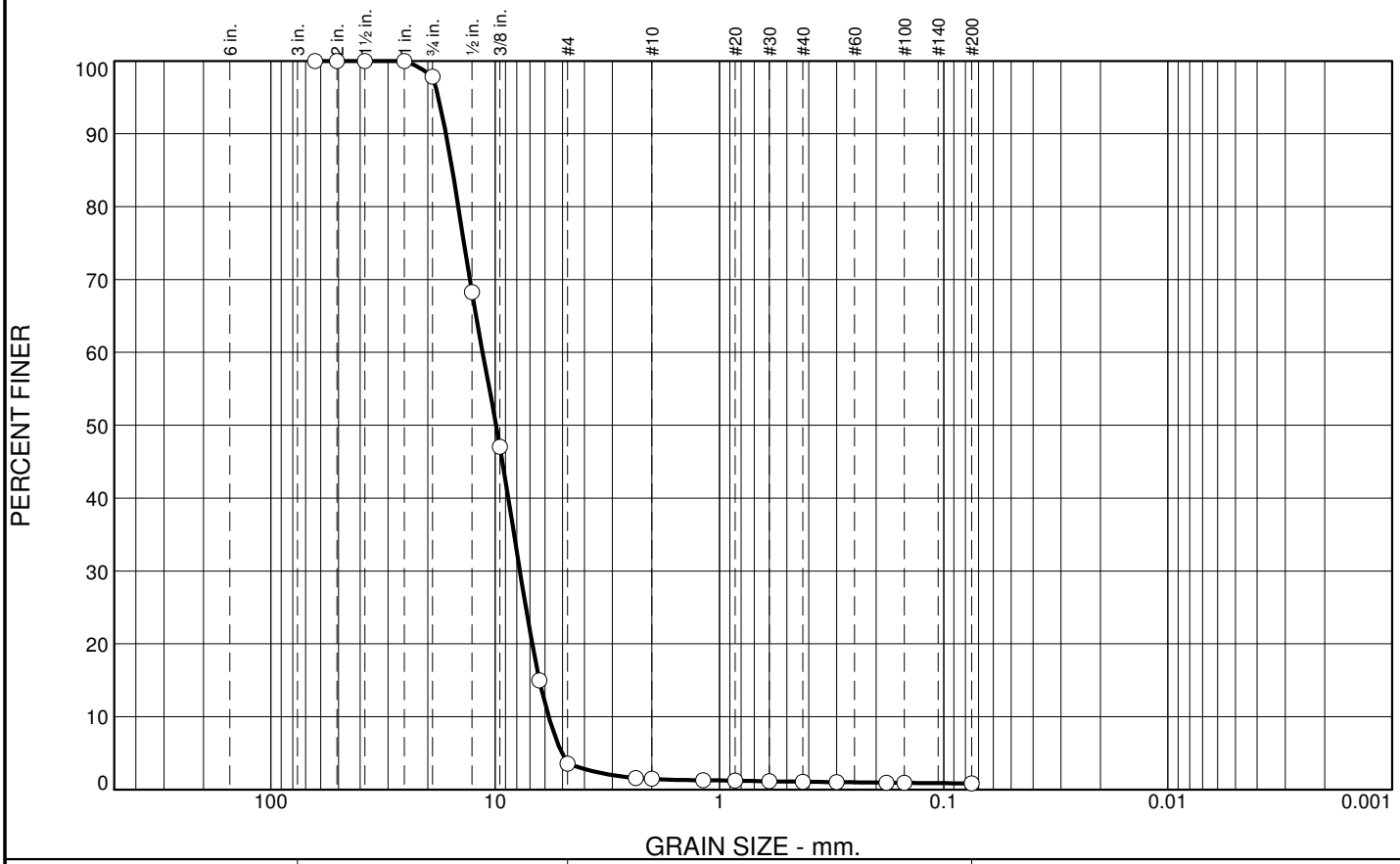
*Piping Results*

| | Actual | Required |
|---|---|---|
| $D15_F/D85_B$ | 0.1 | < 6 |
| $D50_F/D50_B$ | 1.2 | < 25 |
| $D15_F/D15_B$ | 2.3 | < 20 |

### *NOTES*

1. All units are in millimeters unless specified.
2. For very uniform base material (Cu<1.5): $D15_F/D85_B$ may be increased to 6.
3. For broadly graded base material (Cu>4): $D15_F/D15_B$ may be increased to 40 (Piping equation only).
4. To avoid segregation, filter material should contain no sizes larger than 3 inches.
5. To avoid internal movement of fines, filter material should have no more than 5% passing No. 200 sieve. (NAVFAC, 1986)
6. NA = Not Applicable

# Particle Size Distribution Report




| % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 2.2 | 94.3 | 2.0 | 0.4 | 0.3 | 0.8 | |

| SIEVE SIZE | PERCENT FINER | SPEC.* PERCENT | PASS? (X=NO) |
|---|---|---|---|
| 2.5 | 100.0 | | |
| 2.0 | 100.0 | | |
| 1.5 | 100.0 | | |
| 1.0 | 100.0 | | |
| .75 | 97.8 | | |
| .5 | 68.3 | | |
| .375 | 47.0 | | |
| .25 | 15.0 | | |
| #4 | 3.5 | | |
| #8 | 1.6 | | |
| #10 | 1.5 | | |
| #16 | 1.3 | | |
| #20 | 1.2 | | |
| #30 | 1.1 | | |
| #40 | 1.1 | | |
| #50 | 1.0 | | |
| #80 | 1.0 | | |
| #100 | 0.9 | | |
| #200 | 0.8 | | |

* (no specification provided)

**Material Description**

Poorly graded gravel

**Atterberg Limits**

PL= LL= PI=

**Coefficients**

$D_{90}$= 16.5583 $D_{85}$= 15.5103 $D_{60}$= 11.3782
$D_{50}$= 9.9041 $D_{30}$= 7.7598 $D_{15}$= 6.3497
$D_{10}$= 5.7831 $C_u$= 1.97 $C_c$= 0.92

**Classification**

USCS= GP AASHTO=

**Remarks**

**Source of Sample:** Select Aggregate Fill
**Sample Number:** River Run SP-1

**Date:** 08-23-12

**TRC Environmental Corp.**

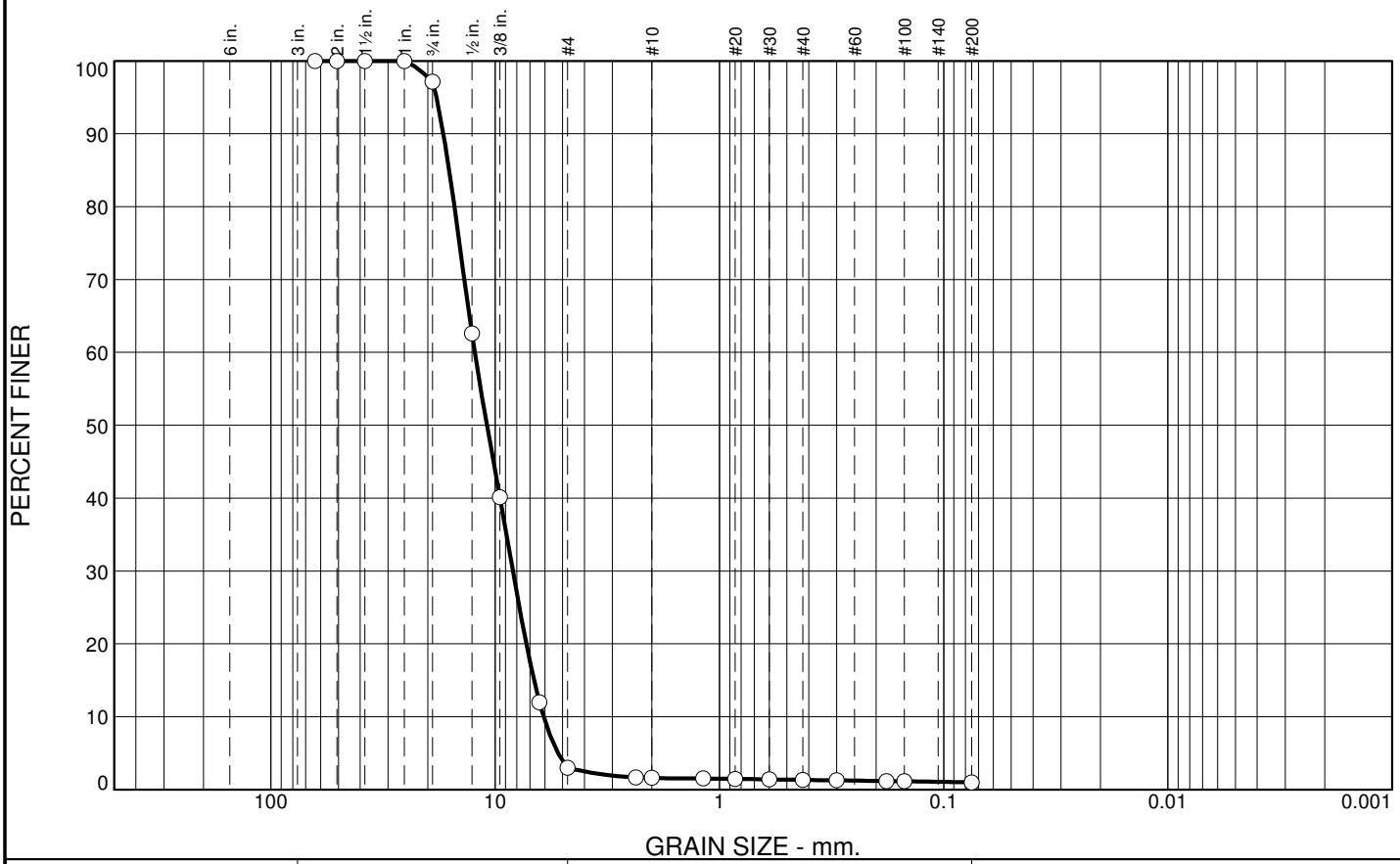
**Madison, Wisconsin**

**Client:** DPC
**Project:** DPC - PH4 Cell 3A

**Project No:** 187576.0000 **Figure**

**Tested By:** JPH **Checked By:** JPH

# Particle Size Distribution Report




| % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 2.8 | 94.2 | 1.4 | 0.3 | 0.3 | 1.0 | |

| SIEVE SIZE | PERCENT FINER | SPEC.* PERCENT | PASS? (X=NO) |
|---|---|---|---|
| 2.5 | 100.0 | | |
| 2.0 | 100.0 | | |
| 1.5 | 100.0 | | |
| 1.0 | 100.0 | | |
| .75 | 97.2 | | |
| .5 | 62.6 | | |
| .375 | 40.1 | | |
| .25 | 12.0 | | |
| #4 | 3.0 | | |
| #8 | 1.7 | | |
| #10 | 1.6 | | |
| #16 | 1.5 | | |
| #20 | 1.5 | | |
| #30 | 1.4 | | |
| #40 | 1.3 | | |
| #50 | 1.3 | | |
| #80 | 1.2 | | |
| #100 | 1.1 | | |
| #200 | 1.0 | | |

* (no specification provided)

**Material Description**

Poorly graded gravel

**Atterberg Limits**

PL= LL= PI=

**Coefficients**

$D_{90}$= 17.0003 $D_{85}$= 16.0276 $D_{60}$= 12.3298
$D_{50}$= 10.8803 $D_{30}$= 8.3374 $D_{15}$= 6.7126
$D_{10}$= 6.0888 $C_u$= 2.03 $C_c$= 0.93

**Classification**

USCS= GP AASHTO=

**Remarks**

**Source of Sample:** Select Aggregate Fill
**Sample Number:** River Run SP-2

**Date:** 08-23-12

**TRC Environmental Corp.**

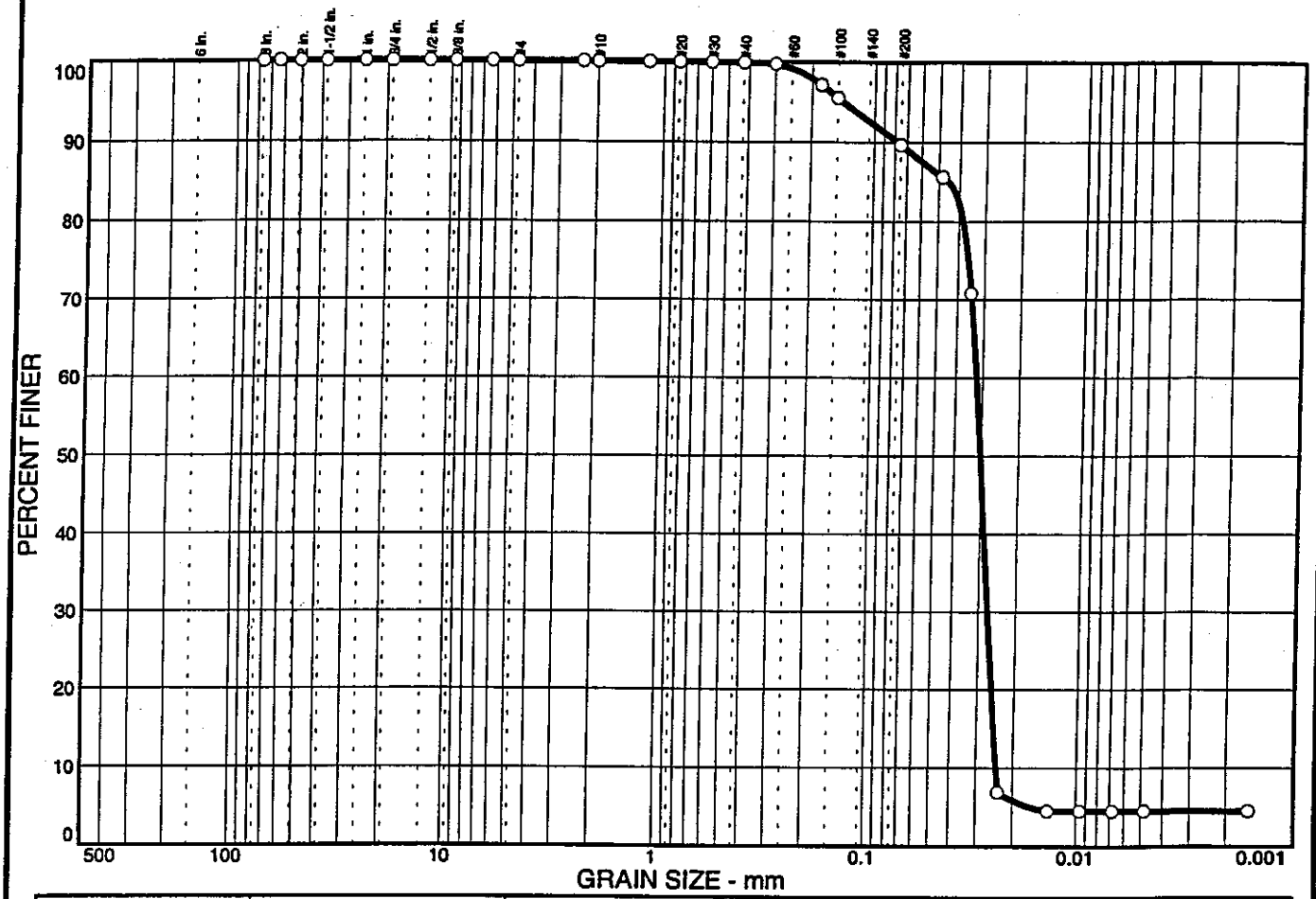
**Madison, Wisconsin**

**Client:** DPC
**Project:** DPC - PH4 Cell 3A

**Project No:** 187576.0000 **Figure**

**Tested By:** JPH **Checked By:** JPH

# GRAIN SIZE DISTRIBUTION TEST REPORT




| % + 3" | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|
| 0.0 | 0.0 | 10.3 | 85.2 | 4.5 |

| SIEVE SIZE | PERCENT FINER | SPEC.* PERCENT | PASS? (X=NO) |
|---|---|---|---|
| 3.0 in. | 100.0 | | |
| 2.5 in. | 100.0 | | |
| 2.0 in. | 100.0 | | |
| 1.5 in. | 100.0 | | |
| 1.0 in. | 100.0 | | |
| .75 in. | 100.0 | | |
| .5 in. | 100.0 | | |
| .375 in. | 100.0 | | |
| .25 in. | 100.0 | | |
| #4 | 100.0 | | |
| #8 | 100.0 | | |
| #10 | 100.0 | | |
| #16 | 100.0 | | |
| #20 | 100.0 | | |
| #30 | 100.0 | | |
| #40 | 99.9 | | |
| #50 | 99.7 | | |
| #80 | 97.1 | | |
| #100 | 95.5 | | |
| #200 | 89.7 | | |

* (no specification provided)

**Soil Description**

(Fly Ash)

**Atterberg Limits**

PL= LL= PI=

**Coefficients**

$D_{85}$= 0.0450 $D_{60}$= 0.0321 $D_{50}$= 0.0303
$D_{30}$= 0.0272 $D_{15}$= 0.0249 $D_{10}$= 0.0241
$C_u$= 1.33 $C_c$= 0.96

**Classification**

USCS= AASHTO=

**Remarks**

**Sample No.:** Alma-1 **Source of Sample:** DPC-Alma **Date:** 6-6-01
**Location:** FLY ASH **Elev./Depth:**

**RMT, Inc.**

**Client:**
**Project:** DAIRYLAND POWER COOPERATIVE
**Project No:** 3081.49 **Figure:**

**DAVY LABORATORIES**
115 South 6th Street
P.O. Box 2076
La Crosse, WI 54602-2076
(608) 782-3130
FAX (608) 784-6611

Division of Davy Engineering Co.

## TABLE 3
## PHYSICAL ANALYSIS RESULTS FOR ALMA BOTTOM ASH

I. Particle Size Distribution

Sample Number: 44639 Sample Size: 50 grams

| Sieve No. | Grams Retained | Total Retained | % Retained | % Total Retained | % Finer |
|---|---|---|---|---|---|
| 3/8 | 0.00 | 0.00 | 0.00 | 0.00 | 100 |
| 4 | 5.16 | 5.16 | 10.33 | 10.33 | 89.67 |
| 8 | 3.53 | 8.69 | 7.07 | 17.40 | 82.60 |
| 16 | 4.50 | 13.19 | 9.01 | 36.41 | 73.59 |
| 30 | 5.75 | 18.94 | 11.51 | 37.92 | 62.07 |
| 50 | 9.00 | 37.94 | 18.02 | 55.94 | 44.06 |
| 100 | 9.73 | 37.67 | 19.48 | 75.42 | 24.58 |
| 200 | 6.81 | 44.48 | 13.64 | 89.06 | 10.94 |
| Pan | 5.46 | --- | --- | --- | --- |

Total Weight Recovered 49.94 grams

II. Bulk Dry Density, pcf (ASTM:C29) 51.8

# I.2
# Cell 3B Liner Construction Documentation Report
# Piping and Permeability Calculation

# Phase IV, Cell 3B Liner Construction Documentation Report

## Dairyland Power Cooperative
## Alma Off-Site Ash Disposal Facility

*License No. 4126*

**October 2015**

WISCONSIN
Douglas R. Genthe
E-27604
Madison, WI
PROFESSIONAL ENGINEER

10-23-2015

Douglas R. Genthe, P.E.
Managing Principal

Todd W. Martin
Project Manager

for Spencer Sellner
Spencer Sellner
Resident Project Representative



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# Appendix N
# Piping and Permeability Calculations

TRC
708 Heartland Trail, Suite 3000, Madison, WI 53717 • www.TRCsolutions.com

| | | |
|---|---|---|
| PROJECT/PROPOSAL NAME/LOCATION: DPC Phase IV Cell 3B Liner Construction | | PROJECT / PROPOSAL NO. |
| SUBJECT: Piping and Permeability Calculation | | 216851.0004 |
| PREPARED BY: T. Halena | DATE: 6/22/2015 | FINAL X |
| CHECKED BY: R. Wienkes | DATE: 10/19/2015 | REVISION |

# Piping and Permeability Calculation

**Base Material / Filter Material / Collection Pipe**

## Input

| Base, Soil Being Retained (Graded Filter) | | | | Filter (Pipe Bedding) | | | |
|---|---|---|---|---|---|---|---|
| $D15_B$ | 2.89 mm | = | 0.11 inches | $D15_F$ | 6.96 mm | = | 0.27 inches |
| $D50_B$ | 3.90 mm | = | 0.15 inches | $D50_F$ | 11.32 mm | = | 0.45 inches |
| $D85_B$ | 5.22 mm | = | 0.21 inches | $D85_F$ | 17.04 mm | = | 0.67 inches |
| $Cu^{2,3}$ | 1.55 mm | = | 0.06 | | | | |

**Collection Pipe**

Pipe Hole Diameter N/A inches or Slot Width N/A inch

## Results

**Permeability Results**

| | Actual | | Required | Results |
|---|---|---|---|---|
| $D15_F / D15_B$ | 2.4 | > | N/A | N/A |

**Perforation Size Results**

| | Actual | | Required | Results |
|---|---|---|---|---|
| $D85_F / _{HOLE}$ | N/A | > | 1.2 | N/A |
| or | | | | |
| $D85_F / _{SLOT}$ | N/A | > | 1.4 | N/A |

**Piping Results**

| | Actual | | Required | Results |
|---|---|---|---|---|
| $D15_F / D85_B$ | 1.3 | < | 5.0 | OK |
| $D50_F / D50_B$ | 2.9 | < | 25.0 | OK |
| $D15_F / D15_B$ | 2.4 | < | 20.0 | OK |

Notes:

1. To avoid segregation, filter material should contain no sizes larger than 3 inches.
2. To avoid internal movement of fines, filter material should have no more than 5% passing No. 200 sieve. (NAVFAC, 1986)
3. For a uniform base (Cu<1.5), $D15_F/D85_B$ may be increased to 6 (piping equation only).
4. For a broadly graded base material (Cu>4), $D15_F/D15_B$ may be increased to 40 (piping equation only).

708 Heartland Trail, Suite 3000, Madison, WI 53717 • www.TRCsolutions.com

| | | |
|---|---|---|
| PROJECT/PROPOSAL NAME/LOCATION: DPC Phase IV Cell 3B Liner Construction | | PROJECT / PROPOSAL NO. |
| SUBJECT: Piping and Permeability Calculation | | 216851.0004 |
| PREPARED BY: T. Halena | DATE: 6/22/2015 | FINAL X |
| CHECKED BY: R. Wienkes | DATE: 10/19/2015 | REVISION |

# Piping and Permeability Calculation

## Base Material / Filter Material / Collection Pipe

### Input

**Base, Soil Being Retained (Select Granular Fill)**

| | | | |
|---|---|---|---|
| $D15_B$ | 0.29 mm | = | 0.01 inches |
| $D50_B$ | 0.50 mm | = | 0.02 inches |
| $D85_B$ | 1.02 mm | = | 0.04 inches |
| $Cu^{2,3}$ | 2.32 mm | = | 0.09 |

**Filter (Select Graded Fill)**

| | | | |
|---|---|---|---|
| $D15_F$ | 3.09 mm | = | 0.12 inches |
| $D50_F$ | 4.30 mm | = | 0.17 inches |
| $D85_F$ | 5.65 mm | = | 0.22 inches |

**Collection Pipe**

Pipe Hole Diameter N/A inches or Slot Width N/A inch

### Results

**Permeability Results**

| | Actual | | Required | Results |
|---|---|---|---|---|
| $D15_F / D15_B$ | 10.7 | > | N/A | N/A |

**Perforation Size Results**

| | Actual | | Required | Results |
|---|---|---|---|---|
| $D85_F / {}_{HOLE}$ | N/A | > | 1.2 | N/A |
| or | | | | |
| $D85_F / {}_{SLOT}$ | N/A | > | 1.4 | N/A |

**Piping Results**

| | Actual | | Required | Results |
|---|---|---|---|---|
| $D15_F / D85_B$ | 3.0 | < | 5.0 | OK |
| $D50_F / D50_B$ | 8.6 | < | 25.0 | OK |
| $D15_F / D15_B$ | 10.7 | < | 20.0 | OK |

Notes:

1. To avoid segregation, filter material should contain no sizes larger than 3 inches.
2. To avoid internal movement of fines, filter material should have no more than 5% passing No. 200 sieve. (NAVFAC, 1986)
3. For a uniform base (Cu<1.5), $D15_F/D85_B$ may be increased to 6 (piping equation only).
4. For a broadly graded base material (Cu>4), $D15_F/D15_B$ may be increased to 40 (piping equation only).

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| | | |
|---|---|---|
| PROJECT/PROPOSAL NAME/LOCATION: DPC Phase IV Cell 3B Liner Construction | | PROJECT / PROPOSAL NO. |
| SUBJECT: Piping and Permeability Calculation | | 216851.0004 |
| PREPARED BY: T. Halena | DATE: 6/22/2015 | FINAL X |
| CHECKED BY: R. Wienkes | DATE: 10/19/2015 | REVISION |

# Piping and Permeability Calculation

## Base Material / Filter Material / Collection Pipe

### Input

**Base, Material Being Retained (Fly Ash)**

| | | | |
|---|---|---|---|
| $D15_B$ | 0.02 mm | = | 0.00 inches |
| $D50_B$ | 0.03 mm | = | 0.00 inches |
| $D85_B$ | 0.05 mm | = | 0.00 inches |
| $Cu^{2,3}$ | 1.33 mm | = | 0.05 |

**Filter (Select Granular Fill)**

| | | | |
|---|---|---|---|
| $D15_F$ | 0.29 mm | = | 0.01 inches |
| $D50_F$ | 0.56 mm | = | 0.02 inches |
| $D85_F$ | 3.36 mm | = | 0.13 inches |

**Collection Pipe**

Pipe Hole Diameter N/A inches or Slot Width N/A inch

### Results

**Permeability Results**

| | Actual | | Required | Results |
|---|---|---|---|---|
| $D15_F / D15_B$ | 14.5 | > | N/A | N/A |

**Perforation Size Results**

| | Actual | | Required | Results |
|---|---|---|---|---|
| $D85_F / {}_{HOLE}$ | N/A | > | 1.2 | N/A |
| or | | | | |
| $D85_F / {}_{SLOT}$ | N/A | > | 1.4 | N/A |

**Piping Results**

| | Actual | | Required | Results |
|---|---|---|---|---|
| $D15_F / D85_B$ | 5.8 | < | 6.0 | OK |
| $D50_F / D50_B$ | 18.7 | < | 25.0 | OK |
| $D15_F / D15_B$ | 14.5 | < | 20.0 | OK |

Notes:

1. To avoid segregation, filter material should contain no sizes larger than 3 inches.
2. To avoid internal movement of fines, filter material should have no more than 5% passing No. 200 sieve. (NAVFAC, 1986)
3. For a uniform base (Cu<1.5), $D15_F/D85_B$ may be increased to 6 (piping equation only).
4. For a broadly graded base material (Cu>4), $D15_F/D15_B$ may be increased to 40 (piping equation only).

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| | | |
|---|---|---|
| PROJECT/PROPOSAL NAME/LOCATION: DPC Phase IV Cell 3B Liner Construction | | PROJECT / PROPOSAL NO. |
| SUBJECT: Piping and Permeability Calculation | | 216851.0004 |
| PREPARED BY: T. Halena | DATE: 6/22/2015 | FINAL X |
| CHECKED BY: R. Wienkes | DATE: 10/19/2015 | REVISION |

# Piping and Permeability Calculation

## Base Material / Filter Material / Collection Pipe

### Input

**Base, Material Being Retained (Bottom Ash)**

| | | | |
|---|---|---|---|
| $D15_B$ | 0.09 mm | = | 0.0035 inches |
| $D50_B$ | 0.25 mm | = | 0.0098 inches |
| $D85_B$ | 3.00 mm | = | 0.1181 inches |
| $Cu^{2,3}$ | mm | = | 0.0000 |

**Filter (Select Granular Fill)**

| | | | |
|---|---|---|---|
| $D15_F$ | 0.29 mm | = | 0.01 inches |
| $D50_F$ | 0.56 mm | = | 0.02 inches |
| $D85_F$ | 3.36 mm | = | 0.13 inches |

**Collection Pipe**

Pipe Hole Diameter N/A inches or Slot Width N/A inch

### Results

**Permeability Results**

| | Actual | | Required | Results |
|---|---|---|---|---|
| $D15_F / D15_B$ | 3.2 | > | N/A | N/A |

**Perforation Size Results**

| | Actual | | Required | Results |
|---|---|---|---|---|
| $D85_F / {}_{HOLE}$ | N/A | > | 1.2 | N/A |
| or | | | | |
| $D85_F / {}_{SLOT}$ | N/A | > | 1.4 | N/A |

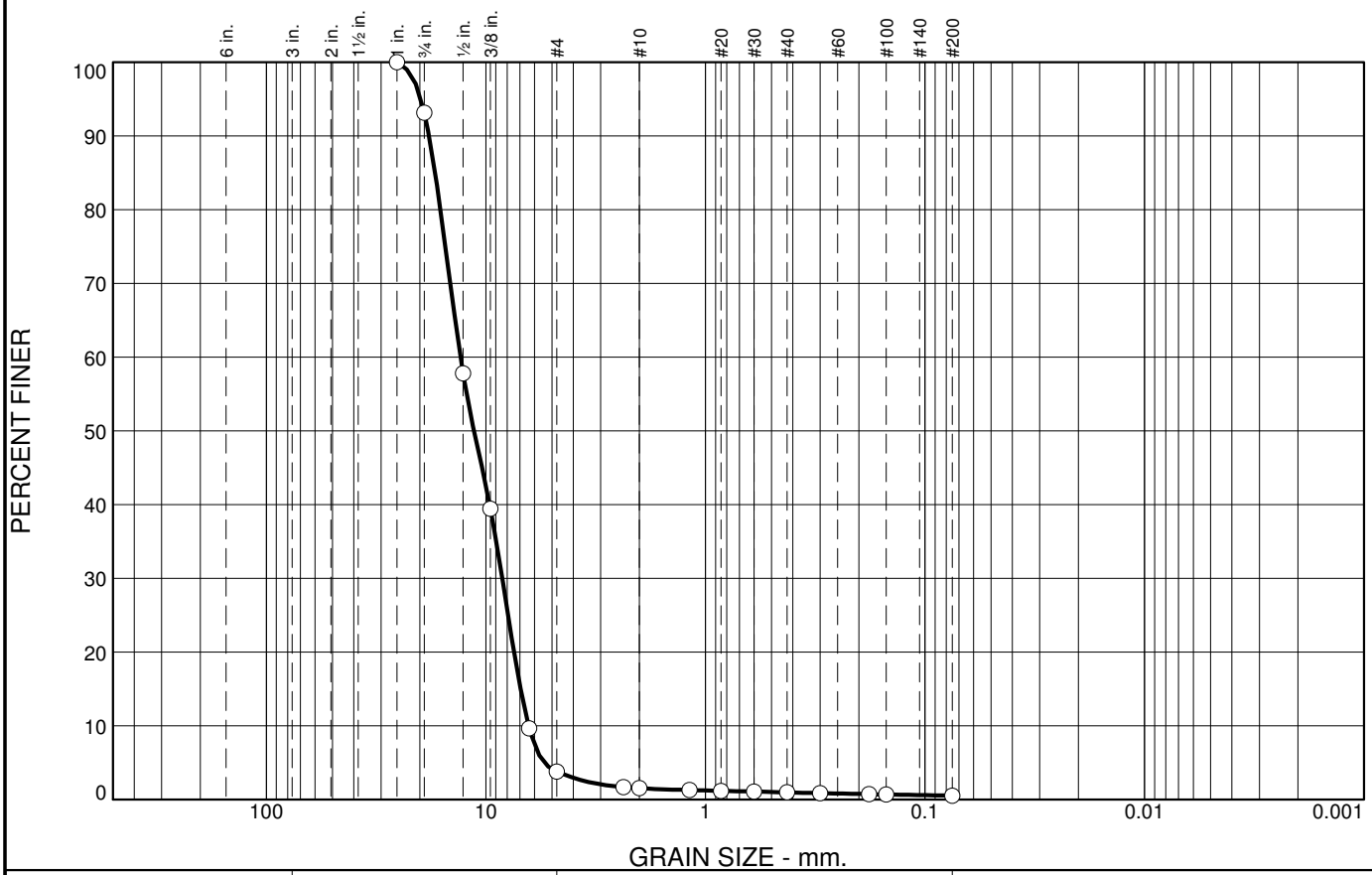
**Piping Results**

| | Actual | | Required | Results |
|---|---|---|---|---|
| $D15_F / D85_B$ | 0.1 | < | 6.0 | OK |
| $D50_F / D50_B$ | 2.2 | < | 25.0 | OK |
| $D15_F / D15_B$ | 3.2 | < | 20.0 | OK |

Notes:

1. To avoid segregation, filter material should contain no sizes larger than 3 inches.
2. To avoid internal movement of fines, filter material should have no more than 5% passing No. 200 sieve. (NAVFAC, 1986)
3. For a uniform base (Cu<1.5), $D15_F/D85_B$ may be increased to 6 (piping equation only).
4. For a broadly graded base material (Cu>4), $D15_F/D15_B$ may be increased to 40 (piping equation only).

# Particle Size Distribution Report




| % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 6.8 | 89.4 | 2.3 | 0.5 | 0.5 | 0.5 | |

| SIEVE SIZE | PERCENT FINER | SPEC.* PERCENT | PASS? (X=NO) |
|---|---|---|---|
| 1.0 | 100.0 | | |
| .75 | 93.2 | | |
| .5 | 57.8 | | |
| .375 | 39.4 | | |
| .25 | 9.7 | | |
| #4 | 3.8 | | |
| #8 | 1.7 | | |
| #10 | 1.5 | | |
| #16 | 1.3 | | |
| #20 | 1.2 | | |
| #30 | 1.1 | | |
| #40 | 1.0 | | |
| #50 | 0.9 | | |
| #80 | 0.7 | | |
| #100 | 0.7 | | |
| #200 | 0.5 | | |

* (no specification provided)

**Material Description**

Poorly graded gravel

**Atterberg Limits**

PL= LL= PI=

**Coefficients**

$D_{90}$= 18.1422 $D_{85}$= 17.0358 $D_{60}$= 13.0457
$D_{50}$= 11.3188 $D_{30}$= 8.4236 $D_{15}$= 6.9563
$D_{10}$= 6.3957 $C_u$= 2.04 $C_c$= 0.85

**Classification**

USCS= GP AASHTO=

**Remarks**

Most conservative (largest) grain size distribution

**Source of Sample:** Select Aggregate Fill
**Sample Number:** Pt. 793

**Date:** 08-20-15

**TRC Environmental Corp.**

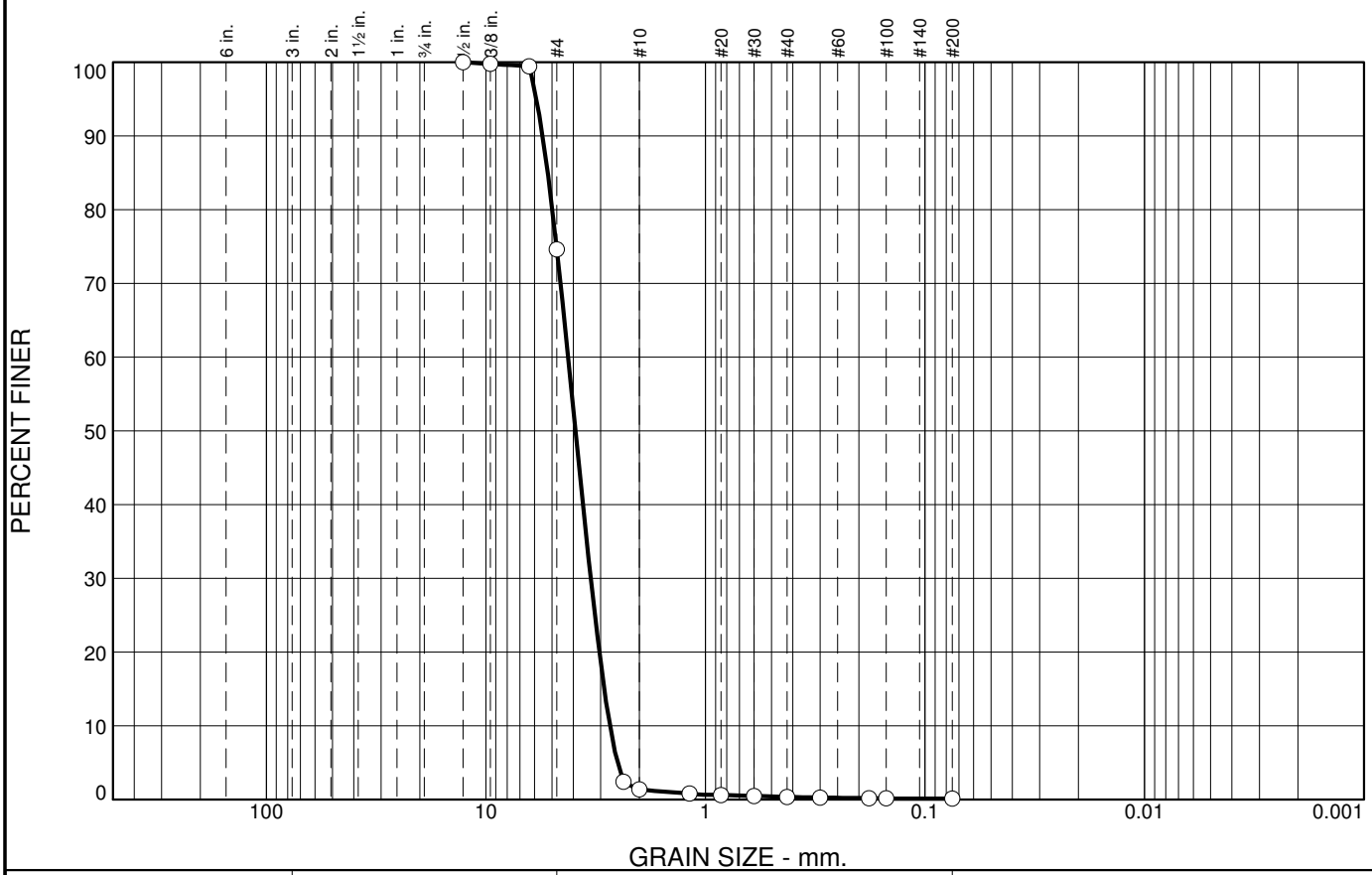
**Madison, Wisconsin**

**Client:** DPC
**Project:** DPC - Phase IV, Cell 3B

**Project No:** 216851.0004 **Figure**

**Tested By:** MBW **Checked By:** MBW

# Particle Size Distribution Report




| % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 25.4 | 73.2 | 1.1 | 0.2 | 0.1 | |

| SIEVE SIZE | PERCENT FINER | SPEC.* PERCENT | PASS? (X=NO) |
|---|---|---|---|
| .5 | 100.0 | | |
| .375 | 99.8 | | |
| .25 | 99.4 | | |
| #4 | 74.6 | | |
| #8 | 2.4 | | |
| #10 | 1.4 | | |
| #16 | 0.8 | | |
| #20 | 0.6 | | |
| #30 | 0.5 | | |
| #40 | 0.3 | | |
| #50 | 0.3 | | |
| #80 | 0.2 | | |
| #100 | 0.1 | | |
| #200 | 0.1 | | |

* (no specification provided)

**Material Description**

Poorly graded sand with gravel

**Atterberg Limits**

PL= LL= PI=

**Coefficients**

$D_{90}$= 5.5110 $D_{85}$= 5.2248 $D_{60}$= 4.2186
$D_{50}$= 3.9042 $D_{30}$= 3.3288 $D_{15}$= 2.8904
$D_{10}$= 2.7237 $C_u$= 1.55 $C_c$= 0.96

**Classification**

USCS= SP AASHTO=

**Remarks**

Most conservative (smallest) grain size distribution

**Source of Sample:** Select Graded Fill
**Sample Number:** Pt. 782

**Date:** 08-20-15

**TRC Environmental Corp.**

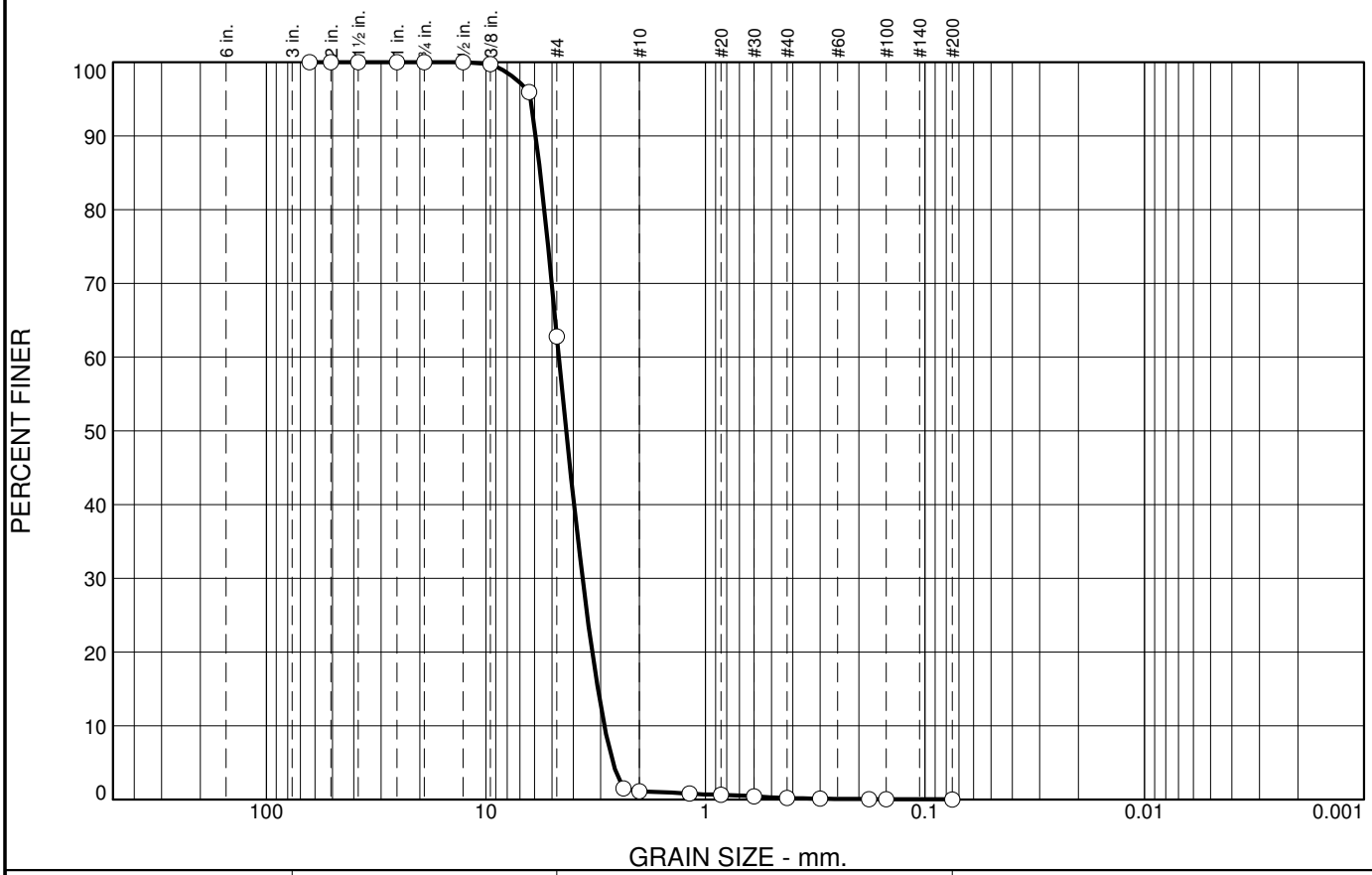
**Madison, Wisconsin**

**Client:** DPC
**Project:** DPC - Phase IV, Cell 3B

**Project No:** 216851.0004 **Figure**

**Tested By:** MBW **Checked By:** MBW

# Particle Size Distribution Report




| % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 37.2 | 61.7 | 0.9 | 0.2 | 0.0 | |

| SIEVE SIZE | PERCENT FINER | SPEC.* PERCENT | PASS? (X=NO) |
|---|---|---|---|
| 2.5 | 100.0 | | |
| 2.0 | 100.0 | | |
| 1.5 | 100.0 | | |
| 1.0 | 100.0 | | |
| .75 | 100.0 | | |
| .5 | 100.0 | | |
| .375 | 99.7 | | |
| .25 | 95.9 | | |
| #4 | 62.8 | | |
| #8 | 1.5 | | |
| #10 | 1.1 | | |
| #16 | 0.8 | | |
| #20 | 0.6 | | |
| #30 | 0.4 | | |
| #40 | 0.2 | | |
| #50 | 0.1 | | |
| #80 | 0.1 | | |
| #100 | 0.0 | | |
| #200 | 0.0 | | |

* (no specification provided)

**Material Description**

Poorly graded sand with gravel

**Atterberg Limits**

PL= LL= PI=

**Coefficients**

$D_{90}$= 5.9193 $D_{85}$= 5.6487 $D_{60}$= 4.6510
$D_{50}$= 4.3038 $D_{30}$= 3.6268 $D_{15}$= 3.0902
$D_{10}$= 2.8854 $C_u$= 1.61 $C_c$= 0.98

**Classification**

USCS= SP AASHTO=

**Remarks**

Most conservative (largest) grain size distribution

**Source of Sample:** Select Graded Fill
**Sample Number:** Sample #1

**Date:** 07-02-15

**TRC Environmental Corp.**

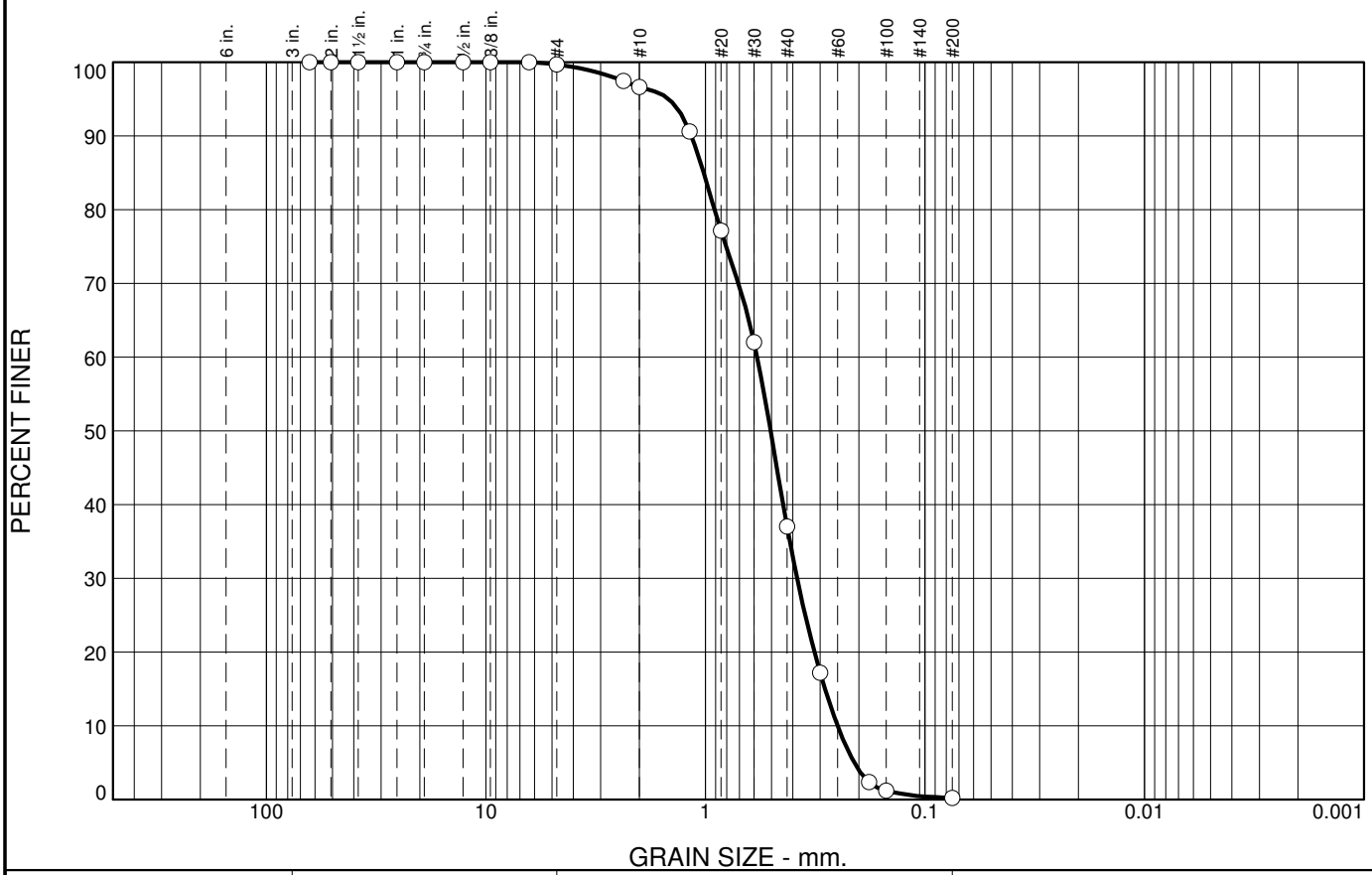
**Madison, Wisconsin**

**Client:** DPC
**Project:** DPC - Phase IV, Cell 3B

**Project No:** 216851.0004 **Figure**

**Tested By:** MBW **Checked By:** MBW

# Particle Size Distribution Report




| % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 0.3 | 3.1 | 59.6 | 36.8 | 0.2 | |

| SIEVE SIZE | PERCENT FINER | SPEC.* PERCENT | PASS? (X=NO) |
|---|---|---|---|
| 2.5 | 100.0 | | |
| 2.0 | 100.0 | | |
| 1.5 | 100.0 | | |
| 1.0 | 100.0 | | |
| .75 | 100.0 | | |
| .5 | 100.0 | | |
| .375 | 100.0 | | |
| .25 | 100.0 | | |
| #4 | 99.7 | | |
| #8 | 97.4 | | |
| #10 | 96.6 | | |
| #16 | 90.6 | | |
| #20 | 77.1 | | |
| #30 | 62.0 | | |
| #40 | 37.0 | | |
| #50 | 17.2 | | |
| #80 | 2.4 | | |
| #100 | 1.2 | | |
| #200 | 0.2 | | |

* (no specification provided)

**Material Description**

Poorly graded sand

**Atterberg Limits**

PL= LL= PI=

**Coefficients**

$D_{90}$= 1.1574 $D_{85}$= 1.0181 $D_{60}$= 0.5806
$D_{50}$= 0.5048 $D_{30}$= 0.3824 $D_{15}$= 0.2852
$D_{10}$= 0.2503 $C_u$= 2.32 $C_c$= 1.01

**Classification**

USCS= SP AASHTO=

**Remarks**

Most conservative (smallest) grain size distribution

**Source of Sample:** Select Granular Fill
**Sample Number:** Sample #2

**Date:** 07-29-15

**TRC Environmental Corp.**

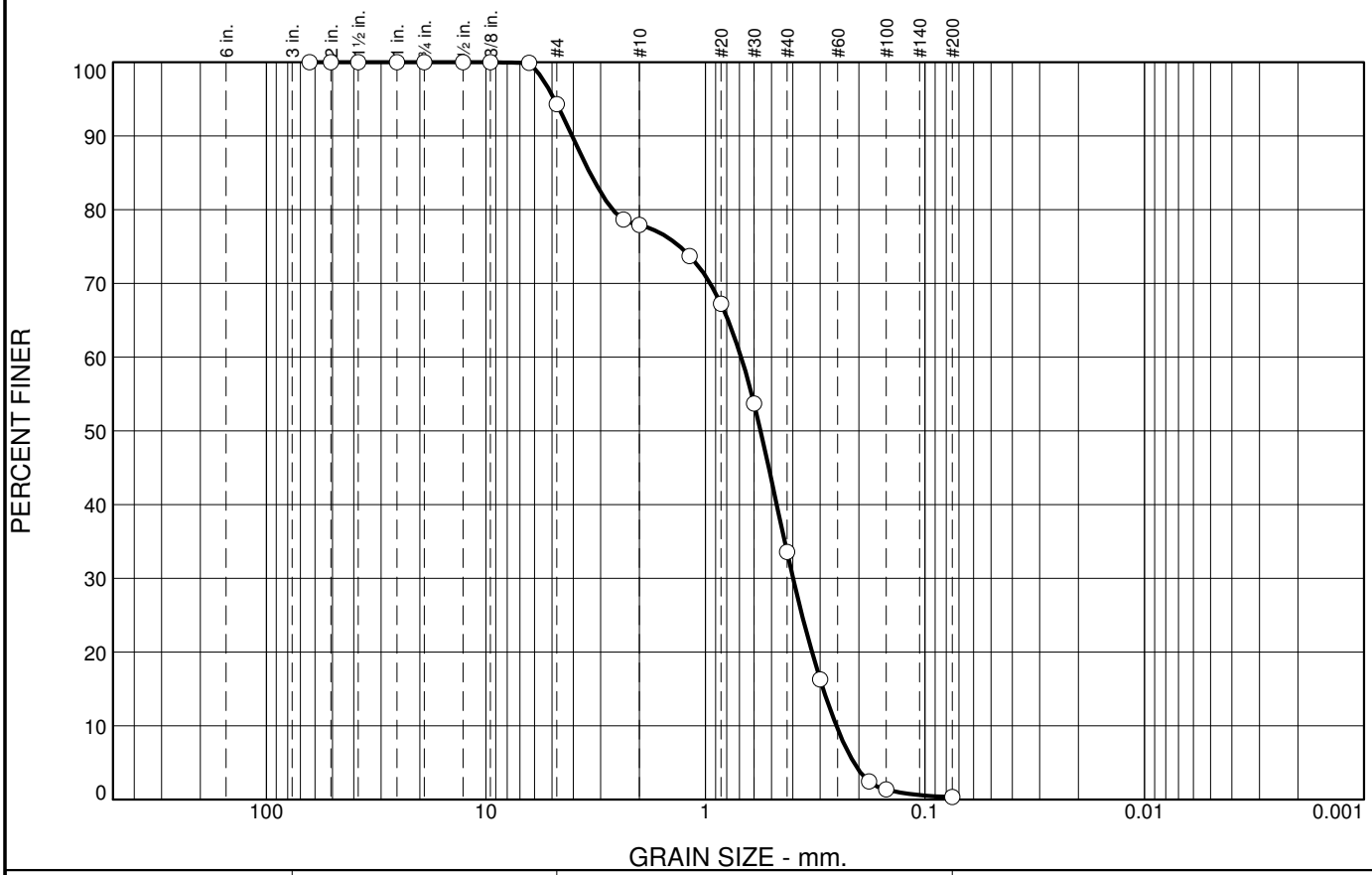
**Madison, Wisconsin**

**Client:** DPC
**Project:** DPC - Phase IV, Cell 3B

**Project No:** 216851.0004 **Figure**

**Tested By:** JPH **Checked By:** JPH

# Particle Size Distribution Report




| % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 5.7 | 16.4 | 44.3 | 33.3 | 0.3 | |

| SIEVE SIZE | PERCENT FINER | SPEC.* PERCENT | PASS? (X=NO) |
|---|---|---|---|
| 2.5 | 100.0 | | |
| 2.0 | 100.0 | | |
| 1.5 | 100.0 | | |
| 1.0 | 100.0 | | |
| .75 | 100.0 | | |
| .5 | 100.0 | | |
| .375 | 100.0 | | |
| .25 | 99.9 | | |
| #4 | 94.3 | | |
| #8 | 78.6 | | |
| #10 | 77.9 | | |
| #16 | 73.7 | | |
| #20 | 67.2 | | |
| #30 | 53.7 | | |
| #40 | 33.6 | | |
| #50 | 16.3 | | |
| #80 | 2.4 | | |
| #100 | 1.4 | | |
| #200 | 0.3 | | |

* (no specification provided)

**Material Description**

Poorly graded sand

**Atterberg Limits**

PL= LL= PI=

**Coefficients**

$D_{90}$= 4.0446 $D_{85}$= 3.3555 $D_{60}$= 0.6875
$D_{50}$= 0.5605 $D_{30}$= 0.3988 $D_{15}$= 0.2907
$D_{10}$= 0.2534 $C_u$= 2.71 $C_c$= 0.91

**Classification**

USCS= SP AASHTO=

**Remarks**

Most conservative (largest) grain size distribution

**Source of Sample:** Select Granular Fill
**Sample Number:** Sample #1

**Date:** 07-02-15

**TRC Environmental Corp.**

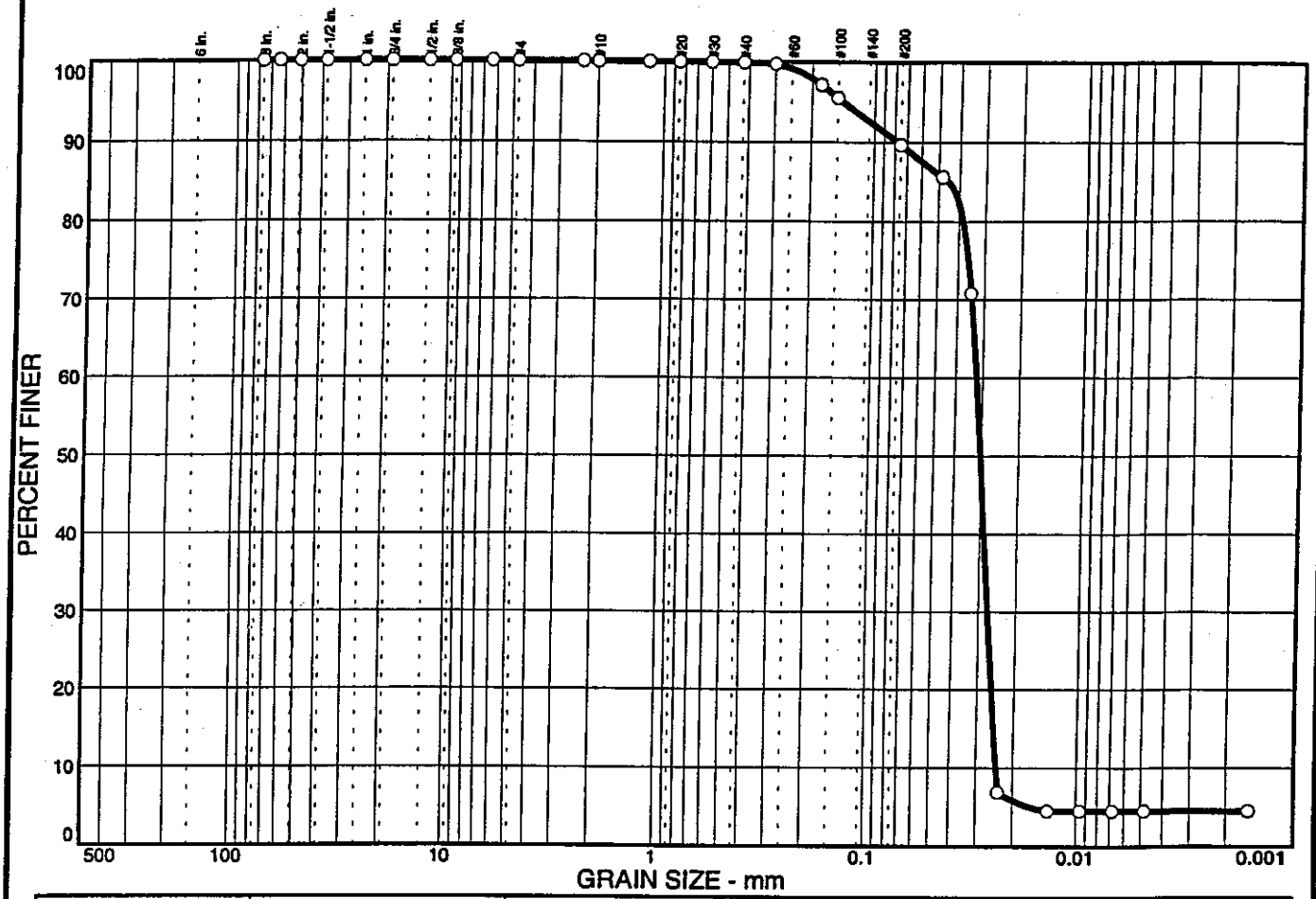
**Madison, Wisconsin**

**Client:** DPC
**Project:** DPC - Phase IV, Cell 3B

**Project No:** 216851.0004 **Figure**

**Tested By:** MBW **Checked By:** MBW

# GRAIN SIZE DISTRIBUTION TEST REPORT




| % + 3" | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|
| 0.0 | 0.0 | 10.3 | 85.2 | 4.5 |

| SIEVE SIZE | PERCENT FINER | SPEC.* PERCENT | PASS? (X=NO) |
|---|---|---|---|
| 3.0 in. | 100.0 | | |
| 2.5 in. | 100.0 | | |
| 2.0 in. | 100.0 | | |
| 1.5 in. | 100.0 | | |
| 1.0 in. | 100.0 | | |
| .75 in. | 100.0 | | |
| .5 in. | 100.0 | | |
| .375 in. | 100.0 | | |
| .25 in. | 100.0 | | |
| #4 | 100.0 | | |
| #8 | 100.0 | | |
| #10 | 100.0 | | |
| #16 | 100.0 | | |
| #20 | 100.0 | | |
| #30 | 100.0 | | |
| #40 | 99.9 | | |
| #50 | 99.7 | | |
| #80 | 97.1 | | |
| #100 | 95.5 | | |
| #200 | 89.7 | | |

* (no specification provided)

**Soil Description**

(Fly Ash)

**Atterberg Limits**

PL= LL= PI=

**Coefficients**

$D_{85}$= 0.0450 $D_{60}$= 0.0321 $D_{50}$= 0.0303
$D_{30}$= 0.0272 $D_{15}$= 0.0249 $D_{10}$= 0.0241
$C_u$= 1.33 $C_c$= 0.96

**Classification**

USCS= AASHTO=

**Remarks**

**Sample No.:** Alma-1 **Source of Sample:** DPC-Alma **Date:** 6-6-01
**Location:** FLY ASH **Elev./Depth:**

**RMT, Inc.**

**Client:**
**Project:** DAIRYLAND POWER COOPERATIVE
**Project No:** 3081.49 **Figure:**

**DAVY LABORATORIES**
115 South 6th Street
P.O. Box 2076
La Crosse, WI 54602-2076
(608) 782-3130
FAX (608) 784-6611

Division of Davy Engineering Co.

## TABLE 3
## PHYSICAL ANALYSIS RESULTS FOR ALMA BOTTOM ASH

I. Particle Size Distribution

Sample Number: 44639 Sample Size: 50 grams

| Sieve No. | Grams Retained | Total Retained | % Retained | % Total Retained | % Finer |
|---|---|---|---|---|---|
| 3/8 | 0.00 | 0.00 | 0.00 | 0.00 | 100 |
| 4 | 5.16 | 5.16 | 10.33 | 10.33 | 89.67 |
| 8 | 3.53 | 8.69 | 7.07 | 17.40 | 82.60 |
| 16 | 4.50 | 13.19 | 9.01 | 36.41 | 73.59 |
| 30 | 5.75 | 18.94 | 11.51 | 37.92 | 62.07 |
| 50 | 9.00 | 37.94 | 18.02 | 55.94 | 44.06 |
| 100 | 9.73 | 37.67 | 19.48 | 75.42 | 24.58 |
| 200 | 6.81 | 44.48 | 13.64 | 89.06 | 10.94 |
| Pan | 5.46 | --- | --- | --- | --- |

Total Weight Recovered 49.94 grams

II. Bulk Dry Density, pcf (ASTM:C29) 51.8

# I.3
# Ineos's Chemical Resistance Guide

# HDPE Chemical Resistance Guide

| Reagent | 70º F (21º C) | 140º F (60º C) |
|---|---|---|
| **A** | | |
| Acetaldehyde | S | O |
| Acetic acid (1-10%) | S | S |
| Acetic acid (10-60%) | S | O |
| Acetic acid (80-100%) | S | O |
| Acetic anhydride | S | S |
| Acetone | S | S |
| Acids (aromatic) | S | S |
| Acrylic emulsions | S | S |
| Adipic acid | S | S |
| Aluminum chloride concentrated | S | S |
| Aluminum chloride dilute | S | S |
| Aluminum fluoride concentrated | S | S |
| Aluminum sulfate concentrated | S | S |
| Alums (all types) concentrated | S | S |
| Amino acetic acid | S | S |
| Ammonia (100% dry gas) | S | S |
| Ammonium acetate | S | S |
| Ammonium bromide | S | S |
| Ammonium carbonate | S | S |
| Ammonium chloride saturated | S | S |
| Ammonium fluoride (20%) | S | S |
| Ammonium hydroxide | S | S |
| Ammonium metaphosphate (sat.) | S | S |
| Ammonium nitrate saturated | S | S |
| Ammonium persulfate saturated | S | S |
| Ammonium phosphate | S | S |
| Ammonium sulfate saturated | S | S |
| Ammonium sulfide saturated | S | S |
| Ammonium thiocyanate saturated | S | S |
| Amyl acetate (100%) | O | U |
| Amyl alcohol (100%) | S | S |
| Amyl Chloride (100%) | O | U |
| Aniline (100%) | S | U |
| Anise seed oil | O | U |
| Antimony chloride | S | S |
| Aqua Regia | O | U |
| Aromatic hydrocarbons | U | U |
| Arsenic | S | S |
| Aspirin | S | S |

| Reagent | 70º F (21º C) | 140º F (60º C) |
|---|---|---|
| **B** | | |
| Barium carbonate saturated | S | S |
| Barium carbonate saturated | S | S |
| Barium hydroxide | S | S |
| Barium sulfate saturated | S | S |
| Barium sulfite saturated | S | S |
| Beer | S | S |
| Benzaldehyde | S | O |
| Benzene | O | U |
| Benzene sulfonic acid | S | S |
| Benzoic acid crystals | S | S |
| Benzoic acid saturated | S | S |
| Bismuth carbonate saturated | S | S |
| Black liquor | S | S |
| Bleach lye (10%) | S | S |
| Borax cold saturated | S | S |
| Boric acid concentrated | S | S |
| Boric acid dilute | S | S |
| Brine | S | S |
| Bromic acid (10%) | S | S |
| Bromine liquid (100%) | O | U |
| Bromochloromethane | U | U |
| Butadiene | U | U |
| Butanediol (10%) | S | S |
| Butanediol (60%) | S | S |
| Butanediol (100%) | S | S |
| Butter | S | S |
| Butyl acetate (100%) | O | U |
| Butyl alcohol (100%) | S | S |
| Butylene glycol | S | S |
| Butyric acid (100%) | S | S |
| **C** | | |
| Caffeine citrate saturated | S | S |
| Calcium bisulfide | S | S |
| Calcium bromide | S | S |
| Calcium carbonate saturated | S | S |
| Calcium Chlorate saturated | S | S |
| Calcium hydroxide | S | S |
| Calcium hypochlorite bleach solution | S | S |
| Calcium nitrate (50%) | S | S |
| Calcium sulfate | S | S |

Legend: S = Satisfactory O = Some attack U = Unsatisfactory



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# HDPE Chemical Resistance Guide

| Reagent | 70º F (21º C) | 140º F (60º C) |
|---|---|---|
| Camphor crystals | S | S |
| Camphor oil | U | U |
| Carbon dioxide (100% dry) | S | S |
| Carbon dioxide (100% wet) | S | S |
| Carbon dioxide cold saturated | S | S |
| Carbon disulphide | O | U |
| Carbon monoxide | S | S |
| Carbon tetrachloride | U | U |
| Carbonic acid | S | S |
| Carnauba wax | S | S |
| Carrot juice | S | S |
| Castor oil concentrated | S | S |
| Catsup | S | S |
| Caustic soda | S | O |
| Cedar leaf oil | U | U |
| Cedar wood oil | U | U |
| Chlorine liquid | O | U |
| Chlorobenzene | O | U |
| Chloroform | U | U |
| Chlorosulfonic acid (100%) | U | U |
| Chrome alum saturated | S | S |
| Chromic acid (10-20%) | S | O |
| Chromic acid (50%) | S | O |
| Cider | S | S |
| Cinnamon | S | S |
| Cinnamon oil | U | U |
| Citric acid saturated | S | S |
| Citronella oil | O | U |
| Cloves (ground) | S | S |
| Coconut oil alcohols | S | S |
| Cod liver oil | S | S |
| Coffee | S | S |
| Copper chloride saturated | S | S |
| Cooper cyanide saturated | S | S |
| Copper fluoride (2%) | S | S |
| Copper nitrate saturated | S | S |
| Copper sulfate dilute | S | S |
| Copper sulfate saturated | S | S |
| Corn oil | S | S |
| Cottonseed oil | S | S |
| Cranberry sauce | S | S |
| Cresols | S | O |
| Cuprous chloride saturated | S | S |
| Cuprous oxide | S | S |
| Cyclohexane | U | U |
| Cyclohexanone | U | U |
| **D** | | |
| Decalin | S | S |
| Detergents (synthetic) | S | S |
| Developers (photogenic) | S | S |
| Dextrin saturated | S | S |
| Dextrose saturated | S | S |
| Dibutyl ether | O | U |
| Dichlorobenzene (ortho and para) | U | U |
| Diethylene glycol | S | S |
| Dioxane | S | S |
| Disodium phosphate | S | S |
| **E** | | |
| Emulsions (photographic) | S | S |
| Ether | O | O |
| Ethyl acetate (100%) | O | O |
| Ethyl alcohol (35%) | S | S |
| Ethyl alcohol (100%) | S | S |
| Ethylbenzene | O | U |
| Ethylene glycol | S | S |
| **F** | | |
| Ferric chloride saturated | S | S |
| Ferric nitrate saturated | S | S |
| Ferrous ammonium citrate | S | S |
| Ferrous chloride saturated | S | S |
| Ferrous sulfate | S | S |
| Fluoboric acid | S | S |
| Fluorine | S | U |
| Fluosilicic acid (32%) | S | S |
| Fluosilicic acid concentrated | S | S |
| Formaldehyde (10-30%) | S | S |
| Formaldehyde (30-40%) | S | O |
| Formic acid (20%) | S | S |
| Formic acid (50%) | S | S |
| Formic acid (100%) | S | S |
| Fructose saturated | S | S |
| Fuel oil | S | U |
| Furfural (100%) | O | U |
| Furfuryl alcohol | S | O |
| **G** | | |
| Gallic acid saturated | S | S |
| Gasoline | S | U |
| Glucose | S | S |
| Glycerine | S | S |
| Glycol | S | S |
| Glycolic acid (30%) | S | S |
| Grape juice | S | S |
| Grapefruit juice | S | S |
| **H** | | |
| Heptane | O | U |
| Hexachlorobenzene | S | S |
| Hexane | U | U |
| Hydrobromic acid (50%) | S | S |

Legend: S = Satisfactory O = Some attack U = Unsatisfactory



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# HDPE Chemical Resistance Guide

| Reagent | 70º F (21º C) | 140º F (60º C) |
|---|---|---|
| Hydrochloric acid (10%) | S | S |
| Hydrochloric acid (30%) | S | S |
| Hydrochloric acid (35%) | S | S |
| Hydrocyanic acid | S | S |
| Hydrocyanic acid saturated | S | S |
| Hydrofluoric acid (40%) | S | S |
| Hydrofluoric acid (60%) | S | S |
| Hydrofluoric acid (75%) | S | S |
| Hydrogen (100%) | S | S |
| Hydrogen bromide (10%) | S | S |
| Hydrogen chloride dry gas | S | S |
| Hydrogen peroxide (30%) | S | O |
| Hydrogen sulfide | S | S |
| Hydroquinone | S | S |
| Hypochlorous acid concentrated | S | S |
| **I** | | |
| Inks | S | S |
| Iodine crystals | O | O |
| Isobutyl alcohol | S | S |
| Isopropyl alcohol | S | S |
| Isopropyl ether | O | U |
| **K** | | |
| Kerosene | O | O |
| **L** | | |
| Lactic acid (10%) | S | S |
| Lactic acid (90%) | S | S |
| Lanolin | S | S |
| Lard | S | S |
| Lead acetate saturated | S | S |
| Lead nitrate | S | S |
| Lemon juice | S | S |
| Lemon oil | O | U |
| Lime juice | S | S |
| Linseed oil | S | S |
| **M** | | |
| Magnesium carbonate saturated | S | S |
| Magnesium chloride saturated | S | S |
| Magnesium hydroxide saturated | S | S |
| Magnesium nitrate saturated | S | S |
| Magnesium sulfate saturated | S | S |
| Margarine | S | S |
| Mercuric chloride | S | S |
| Mercuric cyanide saturated | S | S |
| Mercurous nitrate saturated | S | S |
| Mercury | S | S |
| Methyl alcohol (100%) | S | S |
| Methyl ethyl ketone (100%) | U | U |

| Reagent | 70º F (21º C) | 140º F (60º C) |
|---|---|---|
| Methylene chloride (100%) | U | U |
| Methylsulfuric acid | S | S |
| Milk | S | S |
| Mineral oils | S | U |
| Molasses | S | S |
| Mustard (prepared) | S | S |
| **N** | | |
| Naphtha | O | U |
| Naphthalene | S | U |
| Natural gas (wet) | S | S |
| Nickel chloride saturated | S | S |
| Nickel nitrate concentrated | S | S |
| Nickel sulfate | S | S |
| Nicotinic acid | S | S |
| Nitric acid (0-30%) | S | S |
| Nitric acid (30-50%) | S | O |
| Nitric acid (70%) | S | O |
| Nitric acid (95-98%) | U | U |
| Nitrobenzene (100%) | U | U |
| Nitroglycerine | O | U |
| **O** | | |
| Octane | S | S |
| Oleum concentrated | U | U |
| Olive oil | S | S |
| Orange juice | S | S |
| Oxalic acid dilute | S | S |
| Oxalic acid saturated | S | S |
| Ozone | O | O |
| **P** | | |
| Palm oil | S | S |
| Paraffin oil | S | O |
| Peanut butter | S | S |
| Pepper (fresh ground) | S | S |
| Peppermint oil | O | U |
| Perchloric acid (50%) | S | O |
| Perchloroethylene | U | U |
| Petroleum ether | U | U |
| Petroleum jelly | S | S |
| Phenol | S | S |
| Phosphoric acid (0-30%) | S | S |
| Phosphoric acid (30-90%) | S | S |
| Phosphoric acid (over 90%) | S | S |
| Photographic solutions | S | S |
| Phthalic anhydride | S | S |
| Pickling baths | S | S |
| Hydrochloric acid | S | S |
| Sulfuric acid | S | S |
| Sulfuric-nitric | S | U |

Legend: S = Satisfactory O = Some attack U = Unsatisfactory



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# HDPE Chemical Resistance Guide

| Reagent | 70º F (21º C) | 140º F (60º C) |
|---|---|---|
| Pine oil | O | U |
| Plating solutions | | |
| Brass | S | S |
| Cadmium | S | S |
| Chromium | S | S |
| Copper | S | S |
| Gold | S | S |
| Indium | S | S |
| Lead | S | S |
| Nickel | S | S |
| Rhodium | S | S |
| Silver | S | S |
| Tin | S | S |
| Zinc | S | S |
| Potassium bicarbonate saturated | S | S |
| Potassium borate (1%) | S | S |
| Potassium bromate (10%) | S | S |
| Potassium bromide saturated | S | S |
| Potassium carbonate | S | S |
| Potassium chlorate saturated | S | S |
| Potassium chloride saturated | S | S |
| Potassium chromate (40%) | S | S |
| Potassium cyanide saturated | S | S |
| Potassium dichromate (40%) | S | S |
| Potassium ferri / ferro cyanide | S | S |
| Potassium nitrate saturated | S | S |
| Potassium perborate saturated | S | S |
| Potassium perchlorate (10%) | S | S |
| Potassium permanganate (20%) | S | S |
| Potassium persulfate saturated | S | S |
| Potassium sulfate concentrated | S | S |
| Potassium sulfide concentrated | S | S |
| Potassium sulfite concentrated | S | S |
| Propane gas | S | S |
| Propargyl alcohol | S | S |
| Propyl alcohol | S | S |
| Propylene glycol | S | S |
| Pyridine | S | O |
| **R** | | |
| Rayon coagulating bath | S | S |
| Resorcinol | S | S |
| **S** | | |
| Salicylic acid | S | S |
| Seawater | S | S |
| Shortening | S | S |
| Silicic acid | S | S |
| Silver nitrate solution | S | S |
| Soap solution concentrated | S | S |
| Sodium acetate saturated | S | S |

| Reagent | 70º F (21º C) | 140º F (60º C) |
|---|---|---|
| Sodium benzoate (35%) | S | S |
| Sodium bicarbonate saturated | S | S |
| Sodium bisulfate saturated | S | S |
| Sodium bisulfite saturated | S | S |
| Sodium borate | S | S |
| Sodium carbonate concentrated | S | S |
| Sodium chlorate saturated | S | S |
| Sodium chloride saturated | S | S |
| Sodium cyanide | S | S |
| Sodium dichromate saturated | S | S |
| Sodium ferricyanide | S | S |
| Sodium ferricyanide concentrated | S | S |
| Sodium fluoride saturated | S | S |
| Sodium hydroxide concentrated | S | S |
| Sodium hypochlorite | S | S |
| Sodium nitrate | S | S |
| Sodium nitrite | S | S |
| Sodium perborate | S | S |
| Sodium phosphate | S | S |
| Sodium sulfide (25% to saturated) | S | S |
| Sodium sulfite saturated | S | S |
| Sodium thiosulphate | S | S |
| Soybean oil | S | S |
| Stannic chloride saturated | S | S |
| Stannous chloride saturated | S | S |
| Starch solution saturated | S | S |
| Stearic acid (100%) | S | S |
| Styrene | U | U |
| Sulfuric acid (0-50%) | S | S |
| Sulfuric acid (70%) | S | O |
| Sulfuric acid (80%) | S | U |
| Sulfuric acid (96%) | O | U |
| Sulfuric acid (98% concentrated) | O | U |
| Sulfuric acid (fuming) | U | U |
| Sulfurous acid | S | S |
| **T** | | |
| Tannic acid (10%) | S | S |
| Tartaric acid | S | S |
| Tea | S | S |
| Tetrahydrofuran | O | O |
| Toluene | U | U |
| Tomato juice | S | S |
| Transformer oil | S | O |
| Trichloroethylene | U | U |
| Trisodium phosphate saturated | S | S |
| Turpentine | O | U |
| **U** | | |
| Urea | S | S |
| Urine | S | S |

Legend: S = Satisfactory O = Some attack U = Unsatisfactory



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| Reagent | 70º F (21º C) | 140º F (60º C) |
|---|---|---|
| **V** | | |
| Vanilla extract | S | S |
| Vaseline | S | S |
| Vinegar (commercial) | S | S |
| **W** | | |
| Wetting agents | S | S |
| Whiskey | S | S |
| Wines | S | S |
| **X** | | |
| Xylene | U | U |
| **Y** | | |
| Yeast | S | S |
| **Z** | | |
| Zinc chloride saturated | S | S |
| Zinc oxide | S | S |
| Zinc sulfate saturated | S | S |

**Note: The proceeding information concerns general chemical resistance only. Since other factors such as permeation, ESCR and container design are involved, full compatibility testing is recommended.**

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Legend: S = Satisfactory O = Some attack U = Unsatisfactory



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# Appendix J: Supplemental Final Cover Design Demonstrations

- J.1: 2004 Final Cover Plan of Operation Modification
- J.2: Saturated Head on the Final Cover Liner
- J.3: Final Cover Event 2A Interface Stability Evaluation

# J.1
# 2004 Final Cover Plan of Operation Modification

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# Plan of Operation Modification

## Dairyland Power Cooperative
## Phase IV Disposal Area – License #4126
## Alma Off-Site Ash Disposal Facility
## Town of Belvedere
## Buffalo County, Wisconsin

**January 2004**

*Prepared For*
*Dairyland Power Cooperative*

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Appendix B Beneficial Use Ash Characterization Data
Appendix C Select Previous DPC Ash Studies
Appendix D Final Cover Water Balance Calculations
Appendix E Revised Closure Cost Estimates

# Section 1
# Introduction

## 1.1 Background

Dairyland Power Cooperative (DPC) owns and operates a coal ash disposal facility (Alma off-site disposal facility) located in the Town of Belvedere, Buffalo County, Wisconsin. Phase I of the facility was closed in 1993, Phase II was closed in 1997, and Phase III is expected to be closed in 2004 (License # 2927). A conditional Plan of Operation approval for the Phase IV disposal area (License #4126) was granted on May 15, 2001 (see Appendix A), by the Wisconsin Department of Natural Resources (WDNR). DPC is currently filling Cell 1 of the Phase IV disposal area.

In the Feasibility Report for the Phase IV Ash Disposal Facility, two final cover options were presented for the WDNR's consideration. A "standard" NR 504.07 cover design for a high volume industrial waste landfill, and an alternative final cover system design in accordance with NR 504.10(3). The alternative cover system consisted of a 6-inch–thick soil grading layer over the waste followed by a GCL, a 40-mil geomembrane, a 1-foot–thick sand drainage layer, a 1-foot–thick general soil cover layer, and a 6-inch–thick topsoil layer. The WDNR conditionally approved the alternative cover design in the September 10, 1999, Feasibility Determination, provided that the WDNR's "Guidance for the Use of Geosynthetic Clay Liners (GCLs) at Solid Waste Facilities" and manufacturers recommendations are followed.

DPC and RMT proceeded in preparing the Plan of Operation in late 1999 utilizing the alternative final cover design presented in the Feasibility Report. The Plan of Operation was submitted in October 2000, with the alternative cover design conditionally approved in the Feasibility Determination, with the understanding that the final lift of ash and the grading layer met the intent of the GCL subbase requirements, and with the assumption that concurrence with the WDNR on the final cover design had previously been obtained during the preparation of the Feasibility Study.

In the conditional Plan of Operation approval, the WDNR revised and approved a different final cover than was proposed in both the Feasibility Report and the Plan of Operation. The approved final cover design consisted of a minimum 3 feet of drain layer, rooting zone soil, and topsoil above the geomembrane, and a minimum of 2 feet of barrier layer between the ash and the GCL. The result of this revised final cover design was that the final cover thickness was increased from 3 feet to 5 feet.

The approved final cover design presents several design and construction challenges for this site. First, the quantity of suitable low-permeability soil in the vicinity of the site is limited (refer to Appendix C of Plan of Operation). Second, the increased final cover thickness (3 feet to 5 feet) will require significant design modifications to tie the cover into the sidewall berm and to maintain the site's design capacity, which is critical to DPC. This Plan of Operation Modification is being submitted to modify the approved final cover design to provide an effective final cover that addresses these design and construction challenges.

## 1.2 Purpose and Scope

DPC is proposing to modify the Plan of Operation for Phase IV of the Alma off-site disposal facility to include a final cover system design in accordance with NR 504.10(3) that utilizes beneficially reused fly ash as the low-permeability barrier layer in a composite final cover system. The characteristics of the fly ash, as well as several special design and construction features for the Phase IV disposal facility, are presented in support of this proposed modification.

This text and its accompanying appendices present modifications to the Plan of Operation necessary for the remaining construction, operation, and closure of the facility.

This document is divided into three major sections—Proposed Engineering Modifications (as influenced by the proposed final cover), Site Operations (a description of the select ash placement procedures), and Site Closure (final cover placement and revised cost estimates for financial responsibility). Design calculations, correspondence, plan sheets, and other pertinent data to document the design and operational procedures for this facility are included in the appendices.

# Section 2
# Proposed Engineering Modifications

## 2.1 General

This plan modification for the DPC Phase IV Ash Disposal Facility been prepared in accordance with applicable sections of the Wisconsin Administrative Code s. NR 500 Series, State Statute s. 289 and all prior WDNR plan modification approval documents and accompanying conditions as appropriate. Supporting test data and/or calculations for the design modifications are referenced as appropriate, and are included in the appendices. Details and drawings illustrating design specifications are referenced as applicable and are presented on the attached drawings.

The modifications proposed include the beneficial reuse of select fly ash in a composite final cover system. In addition, several special design and construction features for Phase IV are presented that support the approval of the proposed design. The proposed design will reduce the facility's dependency on on-site or off-site borrow soil and its accompanying costs and degree of environmental impact. The following discussion presents the proposed final cover design.

## 2.2 Final Cover Design

This Plan Modification proposes an alternative cover system in accordance with NR 504.10 (3), consisting of the following components (from bottom to top):

- Two feet of moisture-conditioned and compacted "select" fly ash (i.e., a mixture containing a minimum of 40 percent of the more reactive J.P. Madgett [JPM] fly ash)
- A 40-mil geomembrane with enhanced construction quality assurance
- A 1-foot–thick sand drainage layer
- A 1.5-foot–thick general soil cover layer
- A 6-inch–thick topsoil layer

This design provides the desired 3-foot thickness of soil over the geomembrane, as required in the Plan of Operation conditional approval. The moisture-conditioned and compacted ash layer will be constructed as waste filling progresses within each cell as further described in Section 3. The anticipated properties of the ash layer, once it has cured, are based on extensive previous

studies conducted by DPC as described in Subsection 2.3. The specifications and documentation proposed for the ash layer are described in Subsection 4.2.

The final grades at the site and the design capacity remain consistent with the WDNR 2001 Plan of Operation approval. The 2 feet of fly ash to be used in the final cover are included in the 3,011,000 cubic yards of approved design capacity for the site. DPC will not gain additional disposal capacity as a result of this modification.

The proposed alternative final cover design adequately protects public health, welfare, and the environment and meets or exceeds the performance standards of NR 504.04, as demonstrated in the following sections. In addition, the site provides several special design and construction features that support the approval of the proposed design. These include the following:

- The landfill design includes composite liner and final cover systems that provide upgraded performance as compared to the "standard" NR 504 liner and final systems required for a high-volume industrial waste landfill.
- The integrity of the geomembrane component of the composite liner and composite final cover will be verified using electrical resistivity testing during each phase of construction. As demonstrated during Cell 1 construction, this additional construction quality assurance step was extremely effective in identifying and allowing the repair of liner defects that would have otherwise gone undetected, had "standard" NR 516 construction documentation procedures been followed. The resulting integrity and environmental protection provided by the composite liner and cover systems are considered to be extremely high.
- On-site sand borrow areas will be used to obtain material for construction of the final cover drainage layer. Laboratory testing performed on this material indicates that the sand is over five times more permeable than the minimum acceptable hydraulic conductivity of $1 \times 10^{-3}$ cm/s required for final cover drainage layers. The use of this material will enhance the performance of the final cover system.
- Collection pipes are incorporated in the final cover drainage layer at each of the surface water diversion berms as shown on Detail 2 on Plan Sheet 19 of the Plan of Operation. This provides improved water removal efficiency from the cover as compared to "typical" landfill designs in Wisconsin.
- DPC ash has been extensively employed in various beneficial use applications. Annual testing of the ash has been conducted on the various ash sources in accordance with the requirements of NR 538 (see Appendix B). The fly ash proposed for use in the final cover is classified as a Category 4 ash, and meets all of the Category 3 standards, with the exception of chromium. The fly ash is suitable for use in confined geotechnical fills and in landfill uses as defined in NR 538.

- The ash disposed in the landfill is placed in a low-moisture state (refer to DPC's Fly Ash Characterization Studies contained in Appendix C) and has been shown to have a very high affinity for water, making the overall water balance efficiency of the site very high.

## 2.3 DPC Ash Studies and Performance Data

Fly ash contains primarily oxides of silicon, aluminum iron, and calcium. Magnesium, potassium, sodium, titanium, and sulfur are also present to a lesser degree (ACAA, 2003). The types of coal burned affect the properties of the fly ash. High-calcium fly ash, or Class C fly ash, typically contains more than 20 percent calcium oxide (CaO) or free lime. High-calcium fly ash, when mixed with water, undergoes a hydration reaction that solidifies the ash into a concrete-like mass. Class C fly ash is generally derived from sub-bituminous or western coal. DPC's Madget Station burns a Powder River Basin coal, which is a western coal with a high–calcium oxide content. Low-calcium fly ash, or Class F ash, typically contain less than 10 percent CaO. Class F ash is generally derived from bituminous and anthracite coals or eastern coals. DPC's Alma Units 1-5 and Genoa Stations burn a mixture of eastern (Illinois) and western (Powder River Basin) coals. The proposed final cover barrier layer will consist of 2 feet of moisture-conditioned and compacted fly ash containing at least 40 percent of the more reactive JPM fly ash.

The properties of the JPM fly ash are well suited for use as a barrier layer as demonstrated in DPC's previous landfill phases and in previous ash characterization studies. DPC has invested significant resources into the study of the ash for purposes of controlled landfill placement. The following Subsections provide additional information on the findings of these studies.

### 2.3.1 Fly Ash Characterization Reports

DPC retained Warzyn Engineering, Inc., to complete a series of studies designed to investigate the physical and chemical properties of fly ashes generated from the Alma Generating Station, Units 1 through 5, and the Madgett Generating Station, Unit 6 (Warzyn, 1979, 1980a, 1980b, 1980c, 1980d, and 1980e). These studies investigated the properties of DPC's fly ash as they relate to disposal, site operations, and licensing. Information on the ash's chemical composition, compaction properties, setting properties, specific gravity, permeability, strength, grain size, erosion resistance, and dusting was presented in the reports summarizing these studies.

In the report titled "Supplemental Fly Ash Characterization Report, Fly Ash Conditioning with Low Moisture Content, Alma Madgett Generating Station Units 1–6" (Warzyn 1980e), information was presented on the conclusions of the general fly ash conditioning program. This program looked at the physical characteristics of various

mixtures of JPM ash and Alma Units 1-5 ash in the low-moisture condition (i.e., 5 percent to 15 percent added moisture). A copy of this report, along with the initial fly ash characterization report, is included in Appendix C.

The ash tested in these studies included ash from DPC's Alma and JPM generating stations, as well as ash from similar facilities. The ash used in these studies is similar in composition and physical properties to the ash currently generated by DPC. In fact, the Alma Units 1-5 are currently burning a coal mixture that consists of a greater percentage of Powder River Basin coal, which will result in an even more reactive ash. Based on these studies, it was found that a mixture containing at least 40 percent JPM ash resulted in a compacted hydraulic conductivity ranging from $8 \times 10^{-7}$ cm/s to $1 \times 10^{-9}$ cm/s. The testing, using ash comparable to the JPM ash, had similar results. A summary of these results is included in Table 1.

On the basis of these studies, DPC has used ash mixtures containing at least 40 percent JPM ash as an initial waste lift and in constructing low-permeability ash and ash-slurry containment berms within Phases I through III of their landfill (DPC, 1993). The ash mixtures containing the JPM ash have been found to be extremely dense, durable, and to have a low permeability once compacted and cured. This field experience has supported the findings of the previous ash studies.

**Table 1**
**Fly Ash Hydraulic Conductivity Test Results**
**DPC Off-Site Disposal Facility**

| MIX RATIO[1] | HYDRAULIC CONDUCTIVITY (CM/S) | | | ASH SOURCE[2] |
|---|---|---|---|---|
| | MOISTURE CONTENT 5% | MOISTURE CONTENT 10% | MOISTURE CONTENT 15% | |
| 10/90 | $1x10^{-5}$ | $3x10^{-6}$ to $4x10^{-6}$ | $5x10^{-6}$ to $7x10^{-6}$ | Neal #4 |
| 10/90 | $5x10^{-6}$ | $4x10^{-6}$ to $5x10^{-6}$ | -- | JPM #1 |
| 20/80 | $1x10^{-5}$ | $6x10^{-7}$ to $9x10^{-7}$ | $3x10^{-6}$ to $4x10^{-6}$ | Neal #4 |
| 40/60 | $5x10^{-7}$ | $7x10^{-7}$ to $8x10^{-7}$ | $4x10^{-7}$ | JPM #1 |
| 40/60 | $5x10^{-7}$ to $7 x10^{-7}$ | $1x10^{-7}$ to $2x10^{-7}$ | $2x10^{-7}$ to $3x10^{-7}$ | Neal #4 |
| 60/40 | $1x10^{-6}$ to $4x10^{-7}$ | $1x10^{-7}$ to $8x10^{-8}$ | $1x10^{-7}$ | Neal #4 |
| 80/20 | $1x10^{-7}$ | $2x10^{-7}$ to $5x10^{-8}$ | $1x10^{-7}$ to $5x10^{-8}$ | Neal #4 |
| 100/0 | $2x10^{-9}$ | $1x10^{-9}$ | $2x10^{-9}$ | JPM #1 |
| 100/0 | $2x10^{-7}$ | $5x10^{-8}$ to $8x10^{-8}$ | $5x10^{-8}$ to $6x10^{-8}$ | Neal #4 |

Notes:
Samples cured 7 days prior to testing.
Test results from Warzyn Engineering, Inc., report (Warzyn, 1980e).

Footnotes:
(1) Mix Ratio represents percentage of reactive fly ash/Alma fly ash.
(2) JPM #1 is fly ash obtained from the DPC JPM ash source. Neal #4 is a similar fly ash to the JPM ash obtained from the Neal Unit #4 Iowa Public Service facility.

### 2.3.2 Final Cover Performance Evaluation

The proposed final composite cover will provide significantly better performance, in terms of controlling infiltration, than a standard NR 504 high-volume industrial waste landfill final cover. The proposed cover will also perform equivalently to the composite cover approved in the Plan of Operation. To demonstrate this, HELP Model calculations have been performed comparing the proposed final cover with the approved final cover and a standard NR 504 final cover (Appendix D). For the proposed final cover, the conditioned and compacted fly ash was assumed to have a hydraulic conductivity of 1.0 x $10^{-6}$ cm/s, which can be achieved with a minimum of 40 percent JPM ash, as has been demonstrated through previous studies. On the basis of these calculations the approved final cover and the proposed final cover are over 99.99 percent efficient as compared to the standard NR 504 cover, which is 96.6 percent efficient. These results compare well to previous studies and published data that show that a composite cover with a geomembrane will increase a final cover efficiency to over 99.9 percent as compared to a standard clay cover, which is in the 96 to 97 percent efficiency range. These calculations support the use of the proposed final cover.

# Section 3
# Site Operations

Daily operations at the Phase IV landfill are not expected to change substantially as a result of the proposed plan modification. The placement of low-permeability ash layers and the filling of ash will continue within the approved limits of waste as is currently being performed in order to achieve the final waste grades. Access roads will be constructed as necessary to facilitate access within the cell.

The conditioned and compacted ash layer that will comprise the lower portion of the final cover will be placed in stages as the landfill filling progresses. As in previous phases, a mixture of fly ash containing a minimum of 40 percent JPM ash will be conditioned with 5 to 15 percent moisture and transported to the landfill in dump trucks. The ash will be dumped, and a containment berm will be constructed with the ash mixture around the perimeter of the phase. The ash will be spread and compacted in maximum 12-inch lifts using a dozer. The containment berm will be constructed approximately 10 feet wide at the top. The exterior sideslope will be constructed at a 4:1 (horizontal to vertical) slope to match the final cover grades. The interior sideslope will be constructed at an approximate 2:1 slope. Subsequent truck traffic over the lift will provide additional compaction as the berm is constructed. The berm will typically be constructed to a final height of approximately 10 feet. However, as long as the minimum berm width is 10 feet, the resulting minimum ash layer thickness will be 2.5 feet, given the 4:1 final cover slope.

Construction of the berms in this manner will result in a conditioned and compacted ash layer greater than 2.5 feet in thickness. Periodic surveys will be conducted to set the berm locations, and verification survey shots will be taken by DPC personnel or their designee as the berm construction progresses. Construction of the berm in this manner will ensure that the minimum conditioned and compacted ash layer thickness of 2 feet is achieved.

Given the marketability of the JPM ash during the summer for other beneficial use applications, construction of the ash berms will typically occur during the late fall or early spring. Ash will be placed within the berms when JPM ash is not available. When necessary, DPC will divert the JPM ash from other beneficial use applications when the JPM ash is needed to build the containment berms at the landfill.

Based on current ash disposal records, DPC is projected to generate approximately 51,200 tons of JPM fly ash in 2003. This quantity of ash is sufficient to construct the cover as proposed.

DPC will divert JPM Fly ash from other beneficial use applications as necessary to construct the final cover.

# Section 4
# Site Closure

## 4.1 General

Revised closure activities and cost estimates have been prepared in accordance with the requirements of NR 514.06(9) and (10). The design details for the revised final cover system are discussed in Section 2.

## 4.2 Final Cover Placement and Certification

The conditioned and compacted ash component of the final cover will be constructed incrementally as waste filling progresses as described in Section 3. Once a cell has been brought up to final grades, the remainder of the final cover will be constructed as shown on the phasing plans contained in the Plan of Operation.

Prior to geomembrane placement, the surface of the conditioned and compacted ash layer will be fine-graded and/or additional JPM ash or on-site loess material will be brought in as necessary to fill in uneven areas. The entire geomembrane subgrade will then be smooth drum–rolled and inspected/certified prior to geomembrane placement. The construction of the geomembrane layer, and the subsequent layers of the final cover, will then proceed as described in the Plan of Operation.

Since the ash component of the final cover would be constructed incrementally, certification of this layer will require a different approach than would be applied to a traditional clay barrier layer. Once placed and cured, the conditioned and compacted ash component of the final cover will harden to a low-permeability concrete-like mass as demonstrated on previous landfill phases. Density testing would provide little useful information since the properties of the cured ash are affected by both the ash density and the hydration reactions, and since additional compaction would not be possible. Hydraulic conductivity testing is not practicable owing to the hardness of the cured ash. RMT's experience with the coring of ash to retrieve samples for hydraulic conductivity testing is that the samples develop cracks and are otherwise disturbed, making the laboratory testing results unrepresentative of the field conditions.

Given this, DPC is proposing an approach that utilizes up-front technical studies and field data (i.e., DPC's historical ash studies and subsequent 20 years of operational experience) to determine the properties of the conditioned and compacted ash that can be achieved with a relatively high degree of certainty. Since the proposed cover specifications are based on these

properties (i.e., a minimum 2-foot–thick layer with a maximum hydraulic conductivity of $1x10^{-6}$ cm/s), the operational procedures historically used to achieve these properties will continue to be followed. DPC proposes to monitor that the minimum ash mix proportions and moisture contents are achieved, the approved means of placement are followed, and the minimum thicknesses are achieved. DPC will also commit to an annual audit of the operating procedures to verify that these operating procedures are followed.

Records from the ash processing facility will be used to document the mix proportions and moisture content of the select ash mix. Operating records will be utilized to document the ash placement procedures. Survey data will be utilized to document the ash layer thickness. Density testing, hydraulic conductivity testing, or other ash physical testing is not proposed at this time.

## 4.3 Closure Cost Estimate

The cost of closure for the facility is representative of "the total cost of closure for the point in time during operation of the facility when the extent and manner of its operation make closure most expensive." This cost estimate satisfies NR 520.07, which requires that the premature phased closure be identified. This point in time would occur when Cell 3 is active and final cover would be required over the entire Cell 3 area and over portions of Cells 1, 2A, and 2B.

The premature closure cost estimate assumes that the active Cell 3 area has not yet received the conditioned and compacted ash layer, and that, to close this area, soil needs to be imported, placed, and tested to certify that an equivalent layer to the ash is achieved.

The cost estimate to perform closure activities includes installing a final cover system and a surface water drainage structure, vegetating the final cover, and preparing a closure documentation report. A 25 percent contingency is also included. Final cover construction includes hauling, placing, and compacting the soil components of the final cover; placing the geomembrane; seeding and mulching the topsoil; and constructing drainage controls. The documentation report includes soil testing results and verification that closure activities were performed in accordance with the requirements of the Plan of Operation. The updated closure cost estimate is included in Appendix E. The updated cost of approximately $1.35 million is slightly less than the closure cost of $1.41 million included in the Plan of Operation conditional approval

## 4.4 Financial Responsibility

The net worth method is used by DPC to provide proof of financial responsibility for the closure and long-term care of the landfill site. The necessary amounts of proof of financial responsibility have been calculated in accordance with NR 520.08(1) and (2).

# Section 5
# References


American Coal Ash Association (ACAA). 2003. Fly ash facts for engineers. 4th Edition. FHWA-1F-03-019.

Dairyland Power Cooperative (DPC). 1993. Modified operations manual and design report for offsite ash disposal facilities. License # 02927. January 1993.

Warzyn Engineering, Inc. (Warzyn). 1979. Executive summary and report, fly ash characterization study. Alma-Madgett Generating Station Units 1-6. October 12, 1979.

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Warzyn Engineering, Inc. (Warzyn). 1980d. Supplemental fly ash characterization report, fly ash slurry setting retarder effects. Alma-Madgett Generating Station Units 1–6. September 3, 1980.

Warzyn Engineering, Inc. (Warzyn). 1980e. Supplemental fly ash characterization report, fly ash conditioning with low moisture content. Alma-Madgett Generating Station Units 1 through 6. November 26, 1980.

# Appendix A
# Conditional Plan of Operation Approval for Dairyland Power Cooperative Phase IV Disposal Area. License #4126

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Scott McCallum, Governor
Darrell Bazzell, Secretary
Scott A. Humrickhouse, Regional Director

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May 15, 2001

FID # 606009360
Buffalo Co.
SW/LIC. File

Mr. Robert Carothers
Dairyland Power Cooperative
JPM Station
500 Old State Highway 35
Alma, WI. 54610

Subject: Conditional Plan of Operation Approval for Dairyland Power Cooperative Phase IV Disposal Area, Alma Off-Site Ash Disposal Facility, Town of Belvidere, Buffalo County, License #4126.

Dear: Mr. Carothers:

We have completed our review of your plan of operation for the proposed Phase IV Disposal Area Landfill and determined that it is consistent with Wisconsin's solid waste regulations. Therefore, the plan of operation is approved, subject to compliance with chs. NR 500-590, Wis. Adm. Code, and the conditions of the attached approval.

This approval contains conditions that require certain changes to the proposed design, construction, and monitoring of this facility. They include revisions to the final cover design, leachate extraction system, and several minor aspects of construction documentation, and leachate monitoring.

You are reminded that this approval does not relieve you of obligations to meet all other applicable federal, state and local permits, as well as zoning and regulatory requirements.

If you have any questions regarding this approval please call Marty Herrick at (608) 789-5518 or Barb Hennings at (608) 264-6021.

Sincerely,

David R. Lundberg
Waste Management Team Leader
West Central Region

Attachments: Project Summary, Conditional Plan of Operation Approval, Table 1 (PALs), Table 2 (ACLs), Monitoring Summary

cc: Dennis Mack/Paul Huebner/Bureau Files-WA/3
Jack Tritt-WCR
Barb Hennings-WA/3
Marty Herrick-LAX
Tony McKimmy-DPC
Bernie Krantz-RMT
Colleen Hellenbrand-WA/3
Bob Grefe-WA/3
Steve Karklins – DG/3

PROJECT SUMMARY
DAIRYLAND POWER COOPERATIVE
PHASE IV DISPOSAL AREA
ALMA OFF-SITE ASH DISPOAL FACILITY

GENERAL INFORMATION

AUTHORIZED CONTACT: Mr. Robert Carothers
Dairyland Power Cooperative
JPM Station
500 Old State Highway 35
Alma, WI. 54610

LICENSEE AND PROPERTY OWNER: Dairyland Power Cooperative

SITE LOCATION: Dairyland Power Cooperative (DPC) is proposing to construct an industrial ash landfill located in the NE ¼ of the NE ¼ of Section 19 and portions of Sections 18 and 20, Township 21N, Range 12 W, Town of Belvidere, Buffalo County, Wisconsin. The site is located approximately 4,000 ft. east of State Trunk Highway (STH) "35" and 3200 ft. south of County Road "E".

One water supply well is located within 1,200 feet of the proposed limits of fill and will be abandoned prior to waste placement in the Phase IV disposal facility. A new water supply well will be installed south of the existing landfills at a distance greater than 1200 feet from any limits of filling.

ACREAGE AND ACCESS: The licensed disposal area will be 32.1 acres of a 1,113 acre parcel of land owned by DPC. Access to the facility is from U.S. Highway 35 onto the landfill's private haul road.

PROPOSED CAPACITY AND SITE LIFE: The facility will provide 3,011,000 cubic yards of capacity for the disposal of ash from DPC's Alma and Genoa power generating facilities. The Phase IV disposal area has a projected site life of 13.9 years. The estimated annual quantity of ash to be placed is 217,000 cubic yards. Filling rates will be influenced by power demands and the ability of DPC to use the ash for beneficial reuse purposes.

WASTE TYPES AND GENERATORS SERVED: The site is owned and operated as a private industrial solid waste disposal facility. The facility will accept primarily fly ash and bottom ash from the burning of coal at DPC's Alma and Genoa power generating stations. The facility will also accept sludge from the wastewater treatment plants for the Alma and Genoa facilities and asbestos generated from renovations at the respective facilities as well. An asbestos disposal plan is being approved as part of this plan of operation. The chemical characteristics of the leachate are expected to be similar to the existing Phase III disposal site.

PRESENT LAND USE AND ZONING: Land use in the area of the landfill is restricted by the local vertical relief which is approximately 500 feet between the southern end of the valley floor and the bluff top. Some of the land located above the facility on the bluff tops is used for agricultural purposes. The Phase IV disposal facility is located in the valley below the bluffs and the Phases I though III disposal facilities are located on the adjacent side hills. The bluffs and valley are forested and bedrock crops out at the top of the bluffs.

The proposed landfill is not located within a floodplain or a wetland but is located at the confluence of the surface waterways for the surrounding bluffs. Sediment and retention ponds and diversion channels will

reroute the surface discharges from the surrounding bluffs around the perimeter of the landfill, which will occupy the center of the drainage confluences. Ultimately the surface water drains into the Mississippi River.

DPC is currently using a portion of the property for coal ash disposal operations in Phases I through III. Phases I, II and III are located 1000 feet, 100 feet and 1400 feet respectively to the south/southwest of the proposed landfill's footprint. Phase I was closed in 1993 and Phase II was closed in October 1997. Phase III is approximately 7 acres in size and is expected to reach its final approved capacity in the near future. The 1113 acre parcel is zoned as an agricultural district. As part of this approval DPC has modified the conditional use permit from Buffalo County to include the Phase IV disposal facility. There are no designated recreational areas within a mile of the site and the facility is not visible from U.S. HWY 35. No historical, archaeological or environmentally unique areas are known to be present within one mile of the proposed landfill or borrow sites.

PERIOD OF LONG TERM CARE RESPONSIBILITY: DPC has, by law, a 40 year proof of financial responsibility period for long term care following landfill closure. However, DPC will be responsible for the long term care of the facility in perpetuity.

SITE CHARACTERISTICS

The site is located within the Mississippi River drainage basin in a valley at the confluence of four ephemeral surface water drainage-ways.

The surficial soil at the proposed site generally consists of sand and silty sand with lenses of gravel. Lenses of finer grained soil, including silt and clay, range from a few feet to forty feet in thickness. The sandy soils typically extend to bedrock with depths of 15 to 60 feet below the existing ground surface. The soils are from fluvial deposition and weathering of the sandstone bedrock.

Generally the bedrock in the area is composed of the Prairie du Chien Group Dolomite underlain by Cambrian Sandstone. However in the area of the Phase IV landfill the dolomite has been eroded and the bedrock is composed of the Cambrian Sandstone. The bedrock is fine grained with interbedded lenses of dark brown sandstone and calcareous, shaley constituents. The Prairie du Chien group crops out at upper elevations of the valley. The bedrock surface varies between 24 to 64 feet below the existing ground surface. The subbase of the landfill liner will be a minimum of 12 feet above the bedrock surface and no bedrock removal is anticipated as part of the landfill development.

The groundwater table beneath the site is present both within the unconsolidated sandy sediment and within the sandstone bedrock. The overlying sand and gravel aquifer is hydraulically connected to the sandstone bedrock. The depth to groundwater varies from 27.5 feet to 110 feet below ground surface. The minimum separation between the proposed subbase grades and the high water table is approximately 30 feet. Groundwater flows into the central portion of the valley and then toward the Mississippi River approximately one mile south /southwest of the site.

The *in situ* hydraulic conductivity of the fluvial sand and gravel across the site ranges from $5.3 \times 10^{-3}$ to $2.8 \times 10^{-4}$ cm/sec. The geometric mean horizontal hydraulic conductivity for this unit is approximately $1.4 \times 10^{-3}$ cm/sec. The in situ hydraulic conductivity in the Cambrian sandstone is varied with the permeability ranging from $2.5 \times 10^{-5}$ to $1.0 \times 10^{-2}$ cm/sec. The geometric mean horizontal hydraulic conductivity within the geologic unit is $1.1 \times 10^{-3}$ cm/sec.

For the proposed site, baseline groundwater quality results for indicator parameters and for public health

and welfare parameters were provided as part of the feasibility report. In one or more wells installed at the site the concentrations of lead, manganese, nitrogen (nitrate + nitrite), selenium and sulfate attained or exceeded the preventive action limit (PAL) or enforcement standard (ES) established in ch. NR 140, Wis. Adm. Code. The Department granted exemptions to groundwater standards in the feasibility determination. As part of the plan of operation, DPC has requested both alternative concentration limits (ACLs) for the parameters listed above and additional exemptions to the groundwater standards for selenium and lead. The plan of operation approval grants the exemptions for selenium but rescinds both a previously granted exemption for lead at well MW-101 because 6 of the 8 results are "no detect" and all exemptions at Station 6 because the well will not be part of the monitoring program for Phase IV. The requested exemptions for lead were not granted.

FACILITY DESIGN

The Phase IV ash disposal facility will be developed in four phases with filling beginning in a six acre tract along the east central portion of the site and generally progressing westward. The area of the Phase IV ash disposal is approximately 32 acres with a design capacity of 3, 011,000 cubic yards.

The surface water control system was designed for a 100 year, 24 hour storm event. Surface water control measures will be phased to match the construction of the landfill. Temporary sedimentation basins will be constructed and abandoned during various phases of construction and operation.

The landfill liner design includes the following components from top to bottom: a one foot thick granular drainage layer, a 60 mil High Density Polyethylene (HDPE) geomembrane, a geosynthetic clay liner (GCL) and a 2 foot thick low permeability subbase soil layer. The subbase will be compacted prior to placement of the low permeability soil barrier layer. The subbase is a fluvial sand deposit that will have loess material placed in various locations to bring it to the final grade. The low permeability soil barrier layer is a loess material obtained on site. It will be placed to achieve a density or compaction of at least 90% of the Modified Proctor and a hydraulic conductivity no greater than $1.0 \times 10^{-5}$ cm/s. The loess barrier soils will be obtained as part of the excavation for the respective cells and will be characterized prior to placement.

Leachate from the landfill will be captured in a granular drainage layer and directed to the sump area of the leachate collection system. Because the volume of leachate generated is anticipated to be low a sidewall penetration of the liner is being allowed. This allows leachate to flow by gravity to the leachate collection tank. The leachate collection tank is a 30,000-gallon double walled steel tank located near the existing processing facility. The leachate would then be pumped into the processing facility where it is mixed with a retarding agent and then applied to the incoming ash prior to placement in the landfill. The retarding agent is used to slow the cementing nature of the ash. Excess leachate will be trucked to either DPC's wastewater treatment plant at the Alma generating station or to the City of LaCrosse, Wisconsin wastewater treatment plant.

Final cover for the landfill includes, from the bottom up: a 2 foot soil barrier above the ash, a GCL, a 40 mil very flexible polyethylene (VFPE) geomembrane, a 1 foot sand drainage layer, an 18 inch general cover layer and a 6 inch topsoil layer. Final grades are designed at a maximum of 4H: 1V slope. Because of the lack of organic matter in the ash a gas extraction system is not required. The two foot soil barrier layer below the GCL will consist of a one foot layer of coarse grained material placed on top of the ash and an upper one foot layer having properties similar to the material used for the soil barrier in the liner.

The final use for the landfill is green space.

ENVIRONMENTAL MONITORING

Environmental and performance monitoring will extend through the period of active site operation and perpetual long-term care. Monitoring data will be reported to the Department on diskettes in a format supplied by the Department, as specified in s. NR 507.26(3), Wis. Adm. Code. To determine exceedances of groundwater standards, analytical results will be compared to the indicator PALs in Table 1 and the ACLs in Table 2 of the attached approval, or the standards in ch. NR 140, Wis. Adm. Code.

Environmental monitoring will be conducted semi-annually at groundwater monitoring wells, the water supply well, and sedimentation ponds. Monthly monitoring will be performed at the leachate collection tank and leachate head wells. Environmental monitoring requirements are provided in the Environmental Monitoring Summary Report attached to the plan of operation approval.

Annual testing of the coal ash will be performed for three years following completion of the first phase of the landfill. The results will be compared to the existing data and at the end of the third year a brief report will be submitted. The purpose of the analysis is to account for the variability of the coal sources and demonstrate the compatibility of the ash with the GCL components of the liner and cap for the landfill. Four discrete samples will be collected on a quarterly basis and then blended to form a composite sample from which a synthetic leachate will be generated. The leachate will be analyzed for the following properties: boron, calcium, chromium, potassium, sodium, chloride, specific conductance, total suspended solids and sulfate.

CLOSURE AND LONG TERM CARE COSTS

Although DPC will be perpetually responsible for the long term care of the landfill, proof of owner financial responsibility for a long term care period of 40 years is required by law. Actions to be taken during closure and the 40 year owner financial responsibility period, along with the associated cost estimates, are summarized below. Closure costs for the Phase IV facility are based on a worst case scenario where cell 3 is open and final cover would be required for cells 1, 2A, 2B and 3. The premature closure cost estimate includes installing the final cover system, seeding and vegetating the final cover system and preparing a closure documentation report. The final cover system is composed of the barrier soils, the GCL, the geomembrane and the surface water management features.

CLOSURE COSTS:

| Item | Quantity | Unit Cost | Estimated Cost |
|---|---|---|---|
| Barrier Layer (24 in.) | | | |
| 12 in. Silty Soil | 20,000 cy | $1.5/cy | $30,000 |
| 12 in. Coarse Material | 20,000 cy | $1.5/cy | $30,000 |
| GCL | 542,300 sf | $0.4/sf | $217,000 |
| 40 Mil VFPE Geomembrane | 542,300 sf | $0.36/sf | $195,200 |
| Granular Drainage Layer (12in.) | 60,260 sy | $5.57/sy | $335,700 |
| Vegetative Layer (18 in) | 90,390 sy | $1.26/sy | $113,900 |
| Topsoil (6 in) | 10,000 cy | $1.50/cy | $15,000 |
| Surface Water Control System | | | $50,000 |
| Seed, Fertilize, Mulch | 12.4 Acre | $1350/Acre | $16,700 |
| Construction Plans | | | $20,000 |
| Construction Observation | 16 Weeks | $5500/Week | $88,000 |
| Documentation Report | | | $ 20,000 |
| Contingencies (25%) | | | $282,875 |
| Total Cost | | | $1,414,375 |

LONG TERM CARE COSTS:

Long term care costs are itemized below and are based on estimated yearly expenses for:

| Item | Quantity | Unit Cost | Estimated Cost/Year |
|---|---|---|---|
| Cover Vegetation | | | |
| Reseed/Erosion Damage | 32 Acre | $ 500/Acre | $16,000 |
| Mowing | Event | $3200 | $3200 |
| O &M | | | |
| Storm Water Control Structures | Event | $5000 | $5000 |
| Settlement/Siltation | | | |
| Repair Cover | 32 Acre | $200/Acre | $6400 |
| Sedimentation Basin Cleaning | Event | $500 | $500 |
| Leachate Control Features | | | |
| Leachate Collection Line Cleaning | Event | $2000 | $2000 |
| Operation & Maintenance | Event | $3000 | $3000 |
| Leachate Disposal | 876,000 Gallons | $.025 | $21,900 |
| Environmental Monitoring | Event | $6500 | $6500 |
| Compatibility Testing | Event | $10,000 | $10,000 (one time) |
| Inspections | | $2000 | $2000 |
| Reporting | | $3000 | $3000 |
| Contingencies (25%) | | $17,375 | $17,375 |
| 40 Year Total | | | $3,485,000 |

DPC will use the Net Worth test for demonstrating compliance the long term care account in s. NR 520.06(6), Wis. Adm. Code.

BEFORE THE
STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES

CONDITIONAL PLAN OF OPERATION APPROVAL
FOR
DAIRYLAND POWER COOPERATIVE
PHASE IV DISPOAL AREA
ALMA OFFSITE ASH DISPOAL FACILITY
TOWN OF BELVIDERE, WISCONSIN
WDNR LICENSE # 4126

FINDINGS OF FACT

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The Department finds that:

1. Dairyland Power Cooperative (DPC) has proposed to construct an ash disposal landfill in the NE ¼ of the NE ¼ of Section 19 and portions of Sections 18 and 20, T21N, R12W, Town of Belvidere, Buffalo, County, Wisconsin.

2. The proposed ash disposal facility is intended to serve the needs of DPC as a private industrial solid waste disposal facility. Waste disposed at this site will consist of fly and bottom ash, which is produced at Units 1-5 at the John P. Madgett (JPM) and the Genoa Station No. 3 (G-3) power generating facilities owned and operated by DPC. The facility will also accept sludge from the wastewater treatment plants for the JPM and Genoa facilities and asbestos generated from renovations at the respective facilities as well.

3. The proposed ash disposal landfill would have a design capacity of 3,011,000 cubic yards with an approximate operational life of 13.9 years.

4. On September 10, 1999, the Department issued a favorable feasibility determination for the proposed Dairyland Power Cooperative Phase IV Ash Disposal Facility.

5. On October 23, 2000, the Bureau of Waste Management received a report entitled " Plan of Operation, Phase IV Disposal Area, Alma Off-Site Ash Disposal Facility, Town of Belvidere, Buffalo County Wisconsin." The report, which included 23 plan sheets, was dated October 2000 and was prepared by RMT of Madison, Wisconsin. The Plan of Operation review fee, invoice SWK-0159, for $7000 was received by the Department on November 22, 2000.

6. The information submitted in connection with the plan of operation includes the following:

   a. On September 19, 2000, DPC received a ruling from the Department's Air Management program noting that a construction permit was not required,

   b. On November 21, 2000, additional information on the compatibility testing of the GCL and the associated synthetic leachate generation analysis was submitted to the Department by RMT for DPC,

   c. On February 8, 2001, DPC submitted to the Department an asbestos disposal plan,

d. On March 15, 2001, DPC submitted to the Department additional information including a revised plan sheet number 13. The information was in response to a January 22, 2001 e-mail to DPC and RMT from Martin Herrick of the Department,

e. In response to a telephone conversation with Barb Hennings of the Department, on April 2, 2001, DPC submitted revised monitoring plan sheets because well "Station 6" was removed from the monitoring program.

7. Additional Documents considered in the review of the plan of operation include the following:

a. The Department's guidance on GCL's and sample conditions,

b. The DPC Feasibility Report, accompanying plan sheets, and the Department's Feasibility determination,

c. March 21, 2001 memo from Barb Hennings to the DPC file explaining how PALs and ACLs were reviewed and approved,

d. March 21, 2001 memo from Barb Hennings to Steve Karklins of the Department requesting review of exemptions to groundwater standards,

f. March 27,2001 memo from Steve Karklins to Dave Lundberg concurring with the proposed exemptions to the groundwater standards for selenium at wells P-42A, P-42B, Station 1, W-42, W-101, W-101A, W-102, W-104, W-105, and W-106.

8. Additional facts relevant to the review of the engineering aspects of the plan of operation include the following:

a. Geosynthethic Clay Liners (GCLs) have been proposed, in conjunction with a soil a barrier layer, as a technical substitute for the clay component of composite liners and final covers for this project,

b. The Department has issued guidance on the use of GCL's, which has been combined with technical literature, soil barrier layers, and other project experience to develop conditions that are intended to maximize the longevity and integrity of the GCL's.

9. Additional facts relevant to the review of the groundwater quality and monitoring aspects of the plan of operation include the following:

a. The proposed location of the replacement water supply well is outside the border of plan sheet 3 at station 168470N, 1476700E. This location is 1200 feet from the limits of filling of the Phase 3 landfill.

b. The Plan of Operation included indicator Preventive Action Limit (PAL) and Alternative Concentration Limit (ACL) calculations and requests for approval.

c. The Plan of Operation included a request for additional exemptions to groundwater standards.

d. At least eight values were used in the calculations of PALs. The calculated PALs and ACLs were rounded up to two significant figures.

e. PALs and ACLs were granted largely as proposed except that actual result values were used in the calculation of specific conductance rather than the rounded values used in the calculations by the facility. Several PALs were not calculated due to insufficient information or likely impacts due to well construction.

f. The baseline monitoring results for chemical oxygen demand at wells W-42, W-100, W-101A, and W-105 indicate likely impacts due to well construction. The more recent results show no detect whereas the initial results vary considerably, in the range of 5 to 60 mg/L.

g. Of the eight analytical results submitted for chemical oxygen demand at well W-100A, one is ten times higher than the others. Excluding this outlier leaves seven values to be used for the calculation of a preventive action limit where s. NR 140.20(1), Wis. Adm. Code, requires 8 values.

h. The Department considered the following information while reviewing the need for exemptions to groundwater standards at this facility:

i. Baseline groundwater monitoring data provided in the Plan of Operation, the Addendum and electronic submittal dated 3/05/2001,

ii. Well construction details and boring logs provided in the Feasibility Report,

iii. Well location plan sheets provided with the Plan of Operation and the Addendum,

iv. Water table maps provided in the Feasibility Report and Addenda to the Feasibility Report,

v. Reports from the Department's GEMS electronic database including time vs. concentration plots for various parameters at Station 1 and Station 6,

vi. The landfill design specifications provided in the Plan of Operation as conditioned herein.

10. Based on an examination of site conditions, the Department finds the following:

a. Groundwater concentrations of lead, and selenium are found at concentrations exceeding the ch. NR 140, Wis. Adm. Code, groundwater standards. These exceedances are due to baseline groundwater quality associated with natural hydrogeologic conditions or substances released by other human activities on, or near, the proposed facility,

b. The elevated concentrations of boron at Station 6 reflect groundwater quality related to the Phase II ash disposal area,

c. Station 6 will not be used as a monitoring point for the Phase IV facility.

11. Based on an examination of the groundwater quality data for the proposed facility for substances of public health concern, and the information listed in Findings of Fact 9 and 10, the Department finds the following:

a. Mean baseline concentrations of samples analyzed for selenium in wells P42A, P42B, Station 1, W42, W101, W101A, W102, W104, W105, and W106 are less than the PAL but the results vary

widely,

b. Mean baseline concentrations for lead at wells W104 and W105 approach but are not greater than the PAL. Six of the eight results are no detect. Therefore, an exemption to the groundwater standard for lead at these wells is not necessary,

c. An exemption for the groundwater standard for lead was granted at well W 101 in the 9/10/00 Feasibility Determination. The mean baseline concentration is greater than the PAL for lead. However, 6 of the 8 results are "no detect". Therefore, the exemption to the groundwater standard for lead at well W 101 is not necessary.

d. The proposed facility will not cause the concentration of selenium to exceed the ES for these substances at a point of standards application because of the landfill design,

e. The proposed facility is designed to achieve the lowest possible concentrations for selenium, which are technically and economically feasible.

12. The indicator PALs and special conditions set forth below are needed to assure that an increase in the concentration of selenium does not cause an increased threat to public health or welfare or inhibit compliance with chs. NR 500-590, Wis. Adm. Code.

13. Neither the applicant, nor any person owning a 10% or greater legal or equitable interest in the applicant or in the assets of the applicant:

    a. Is in noncompliance with a plan approval or order issued by the Department for a solid or hazardous waste facility in Wisconsin,

    b. Owns or previously owned a 10% or greater legal or equitable interest in a person, or in the assets of a person, who is not in compliance with a plan approval or order issued by the Department for a solid or hazardous waste facility in Wisconsin.

14. Granting the exemptions that are set forth below will not inhibit compliance with the Wisconsin solid waste management standards in chs. NR 500 through 590, Wis. Adm. Code

15. The Department has complied with the requirements of NR 150, Wis. Adm. Code, and s.1.11, Stats., and has adopted all practical means to avoid or minimize environmental harm consistent with social, economic and other essential considerations.

The special conditions set forth below are needed to assure that the facility will not pose a substantial hazard to public health or welfare.

## CONCLUSIONS OF LAW

1. The Department has authority under s. 289.30, Stats. to approve a plan of operation with special conditions if the conditions are needed to ensure compliance with chs. NR 500 to 590, Wis. Adm. Code.

2. The Department has authority s. NR 500.08(4), Wis. Adm. Code, to approve exemptions to the requirements of chs. NR 500 to 590 in special cases except as otherwise provided.

3. The Department has the authority under s. NR 140.28, Wis. Adm. Code, and ss. 160.19 (8) and (9), Stats., to grant exemptions to groundwater standards and to specify terms and conditions under which the Department may seek remedial action relating to standards for which an exemption has been granted. This may include establishing alternative concentration limits.

4. The Department has the authority under s. 160.15(3), Stats., and s. NR 140.20, Wis. Adm. Code, to establish preventive action limits for indicator parameters.

5. The conditions of approval set forth below are needed to ensure compliance with chs. NR 500 to 590, Wis. Adm. Code.

6. In accordance with foregoing, the Department has the authority under ch. 289, Stats., to issue the following conditional approval.

## GRANT OF EXEMPTIONS

1. DPC has demonstrated circumstances, which warrant an exemption from s. NR 504.05(5), Wis. Adm. Code requirement, whereby leachate flowing across the base of a liner is required to encounter a perforated leachate collection line within 130 feet. The following areas are exempted from the 130 foot flow length requirement:

| Location | Area (acres) | Average Exceedance | Base Slope |
|---|---|---|---|
| NE Corner of Cell 2, Module A | 0.165 | 27 | 6% |
| SW Corner of Cell 3 | 0.025 | 9 | 6% |
| SW Corner of Cell 4, Module A | 0.070 | 19 | 6% |
| Small Area along East Wall of Cell 4, Module B | 0.035 | 12 | 10% |

2. DPC has demonstrated circumstances, which warrant an exemption from s. NR 504.06(5)(j), Wis. Adm. Code, whereby a penetration through the sideslope of the liner is being allowed and a sump and sideslope riser will not be installed. But instead the leachate is able to gravity drain to the leachate collection tank located near the ash processing facility.

3. DPC has demonstrated circumstances, which warrant an exemption to the groundwater standards for selenium in ch. NR 140, Wis. Adm. Code as specified in s. NR 140.28, Wis. Adm. Code. Therefore, the Department grants an exemption to allow the landfill to be developed in an area where a preventive action limit or enforcement standard has been attained or exceeded. Exemptions are, therefore, granted for these parameters and the wells listed in Findings of Facts 9 and 10. The Alternative Concentration Limits established for these exemptions and those granted in the Feasibility determination can be found in Table 2 of this approval. Based on additional information the Department may modify this approval.

## RESCINDED EXEMPTIONS

1. With the initial four sampling results DPC demonstrated that an exemption to the groundwater standard for lead at well W101 was warranted. However, of the last four sampling results, three were no detect for a total of 6 results that showed no detect. Therefore, an exemption to the groundwater standard for lead at well W101 is not necessary and the grant of exemption is rescinded.

2. DPC demonstrated that an exemption to the groundwater standards for selenium and sulfate at well Station 6 was warranted. However, DPC has removed well Station 6 from the groundwater monitoring plan for this facility. Therefore, an exemption to the groundwater standards for sulfate and selenium at well Station 6 is not necessary and the grant of exemption is rescinded.

## CONDITIONAL PLAN OF OPERATION APPROVAL

The Department hereby approves the Plan of Operation for the DPC Phase IV Ash Disposal Area, subject to compliance with chs. NR 500 to 590 Wis. Adm. Code, and the following conditions:

General

1. The capacity of this facility may not exceed its design volume of 3,011,000 cubic yards.

2. DPC shall perform all aspects of construction and operation of the landfill in accordance with the plan of operation, the requirements of chs. NR 500 to 590, Wis. Adm. Code, and the conditions of the approval. In the case of any discrepancies between the approval conditions and the plan of operation and its associated plan sheets, the approval conditions shall take precedence.

3. DPC shall present any proposed changes to the plan or this approval to the Department. If the changes are compatible with the desired performance of this landfill, as determined by the Department, an addendum will be added to this approval indicating acceptance of those modifications to this approval. Written Department approval is necessary prior to implementing any changes with the exception of minor field modifications that are documented in accordance with s. NR 516.04(3)(d), Wis. Adm. Code. All field modifications shall be discussed with the Department prior to implementation. Other changes may be handled as expedited plan modifications under s. NR 514.09, Wis. Adm. Code, as appropriate.

Design, Construction and Construction Documentation

4. A preconstruction report shall be submitted to the Department for review at least 2 weeks prior to the installation of the GCL component of the liner and final cover. One copy shall be submitted to the Bureau of Waste Management Technical Support Section and one copy shall be submitted to the regional environmental engineer. The report shall:

   a. Identify any proposed revisions to the approved design, construction or documentation requirements including detailed diagrams incorporating all changes.

   b. Identify the manufacturer of the GCL and the manufacturer's qualifications, and provide technical specifications of the bentonite and geosynthetics used for the GCL (e.g., thickness, bentonite mass, powdered or granules, bonding method, printed overlap lines on both sides).

   a. Identify the installation contractor for the GCL, indicating specific on-site supervisory staff and a summary of their qualifications and experience, and quality control plans that the installation contractors will follow in the installation of the GCL.

   b. Identify the quality assurance consultant indicating specific on-site staff and summarizing their qualifications and experience, and include a copy of the construction quality assurance plan to be used during documentation of the construction.

   c. Describe contractor-specific storage and material handling procedures, deployment methods, attachment methods, panel overlaps, patching, procedures for minimizing bentonite loss in the GCL, and acceptable limits on sub-grade including maximum rut depth, maximum stone size and weather conditions.

d. Provide results of all chemical compatibility and slope stability testing. Describe any measures intended to assure that an adequate slope stability safety factor will be present during construction and after hydration of the GCL.

e. Describe the method to be used to assure a smooth and firm surface prior to GCL placement including a method of removing gravel, cobbles and other debris in the surface of the soil layer.

f. Describe the method to be used to assure the GCL does not become saturated prior to covering with soil and the procedure that will be followed if the GCL does become saturated. Describe the methods and equipment to be used to place the geomembrane over the GCL, and the maximum time between deployment of the GCL and placement of soil cover layers to limit free swell of bentonite.

g. Provide the planned panel layout pattern for GCL placement.

5. Conformance sampling and testing shall be conducted on the GCL delivered on site and used in construction. Sampling shall be conducted by the quality assurance engineer or qualified technician. Laboratory testing shall be performed by the quality assurance engineer or at another laboratory not affiliated with the quality control testing.

   a. Clay mass per unit area (dried) shall be tested at a rate of one test per 40,000 $ft^2$ of GCL installed; results shall be reported at 0% moisture content.

   b. Grab and peel tensile strength (MD and CD) shall be tested at a rate of one test per 100,000 $ft^2$ of GCL installed (ASTM D-4632).

   c. Index flux shall be tested at a rate of one test per 100,000 $ft^2$ of GCL installed (ASTM D-5887).

   d. Bentonite recovered from GCL sample shall be tested for free swell at a rate of one test per 100,000 $ft^2$ of GCL installed.

   e. GCL shall be certified needle-free through magnetic and metal detection tests.

6. The placement of the GCL component of the final cover shall comply with the following:

   a. The GCL shall consist of a layer of pure sodium bentonite clay encapsulated between two geotextiles.

   b. The GCL shall be installed in a relaxed condition and shall be free of tension or stress upon completion of the installation. Stretching of the GCL to fit shall not be allowed.

   c. Adjoining panels of GCL shall be laid with a minimum of six inches of overlap on the longitudinal seams and a minimum 20 inches of overlap on the panel end seams.

   d. Irregular shapes, cuts, or tears in the installed GCL shall be covered with a GCL patch that provides a twelve-inch overlap onto adjacent GCL surfaces.

   e. Loose bentonite or bentonite amended soil shall be placed at all penetrations.

   f. The GCL shall be covered with a geomembrane the same day that it is unpacked and placed in

position. The GCL shall not be installed in standing water or during rain. The GCL shall be dry when installed and covered. GCL exhibiting unconfined swelling shall be removed and replaced.

g. A rub sheet shall be placed over the GCL during installation of a geomembrane if a textured geomembrane will be in contact with the GCL.

7. Placement and testing of the two-foot soil barrier layer below the GCL shall meet the following minimum requirements:

   a. The upper one-foot of the barrier layer shall be composed of either a fine-grained soil or a well graded sandy soil with fines, with a maximum particle diameter less than one inch and meeting the criteria for USCS soil types ML, CL, CH, SM or SC with at least 80% by weight passing the No. 60 screen and a P200 content of 40% or greater.

   b. Compacted in maximum one-foot lifts to at least 90% modified Proctor density.

   c. One sample grain size distribution through the .005-millimeter particle size for each 1,500 cubic yards of soil placed.

   d. Dry density and moisture testing in accordance with s. NR 516.07(1)(a), Wis. Adm. Code.

8. Quality assurance personnel shall be on site and performing their assigned duties at all times that the GCL is being deployed and covered. Daily inspector's summary reports shall be prepared by the quality assurance personnel for each day that installation of the GCL is either attempted or accomplished. The reports shall describe practices employed during the low-permeability soil layer placement and acceptance before GCL installation. Outline drawings on 8-1/2" X 11" paper shall be prepared as necessary to record the construction events. These reports shall be appended to the construction documentation reports and shall include the following information:

   a. Amount and location of the GCL placed, with changes from the design plan noted.

   b. Methods and procedures used during placement of the GCL, minimum overlap of the panels, placement of additional bentonite, any problems due to precipitation events, and any loss of bentonite from the GCL.

   c. Methods and equipment used to place the geomembrane over the GCL. The amount of time elapsed between placement of the GCL and placement of the geomembrane over the GCL.

   d. Dates, locations and panel numbers where GCL samples are taken.

9. DPC shall notify the Department's environmental engineer assigned to this site a minimum of one week prior to beginning each of the construction events, listed below, for the purpose of allowing the Department to inspect the work. A construction documentation report shall be submitted in accordance with the requirements in ch. NR 516, Wis. Adm. Code, for the liner and final cover construction in the respective cells as noted below. Fees shall be paid to the Department in accordance with s. NR 520.04(5), Wis. Adm. Code, for each of the inspections and associated construction documentation reports as noted below.

| | Liner Construction | Final Construction |
|---|---|---|
| Cells | 1, 2A, 2B, 3, 4A, 4B | 1, 2A& 2B, 3, 4A, 4B |
| Inspections | Subase & barrier soils | Barrier Layer Soils |
| | Place GCL & geomembrane | GCL & Geomembrane installation |
| | Leachate collections system components | Drainage Layer |
| | Drainage blanket | Rooting Zone & Topsoil Placement |

10. The construction documentation reports for the final cover shall include the following additional items listed below:

    a. Written certifications from the GCL installer's quality control representative, and the quality assurance consultant, that the construction was completed in accordance with approved plans with any deviations noted.

    b. Identification of all contractors and subcontractors involved with construction.

    c. Identification of the GCL supplier/manufacturer, material specifications of the installed GCL, and attachment methods used on the project. The report shall include the names of the on-site GCL installer and quality assurance personnel. A sample of the GCL used in the construction shall be included with the report.

    d. A narrative chronologically describing the construction including placement and compaction of the soil barrier layer, installation of the GCL, orientation, repairs and penetrations of the GCL, and placement of the geomembrane. If a textured geomembrane is used, the discussion of the method of placing the geomembrane shall include the type of slip sheet used. The narrative shall describe in detail the method used to connect the GCL to the previously constructed area and protection of edges for future connections.

    e. Identification of the source of the soil used to construct the low-permeability soil layer below the GCL.

    f. Documentation of the soil barrier layer thickness below the GCL on a 100-foot grid pattern, and results of all testing completed on the soil barrier layer.

    g. Photos/details documenting the following construction activities:

        i. Equipment compacting the soil barrier layer in preparation for GCL placement.

        ii. Equipment deploying the GCL and overlying materials.

        iii. Tie-in of GCL to previously placed barrier (i.e., clay or GCL) layers.

        iv. Protection of the edge of the GCL at end of day and for future connections.

11. The final cover structure shall be revised to include the following:

    a. A minimum of three feet of drain layer, rooting zone soil, and topsoil above the geomembrane component of the composite capping layer.

    b. A minimum of two feet of soil barrier layer between the top of the ash waste and the bottom of the GCL component of the capping layer. The soil barrier component of the composite capping layer shall include a minimum one foot of compacted soil meeting the construction and material specifications of the soil barrier layer component of the composite liner. A minimum of one foot of coarse-grained soil shall underlay the fine-grained upper layer. The coarse-grained lower layer shall be selected based on grain size and permeability properties such that this layer acts as a capillary break between the ash waste and the fine grained component.

12. Soil borrow sources for the fine-grained and coarse--grained components of the soil barrier component of the capping layer shall be identified, investigated, sampled, and proposed to the Department for review and approval no later than the date of submittal of the preconstruction report for the liner construction of cell 2A. The soil properties of the fine-grained and coarse-grained soils shall be compared and analyzed to demonstrate that the proposed soils are compactable, self-filtering, and capable of establishing a capillary break.

13. The construction documentation requirements proposed in the plan of operation and required by ch, NR 516, Wis. Adm. Code, shall be amended to include the following items and submitted within 90 days from the date of this approval:

    a. The fine-grained components of the soil barrier layer components of the composite liner and cap shall be sampled and tested for liquid limit and plasticity index at a minimum rate of 1 per 5,000 $yd^3$ of soil placed. Testing of the coarse grained component of the soil barrier layer of the cap shall be conducted as proposed in the plan of operation.

    b. Piping/permeability calculations for the ash waste and leachate collection sand, based upon the grain size characteristics of the ash waste and the soil used for the collection layer.

    c. Summary of the electrical resistivity testing to be conducted on the geomembrane component of the liner and capping layer for each cell. The summary shall include identification of the contractor that performed the inspection, and identification of all defects detected and remedial measures taken to correct such defects. A plan sheet with locations and identifications of all defects and repairs, and actions taken to replace and repair other soil and geosynthetic layers that were disturbed as a part of the remedial actions.

    d. Summary of quality assurance measures taken to detect and remove broken needles in the geotextile and GCL products used in the liner or final cover construction, both in fabricating plants and during installation of geosynthetics.

14. The leachate removal system shall be revised to include details for the anti-seep collar and use of factory-fabricated pipe boots and liner penetrations.

15. The final cover drainage system shall be revised to include a downslope flume on the Northeast side of the final covered area. The downslope flume shall intercept drainage sufficiently to eliminate routing water around the eastern exterior corner of the final cover.

16. The collection tank design shall be revised to eliminate the direct connection of the piping from manhole 5. The drain piping from manhole 5 shall be revised to connect directly to the manway of the tank, with provisions for inspecting, cleaning and pressure testing the pipe as the need arises.

17. Sedimentation basin details 2/22 and 3/22 shall be revised to include shutoff valves to control flow from the sedimentation basins.

18. Geotechnical stability analyses shall be conducted on each cell of liner construction, using the site specific testing data from ash waste, soils, and geosynthetics to be used in each cell. The stability analyses shall include a sliding block analysis. The sliding block analysis for cell 1 shall be submitted no later than the construction documentation for cell 1. For all subsequent liner cells, the analysis shall be included in the preconstruction report for each cell. The report for the analysis shall assess each interface of ash waste, soils, and geosynthetics for its effect on the stability analysis.

Environmental Monitoring

19. DPC shall perform environmental monitoring during both the active and post closure perpetual care periods in accordance with the attached Environmental Monitoring Summary report.

20. DPC shall provide all environmental monitoring data required in the Department's electronic format. Semi–annual environmental monitoring shall be performed in the months of March and September and the annual monitoring shall be performed in September. Monthly monitoring results shall be submitted with the semi-annual monitoring results.

21. Based on Finding of Fact 11c, the exemption to the groundwater standard for lead at well W-101 is no longer necessary. The exemption for lead at well W-101 is withdrawn.

22. DPC shall electronically submit the results for alkalinity, parameter number 39036, at wells W-102 on 12/15/1997 and W-107 on 9/8/1998 with in 30 days from the date of this approval.

23. Results from at least four additional rounds at wells W-42, W-100, W-101A and W105 shall be submitted to the Department electronically, in order to calculate PALs for chemical oxygen demand.

24. Indicator PALs and ACLs are established as presented in Tables 1 and 2. PALs and ESs for all other substances shall be as specified in ch. NR 140, Wis. Adm. Code, Tables 1 and 2. When submitting data to the Department, DPC shall compare the groundwater sampling results with these standards to determine whether exceedances have occurred.

Replacement Wells

25. The replacement water supply well shall be located no closer than 1200 feet from any limits of filling. The proposed location is approximately station 168470N, 1476700E.

26. In addition to any other Department requirements, DPC shall submit both the assigned Wisconsin Unique Well Number and copies of the well construction and well development forms to the Department's waste management hydrogeologist located in the LaCrosse Service Center.

27. The location of well nest W-100R, as proposed in the March 9, 2001 revised plan sheet 13, is approved. In the event that the W-100R well nest is submerged, DPC shall notify the Department within 30 days.

28. At any new or replacement wells, DPC shall collect the eight baseline monitoring samples no more than 90 days apart during the first two years following installation

Compatibility Testing and Report

29. In the event of a major process change or change of a coal source, DPC shall analyze the ash for compatibility with the GCL. The compatibility test protocol shall be proposed to the Department for review and approval prior to starting the compatibility testing. Compatibility testing shall assess the impact of the ash leachate on the bentonite minerals of the GCL, particularly concerning geochemical changes and subsequent permeability changes.

30. Beginning during the first year of filling, DPC shall perform testing of the coal ash for compatibility with the GCL by taking a representative sample of the ash quarterly and then blending it to make one composite sample. The composite sample shall be tested annually using the synthetic leachate analysis procedures in Appendix J of the feasibility submittal. At a minimum the compatibility test protocol shall include the following constituents be analyzed annually according to the referenced test methods:

| Analyte | Units | Prep Method | Analysis Method |
|---|---|---|---|
| Boron | Ug/l | SW 846 3015 | SW 846 6010B |
| Calcium | Ug/l | SW 846 3015 | SW 846 6010B |
| Chromium | Ug/l | SW 846 3015 | SW 846 6010B |
| Potassium | Ug/l | SW 846 3015 | SW 846 6010B |
| Sodium | Ug/l | SW846 3015 | SW 846 6010B |
| Chloride | Ug/l | EPA 300.0 | EPA 300.0 |
| Conductance, specific | Umhos/cm | | EPA 120.1 |
| Solids, total suspended | Mg/l | EPA 160.2 | EPA 160.2 |
| Sulfate | Mg/l | EPA 300.0 | EPA 300.0 |

a. The sample results shall be submitted electronically within 90 days of testing and can be included with another data submittal.

b. After the third year, DPC shall analyze the trends and provide the Department with a recommendation whether additional testing or other modifications are warranted. The recommendation shall be submitted to the department within 90 days of the completion of testing.

The Department reserves the right to require the submittal of additional information and to modify this approval at any time, if in the Department's opinion, modifications are necessary. Unless specifically noted, the conditions of this approval do not supersede or replace any previous conditions of approval for this facility.

NOTICE OF APPEAL RIGHTS

If you believe that you have a right to challenge this decision, you should know that Wisconsin statutes and administrative rules establish time periods within which requests to review Department decisions must be filed.

For judicial review of a decision pursuant to ss. 227.52 and 227.53, Stats., you have 30 days after the decision is mailed, or otherwise served by the Department, to file your petition with the appropriate circuit court and serve the petition on the Department. Such a petition for judicial review shall name the Department of Natural Resources as the respondent.

This notice is provided pursuant to s. 227.48(2), Stats.

Dated: May 15, 2001

DEPARTMENT OF NATURAL RESOURCES
For the Secretary

David R. Lundberg
Waste Management Team leader
West Central Region

Martin Herrick, P.E.
Environmental Engineer
West Central Region

Barbara Hennings, P.G.
Hydrogeologist
West Central Region

TABLE 1
Summary of Indicator Preventive Action Limits

| Well Name | **Specific Conductance** (umho/cm) | **Chemical Oxygen Demand,** Filtered (mg/l) | **Hardness,** Total Filtered (mg/l as $CaCO_3$) | **Alkalinity,** Total Filtered (mg/l as $CaCO_3$) |
|---|---|---|---|---|
| Station 1 | 700 | 30 | 410 | 390 |
| W-42 | 680 | -- | 410 | 390 |
| P-42A | 680 | 36 | 410 | 390 |
| P-42B | 660 | 31 | 410 | 390 |
| W-100 | 1300 | -- | 660 | 710 |
| W-100A | 870 | -- | 490 | 650 |
| W-101 | 670 | 39 | 400 | 380 |
| W-101A | 660 | -- | 390 | 380 |
| W-102 | 660 | 49 | 400 | -- |
| W-102A | 640 | 33 | 390 | 370 |
| W-104 | 660 | 36 | 390 | 380 |
| W-104A | 660 | 41 | 400 | 370 |
| W-105 | 670 | -- | 390 | 370 |
| W-106 | 670 | 32 | 400 | 380 |
| W-107 | 740 | 38 | 420 | -- |

Note: Empty cells indicate insufficient data available to calculate PALs.

TABLE 2
Summary of Approved Alternative Concentration Limits

| Well Name | **Selenium**, Filtered (ug/L) PAL = 10, ES = 50 | **Nitrate plus Nitrate**, Filtered (mg/L as N) PAL = 2, ES = 10 | **Lead**, Filtered (ug.L) PAL = 1.5, ES = 15 |
|---|---|---|---|
| Station 1 | 23 | -- | -- |
| P-42 | 23 | -- | -- |
| P-42A | 25 | -- | -- |
| P-42B | 24 | -- | -- |
| W-100 | 56 | 4.4 | -- |
| W-100A | 31 | 3.4 | 12 |
| W-101 | 22 | -- | exemption rescinded |
| W-101A | 20 | -- | -- |
| W-102 | 20 | -- | -- |
| W-102A | 25 | -- | -- |
| W-104 | 24 | -- | -- |
| W-104A | 26 | -- | -- |
| W-105 | 24 | -- | -- |
| W-106 | 25 | -- | -- |
| W-107 | -- | 2.8 | -- |

Note: Empty cells denote no groundwater standard exemption.

License: 4126 Facility: DAIRYLAND POWER COOP PHASE IV-BELVIDERE

FID: 606043900 County: Buffalo City: BELVIDERE TN, WI

| DNR Point ID | Point Name | Point Type | Point Status | WUWN | Linked | Gradient |
|---|---|---|---|---|---|---|
| 1 | STATION 1 | 12 Piezometer-Non Sub D Well | A | BX385 | Y | Up |
| 2 | STATION 2 | 12 Piezometer-Non Sub D Well | A | BX386 | Y | Up |
| 17 | W-42 | 11 WT Obs Well-Non Sub D | A | LO914 | | Side |
| 18 | P-42A | 12 Piezometer-Non Sub D Well | A | LO915 | | Side |
| 19 | P-42B | 12 Piezometer-Non Sub D Well | A | LO916 | | Side |
| 20 | W-43 | 11 WT Obs Well-Non Sub D | A | LO917 | | Down |
| 21 | W-100 | 11 WT Obs Well-Non Sub D | A | LO918 | | Down |
| 22 | W-100A | 12 Piezometer-Non Sub D Well | A | LO919 | | Down |
| 23 | W-101 | 11 WT Obs Well-Non Sub D | A | LO920 | | Up |
| 24 | W-101A | 12 Piezometer-Non Sub D Well | A | LO921 | | Up |
| 25 | W-102 | 11 WT Obs Well-Non Sub D | A | LO922 | | Side |
| 26 | W-102A | 12 Piezometer-Non Sub D Well | A | LO923 | | Side |
| 27 | W-104 | 11 WT Obs Well-Non Sub D | A | LO924 | | Side |
| 28 | W-104A | 12 Piezometer-Non Sub D Well | A | LO925 | | Side |
| 29 | W-105 | 11 WT Obs Well-Non Sub D | A | LO926 | | Side |
| 30 | W-106 | 11 WT Obs Well-Non Sub D | A | LO927 | | Side |
| 31 | W-107 | 11 WT Obs Well-Non Sub D | A | LO928 | | Up |
| 32 | PW-01 | 13 Private Well - Potable | A | LO929 | | Down |
| 33 | PW-02 | 99 Other | I | | | |
| 40 | W-100R | 99 Other | I | | | |

License: 4126 Facility: DAIRYLAND POWER COOP PHASE IV-BELVIDERE

FID: 606043900 County: Buffalo City: BELVIDERE TN, WI

| DNR Point ID | Point Name | Point Type | Point Status | WUWN | Linked | Gradient |
|---|---|---|---|---|---|---|
| 42 | MW-100AR | 99 Other | I | | | |
| 44 | W-102R | 99 Other | I | | | |
| 46 | W-102AR | 99 Other | I | | | |
| 401 | LEACHATE TANK | 23 Leachate Collection Sys | I | | | |
| 601 | LH-1 | 24 Leachate Head Well | I | | | |
| 604 | LH-2 | 24 Leachate Head Well | I | | | |
| 607 | LH-3 | 24 Leachate Head Well | I | | | |
| 610 | LH-4 | 24 Leachate Head Well | I | | | |
| 613 | LH-5 | 24 Leachate Head Well | I | | | |
| 616 | LH-6 | 24 Leachate Head Well | I | | | |
| 619 | LH-7 | 24 Leachate Head Well | I | | | |
| 622 | LH-8 | 24 Leachate Head Well | I | | | |
| 851 | SG-1 | 36 Staff Gauge | I | | | |
| 852 | SG-2 | 36 Staff Gauge | I | | | |
| 871 | OUTFALL 001 | 34 Run-Off | I | | | |
| 872 | OUTFALL 002 | 34 Run-Off | I | | | |
| 997 | FIELD BLANK | 99 Other | A | | | |

# Environmental Monitoring Summary
## By Group Category Report Order Number



License Number: 4126 Facility: DAIRYLAND POWER COOP PHASE IV-BELVIDERE

FID: 606043900 DNR Region: West Central Region County: Buffalo

PLAN OF OPERATION APPROVAL

Group Category: Groundwater Monitoring Well Group Description: routine monitoring wells

Group Number: 1 Group Name: GROUNDWATER MONITORING WELLS

| Common Name | DNR ID # |
|---|---|
| MW-101AR | 42 |
| P-42A | 18 |
| STATION 1 | 1 |
| W-100 | 21 |
| W-100A | 22 |
| W-100R | 40 |
| W-101 | 23 |
| W-101A | 24 |
| W-102 | 25 |
| W-102A | 26 |
| W-102AR | 46 |
| W-102R | 44 |
| W-104 | 27 |
| W-104A | 28 |
| W-105 | 29 |
| W-106 | 30 |
| W-107 | 31 |
| W-42 | 17 |

Sample Frequency: Semi-Annual Schedule Number: 1

Sample Months: J F M-Yes A M J J A S-Yes O N D

| Parameter | |
|---|---|
| 1 | COMMENT, SAMPLE ODOR |
| 2 | COMMENT, SAMPLE COLOR |
| 3 | COMMENT, SAMPLE TURBIDITY |
| 10 | TEMPERATURE, WATER (DEGREES CENTIGRADE) |
| 94 | SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C) |
| 341 | CHEMICAL OXYGEN DEMAND, FILTERED (MG/L) |
| 400 | PH, FIELD (STANDARD UNITS) |
| 946 | SULFATE, DISSOLVED (MG/L SO4) |
| 1020 | BORON, DISSOLVED (MG/L B) |
| 1145 | SELENIUM, DISSOLVED (UG/L SE) |
| 22413 | HARDNESS, TOTAL, FILTERED (MG/L AS CACO3) |
| 39036 | ALKALINITY, TOTAL FILTERED (MG/L AS CACO3) |
| 72020 | ELEVATION, GROUNDWATER (FEET ABOVE MSL) |

License Number: 4126 Facility: DAIRYLAND POWER COOP PHASE IV-BELVIDERE
FID: 606043900 DNR Region: West Central Region County: Buffalo

PLAN OF OPERATION APPROVAL

Group Category: Groundwater Monitoring Well Group Description: Elevation only

Group Number: 2 Group Name: WELLS TO BE ABANDONED

Sample Frequency: Semi-Annual Schedule Number: 2

Sample Months: J F M-Yes A M J J A S-Yes O N D

| Common Name | DNR ID # |
|---|---|
| STATION 2 | 2 |
| W-43 | 20 |

| Parameter | |
|---|---|
| 72020 | ELEVATION, GROUNDWATER (FEET ABOVE MSL) |

License Number: 4126 Facility: DAIRYLAND POWER COOP PHASE IV-BELVIDERE
FID: 606043900 DNR Region: West Central Region County: Buffalo

PLAN OF OPERATION APPROVAL

Group Category: Groundwater Monitoring Well Group Description: wells for background monitoring
Group Number: 8 Group Name: REPLACEMENT GROUNDWATER WELLS

| Common Name | DNR ID # |
|---|---|
| MW-101AR | 42 |
| W-100R | 40 |
| W-102AR | 46 |
| W-102R | 44 |

Sample Frequency: Quarterly Schedule Number: 10
Sample Months: J F M-Yes A M J-Yes J A S-Yes O N D-Yes

| Parameter | |
|---|---|
| 1 | COMMENT, SAMPLE ODOR |
| 2 | COMMENT, SAMPLE COLOR |
| 3 | COMMENT, SAMPLE TURBIDITY |
| 10 | TEMPERATURE, WATER (DEGREES CENTIGRADE) |
| 94 | SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C) |
| 341 | CHEMICAL OXYGEN DEMAND, FILTERED (MG/L) |
| 400 | PH, FIELD (STANDARD UNITS) |
| 631 | NITRITE PLUS NITRATE, DIS. 1 DET. (MG/L AS N) |
| 946 | SULFATE, DISSOLVED (MG/L SO4) |
| 950 | FLUORIDE, DISSOLVED (MG/L F) |
| 1000 | ARSENIC, DISSOLVED (UG/L AS) |
| 1005 | BARIUM, DISSOLVED (UG/L BA) |
| 1020 | BORON, DISSOLVED (MG/L B) |
| 1025 | CADMIUM, DISSOLVED (UG/L CD) |
| 1030 | CHROMIUM, DISSOLVED (UG/L CR) |
| 1040 | COPPER, DISSOLVED (UG/L CU) |
| 1049 | LEAD, DISSOLVED (UG/L PB) |
| 1056 | MANGANESE, DISSOLVED (UG/L MN) |
| 1075 | SILVER, DISSOLVED (UG/L AG) |
| 1090 | ZINC, DISSOLVED (UG/L ZN) |
| 1145 | SELENIUM, DISSOLVED (UG/L SE) |
| 22413 | HARDNESS, TOTAL, FILTERED (MG/L AS CACO3) |
| 39036 | ALKALINITY, TOTAL FILTERED (MG/L AS CACO3) |
| 71890 | MERCURY, DISSOLVED (UG/L HG) |
| 72020 | ELEVATION, GROUNDWATER (FEET ABOVE MSL) |

# Environmental Monitoring Summary
## By Group Category Report Order Number

License Number: 4126 Facility: DAIRYLAND POWER COOP PHASE IV-BELVIDERE
FID: 606043900 DNR Region: West Central Region County: Buffalo

PLAN OF OPERATION APPROVAL

Group Category: Private Well Group Description: water supply

Group Number: 3 Group Name: WATER SUPPLY WELL

Sample Frequency: Semi-Annual Schedule Number: 3

Sample Months: J F M-Yes A M J J A S-Yes O N D

| Common Name | DNR ID # |
|---|---|
| PW-01 | 32 |
| PW-02 | 33 |

| Parameter | |
|---|---|
| 1 | COMMENT, SAMPLE ODOR |
| 2 | COMMENT, SAMPLE COLOR |
| 3 | COMMENT, SAMPLE TURBIDITY |
| 10 | TEMPERATURE, WATER (DEGREES CENTIGRADE) |
| 94 | SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C) |
| 340 | CHEMICAL OXYGEN DEMAND, UNFILTERED (MG/L) |
| 400 | PH, FIELD (STANDARD UNITS) |
| 410 | ALKALINITY, TOTAL (MG/L AS CACO3) |
| 900 | HARDNESS, TOTAL (MG/L AS CACO3) |
| 945 | SULFATE, TOTAL (MG/L SO4) |
| 1022 | BORON, TOTAL (MG/L B) |
| 1147 | SELENIUM, TOTAL (UG/L SE) |

License Number: 4126 Facility: DAIRYLAND POWER COOP PHASE IV-BELVIDERE
FID: 606043900 DNR Region: West Central Region County: Buffalo

PLAN OF OPERATION APPROVAL

Group Category: Leachate Group Description: collection tank
Group Number: 4 Group Name: LEACHATE COLLECTION TANK

| Common Name | DNR ID # |
|---|---|
| LEACHATE TANK | 401 |

Sample Frequency: Semi-Annual Schedule Number: 4
Sample Months: J F M-Yes A M J J A S-Yes O N D

| Parameter | |
|---|---|
| 1 | COMMENT, SAMPLE ODOR |
| 2 | COMMENT, SAMPLE COLOR |
| 3 | COMMENT, SAMPLE TURBIDITY |
| 94 | SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C) |
| 150 | SOLIDS, TOTAL SUSPENDED (MG/L) |
| 310 | BIOCHEMICAL OXYGEN DEMAND (MG/L, 5 DAY - 20DEG C) |
| 340 | CHEMICAL OXYGEN DEMAND, UNFILTERED (MG/L) |
| 400 | PH, FIELD (STANDARD UNITS) |
| 410 | ALKALINITY, TOTAL (MG/L AS CACO3) |
| 900 | HARDNESS, TOTAL (MG/L AS CACO3) |
| 940 | CHLORIDE, TOTAL OR DISSOLVED IN WTR SMPL (MG/L CL) |
| 945 | SULFATE, TOTAL (MG/L SO4) |
| 1022 | BORON, TOTAL (MG/L B) |
| 1027 | CADMIUM, TOTAL (UG/L CD) |
| 1051 | LEAD, TOTAL (UG/L PB) |
| 1055 | MANGANESE, TOTAL (UG/L MN) |
| 1147 | SELENIUM, TOTAL (UG/L SE) |
| 71900 | MERCURY, TOTAL (UG/L HG) |
| 74010 | IRON, TOTAL (MG/L FE) |

Sample Frequency: Annual Schedule Number: 5 ***** ACID / BASE Neutral Extractable *****
Sample Months: J F M A M J J A S-Yes O N D

| Parameter |
|---|

Environmental Mon[illegible]ring Summary
By Group Category R[illegible]t Order Number

License Number: 4126 Facility: DAIRYLAND POWER COOP PHASE IV-BELVIDERE
FID: 606043900 DNR Region: West Central Region County: Buffalo

PLAN OF OPERATION APPROVAL

Group Category: Leachate Group Description: collection tank

Group Number: 4 Group Name: LEACHATE COLLECTION TANK ***** GROUP CONTINUED FROM PREVIOUS PAGE *****

| Common Name | DNR ID # |
|---|---|

Sample Frequency: Monthly Schedule Number: 6

Sample Months: J-Yes F-Yes M-Yes A-Yes M-Yes J-Yes J-Yes A-Yes S-Yes O-Yes N-Yes D-Yes

| Parameter | |
|---|---|
| 32 | LEACHATE, VOLUME PUMPED (1000 GALLONS) |

License Number: 4126 Facility: DAIRYLAND POWER COOP PHASE IV-BELVIDERE

FID: 606043900 DNR Region: West Central Region County: Buffalo

PLAN OF OPERATION APPROVAL

Group Category: Leachate Group Description: leachate head wells

Group Number: 5 Group Name: LEACHATE HEAD WELLS

| Common Name | DNR ID # |
|---|---|
| LH-1 | 601 |
| LH-2 | 604 |
| LH-3 | 607 |
| LH-4 | 610 |
| LH-5 | 613 |
| LH-6 | 616 |
| LH-7 | 619 |
| LH-8 | 622 |

Sample Frequency: Monthly Schedule Number: 7

Sample Months: J-Yes F-Yes M-Yes A-Yes M-Yes J-Yes J-Yes A-Yes S-Yes O-Yes N-Yes D-Yes

| Parameter | |
|---|---|
| 31 | LEACHATE, DEPTH IN FEET |
| 99423 | ELEVATION, LEACHATE (FEET ABOVE MEAN SEA LEVEL) |

# Environmental Mon[illegible]ring Summary
## By Group Category R[illegible]t Order Number

License Number: 4126 Facility: DAIRYLAND POWER COOP PHASE IV-BELVIDERE
FID: 606043900 DNR Region: West Central Region County: Buffalo

PLAN OF OPERATION APPROVAL

Group Category: Surface Water Group Description: sed pond outfalls

Group Number: 7 Group Name: OUTFALLS

Sample Frequency: Semi-Annual Schedule Number: 9

Sample Months: J F M-Yes A M J J A S-Yes O N D

| Common Name | DNR ID # |
|---|---|
| OUTFALL 001 | 871 |
| OUTFALL 002 | 872 |

| Parameter | |
|---|---|
| 3 | COMMENT, SAMPLE TURBIDITY |
| 10 | TEMPERATURE, WATER (DEGREES CENTIGRADE) |
| 94 | SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C) |
| 340 | CHEMICAL OXYGEN DEMAND, UNFILTERED (MG/L) |
| 400 | PH, FIELD (STANDARD UNITS) |
| 410 | ALKALINITY, TOTAL (MG/L AS CACO3) |
| 900 | HARDNESS, TOTAL (MG/L AS CACO3) |
| 945 | SULFATE, TOTAL (MG/L SO4) |
| 1022 | BORON, TOTAL (MG/L B) |
| 1147 | SELENIUM, TOTAL (UG/L SE) |

License Number: 4126 Facility: DAIRYLAND POWER COOP PHASE IV-BELVIDERE

FID: 506043900 DNR Region: West Central Region County: Buffalo

PLAN OF OPERATION APPROVAL

Group Category: Surface Water Group Description: sed ponds

Group Number: 6 Group Name: STAFF GAGES

| Common Name | DNR ID # |
|---|---|
| SG-1 | 851 |
| SG-2 | 852 |

Sample Frequency: Semi-Annual Schedule Number: 8

Sample Months: J F M-Yes A M J J A S-Yes O N D

| Parameter | |
|---|---|
| 72020 | ELEVATION, GROUNDWATER (FEET ABOVE MSL) |

# Appendix B
# Beneficial Use Ash Characterization Data

# 2003 Dairyland Power Ash Products - Coal Sources and Classifications

| Ash | Sample Date | Composition | Wisconsin NR 538 Classification |
|---|---|---|---|
| Genoa Bottom Ash | 2/26/03 | Composite Mix | Category 3 |
| Alma Bottom Ash | 2/24/03 | Composite Mix | Category 3 |
| Genoa-3 Fly Ash | 2/26/03 | 50% Rend Lake, IL<br>50% Antelope - Kenicot | Category 4 |
| JPM Fly Ash | 2/18/03 | East Pit (Peabody) - Powder River Basin | Category 4 |
| Alma 1-5 Fly Ash | 2/18/03 | High BTU - Prosperity (Indiana)<br>Low BTU - Antelope | Category 4 |

# 2003 Total Elemental Analysis

*Alma and Genoa Ash Products*

| Parameter | WI DNR Category 1 Limits (mg/kg) | WI DNR Category 2 Limits (mg/kg) | G-3 Bottom Ash (mg/kg) | Alma Bottom Ash (mg/kg) | G-3 Fly Ash (mg/kg) | JPM Fly Ash (mg/kg) | Alma 1-5 Fly Ash (mg/kg) | Analysis Date |
|---|---|---|---|---|---|---|---|---|
| Aluminum | | | 39,800 | 47,500 | 54,800 | 80,300 | 33,500 | 4/14/03 |
| Antimony | 6.3 | | <2.3 | <2.3 | <2.5 | <2.5 | <2.5 | 4/29/03 |
| Arsenic | 0.042 | 21 | 32 | 38 | 230 | 60 | 110 | 4/30/03 |
| Barium | 1100 | | 1,200 | 2,300 | 900 | 610 | 900 | 4/15/03 |
| Beryllium | | 7 | 2.6 | 2.3 | 7.5 | 2.6 | 11 | 4/29/03 |
| Boron | 1400 | | 200 | 220 | 1,200 | 580 | 1,200 | 4/29/03 |
| Cadmium | 7.8 | | 1.3 | 1.2 | 2.8 | 2.5 | 2.1 | 4/15/03 |
| Calcium | | | 47,200 | 89,700 | 61,400 | 170,000 | 43,100 | 4/14/03 |
| Chromium | | | 26 | 21 | 76 | 47 | 52 | 4/15/03 |
| Cobalt | | | 15 | 14 | 28 | 22 | 23 | 4/29/03 |
| Copper | | | 27 | 53 | 80 | 130 | 52 | 4/15/03 |
| Iron | | | 27,700 | 30,700 | 58,300 | 39,700 | 51,400 | 4/14/03 |
| Lead | 50 | | 21 | 9.1 | 170 | 30 | 50 | 4/15/03 |
| Magnesium | | | 9,400 | 15,500 | 12,400 | 33,200 | 8,500 | 4/14/03 |
| Manganese | | | 43 | 61 | 50 | 100 | 79 | 4/15/03 |
| Mercury | 4.7 | | <0.040 | <0.040 | 0.35 | <0.040 | 0.38 | 5/2/03 |
| Molybdenum | | | <4.6 | <4.6 | 11 | <5.0 | 7.5 | 4/29/03 |
| Nickel | 310 | | 28 | 21 | 68 | 29 | 73 | 4/15/03 |
| Selenium | | | <0.14 | 0.13 | 1.2 | 3.7 | 1.8 | 4/30/03 |
| Silver | | | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | 4/15/03 |
| Sodium | | | 3,500 | 5,300 | 4,000 | 10,700 | 2,700 | 4/14/03 |
| Thallium | 1.3 | | <0.14 | <0.14 | 2.4 | <0.15 | 2.3 | 5/1/03 |
| Zinc | 4700 | | 46 | 35 | 170 | 81 | 96 | 4/15/03 |
| % Solids | | | 71.9% | 76.6% | 100.0% | 100.0% | 100.0% | 4/3/03 |

*** Note** Values are reported on a dry weight basis

DAIRYLAND Power
COOPERATIVE · LACROSSE, WISCONSIN

**Chemical Services Laboratory**
3251 East Ave. South
La Crosse, WI 54601
(608)788-4000

## Chemical Analysis Report Form

**Sample ID:** **Genoa Bottom Ash Composite** Report Date: 5/7/03

Sampling Location: Genoa, WI
Collected By: Tad Schwartzhoff
Delivered By: Tad Schwartzhoff

Sample Type: Bottom Ash
Date Collected: 2/26/03
Date Received: 2/26/03

| Parameter | Method | LOD | LOQ | Result | Units | Notes |
|---|---|---|---|---|---|---|
| Aluminum, Total | 6010B | 4.6 | 15 | 39,800 | mg/kg, dry wt. | |
| Antimony, Total | 6010B | 2.3 | 7.7 | <2.3 | mg/kg, dry wt. | |
| Arsenic, Total | 7060A | 0.093 | 0.31 | 32 | mg/kg, dry wt. | |
| Barium, Total | 6010B | 0.46 | 1.5 | 1,200 | mg/kg, dry wt. | A |
| Beryllium, Total | 6010B | 0.046 | 0.15 | 2.6 | mg/kg, dry wt. | |
| Boron, Total | 6010B | 1.2 | 4.0 | 200 | mg/kg, dry wt. | |
| Cadmium, Total | 6010B | 0.23 | 0.77 | 1.3 | mg/kg, dry wt. | A |
| Calcium, Total | 6010B | 46 | 153 | 47,200 | mg/kg, dry wt. | |
| Chromium, Total | 6010B | 0.46 | 1.5 | 26 | mg/kg, dry wt. | |
| Cobalt, Total | 6010B | 2.3 | 7.7 | 15 | mg/kg, dry wt. | A |
| Copper, Total | 6010B | 0.93 | 3.1 | 27 | mg/kg, dry wt. | |
| Iron, Total | 6010B | 1.2 | 4.0 | 27,700 | mg/kg, dry wt. | |
| Lead, Total | 6010B | 2.3 | 7.7 | 21 | mg/kg, dry wt. | A |
| Magnesium, Total | 6010B | 46 | 153 | 9,400 | mg/kg, dry wt. | |
| Manganese, Total | 6010B | 0.46 | 1.5 | 43 | mg/kg, dry wt. | |
| * Mercury, Total | 7471A | 0.040 | 0.13 | <0.040 | mg/kg, dry wt. | B |
| Molybdenum, Total | 6010B | 4.6 | 15 | <4.6 | mg/kg, dry wt. | A |
| Nickel, Total | 6010B | 0.93 | 3.1 | 28 | mg/kg, dry wt. | A |
| Selenium, Total | 7740 | 0.14 | 0.47 | <0.14 | mg/kg, dry wt. | A |
| Silver, Total | 6010B | 0.93 | 3.1 | <1.0 | mg/kg, dry wt. | |
| Sodium, Total | 6010B | 46 | 153 | 3,500 | mg/kg, dry wt. | |
| Thallium, Total | 7841 | 0.14 | 0.47 | <0.14 | mg/kg, dry wt. | |
| Zinc, Total | 6010B | 0.46 | 1.5 | 46 | mg/kg, dry wt. | |
| % Solids | | N/A | N/A | 71.9 | % | |

LOD = Limit of Detection LOQ = Limit of Quantitation

# = Results between LOD and LOQ
A = Matrix Spike Recovery was outside of control limits
B = Matrix Duplicate recovery was outside of control limits

The laboratory analyses reported above were determined in accordance with approved EPA Methodology and the latest edition of STANDARD METHODS.

Dairyland Power Cooperative Chemical Services Laboratory is a Wisconsin Registered Testing Laboratory.
Our Wisconsin Registration ID Number is 632023810.
* Mercury analysis was performed by Great Lakes Analytical of Buffalo Grove, IL.

Submitted by:

Dairyland Power Cooperative Chemical Services Laboratory

Tad Schwartzhoff, Analytical Chemist II.

DAIRYLAND Power
COOPERATIVE - LACROSSE, WISCONSIN

**Chemical Services Laboratory**
3251 East Ave. South
La Crosse, WI 54601
(608)788-4000

## Chemical Analysis Report Form

**Sample ID:** **Alma Bottom Ash Composite** Report Date: 5/7/03

Sampling Location: Alma, WI
Collected By: Ron Franz
Delivered By: Dave Lesky

Sample Type: Bottom Ash
Date Collected: 2/24/03
Date Received: 2/25/03

| Parameter | Method | LOD | LOQ | Result | Units | Notes |
|---|---|---|---|---|---|---|
| Aluminum, Total | 6010B | 4.6 | 15 | 47,500 | mg/kg, dry wt. | |
| Antimony, Total | 6010B | 2.3 | 7.7 | <2.3 | mg/kg, dry wt. | |
| Arsenic, Total | 7060A | 0.093 | 0.31 | 38 | mg/kg, dry wt. | |
| Barium, Total | 6010B | 0.46 | 1.5 | 2,300 | mg/kg, dry wt. | A |
| Beryllium, Total | 6010B | 0.046 | 0.15 | 2.3 | mg/kg, dry wt. | |
| Boron, Total | 6010B | 1.2 | 4.0 | 220 | mg/kg, dry wt. | |
| Cadmium, Total | 6010B | 0.23 | 0.77 | 1.2 | mg/kg, dry wt. | A |
| Calcium, Total | 6010B | 46 | 153 | 89,700 | mg/kg, dry wt. | |
| Chromium, Total | 6010B | 0.46 | 1.5 | 21 | mg/kg, dry wt. | |
| Cobalt, Total | 6010B | 2.3 | 7.7 | 14 | mg/kg, dry wt. | A |
| Copper, Total | 6010B | 0.93 | 3.1 | 53 | mg/kg, dry wt. | |
| Iron, Total | 6010B | 1.2 | 4.0 | 30,700 | mg/kg, dry wt. | |
| Lead, Total | 6010B | 2.3 | 7.7 | 9.1 | mg/kg, dry wt. | A |
| Magnesium, Total | 6010B | 46 | 153 | 15,500 | mg/kg, dry wt. | |
| Manganese, Total | 6010B | 0.46 | 1.5 | 61 | mg/kg, dry wt. | |
| * Mercury, Total | 7471A | 0.040 | 0.13 | <0.040 | mg/kg, dry wt. | B |
| Molybdenum, Total | 6010B | 4.6 | 15 | <4.6 | mg/kg, dry wt. | A |
| Nickel, Total | 6010B | 0.93 | 3.1 | 21 | mg/kg, dry wt. | A |
| Selenium, Total | 7740 | 0.14 | 0.5 | 0.13 | mg/kg, dry wt. | A |
| Silver, Total | 6010B | 0.93 | 3.1 | <1.0 | mg/kg, dry wt. | |
| Sodium, Total | 6010B | 46 | 153 | 5,300 | mg/kg, dry wt. | |
| Thallium, Total | 7841 | 0.14 | 0.47 | <0.14 | mg/kg, dry wt. | |
| Zinc, Total | 6010B | 0.46 | 1.5 | 35 | mg/kg, dry wt. | |
| % Solids | | N/A | N/A | 76.6 | % | |

LOD = Limit of Detection LOQ = Limit of Quantitation

# = Results between LOD and LOQ
A = Matrix Spike Recovery was outside of control limits
B = Matrix Duplicate recovery was outside of control limits

The laboratory analyses reported above were determined in accordance with approved EPA Methodology and the latest edition of STANDARD METHODS.

Dairyland Power Cooperative Chemical Services Laboratory is a Wisconsin Registered Testing Laboratory.
Our Wisconsin Registration ID Number is 632023810.
* Mercury analysis was performed by Great Lakes Analytical of Buffalo Grove, IL.

Submitted by:

Dairyland Power Cooperative Chemical Services Laboratory

Tad Schwartzhoff, Analytical Chemist II.

DAIRYLAND Power
COOPERATIVE - LA CROSSE, WISCONSIN

**Chemical Services Laboratory**
3251 East Ave. South
La Crosse, WI 54601
(608)788-4000

## Chemical Analysis Report Form

**Sample ID:** **Genoa- 3 Fly Ash** Report Date: 5/7/03

Sampling Location: Genoa, WI
Collected By: Tad Schwartzhoff
Delivered By: Tad Schwartzhoff

Sample Type: Fly Ash
Date Collected: 2/26/03
Date Received: 2/26/03

| Parameter | Method | LOD | LOQ | Result | Units | Notes |
|---|---|---|---|---|---|---|
| Aluminum, Total | 6010B | 5.0 | 17 | 54,800 | mg/kg, dry wt. | |
| Antimony, Total | 6010B | 2.5 | 8.3 | <2.5 | mg/kg, dry wt. | |
| Arsenic, Total | 7060A | 0.10 | 0.33 | 230 | mg/kg, dry wt. | |
| Barium, Total | 6010B | 0.50 | 1.7 | 900 | mg/kg, dry wt. | A |
| Beryllium, Total | 6010B | 0.050 | 0.17 | 7.5 | mg/kg, dry wt. | |
| Boron, Total | 6010B | 1.3 | 4.2 | 1,200 | mg/kg, dry wt. | |
| Cadmium, Total | 6010B | 0.25 | 0.83 | 2.8 | mg/kg, dry wt. | A |
| Calcium, Total | 6010B | 50 | 167 | 61,400 | mg/kg, dry wt. | |
| Chromium, Total | 6010B | 0.50 | 1.7 | 76 | mg/kg, dry wt. | |
| Cobalt, Total | 6010B | 2.5 | 8.3 | 28 | mg/kg, dry wt. | A |
| Copper, Total | 6010B | 1.0 | 3.3 | 80 | mg/kg, dry wt. | |
| Iron, Total | 6010B | 1.3 | 4.2 | 58,300 | mg/kg, dry wt. | |
| Lead, Total | 6010B | 2.5 | 8.3 | 170 | mg/kg, dry wt. | A |
| Magnesium, Total | 6010B | 50 | 167 | 12,400 | mg/kg, dry wt. | |
| Manganese, Total | 6010B | 0.50 | 1.7 | 50 | mg/kg, dry wt. | |
| * Mercury, Total | 7471A | 0.040 | 0.13 | 0.35 | mg/kg, dry wt. | B |
| Molybdenum, Total | 6010B | 5.0 | 17 | 11 | mg/kg, dry wt. | #, A |
| Nickel, Total | 6010B | 1.0 | 3.3 | 68 | mg/kg, dry wt. | A |
| Selenium, Total | 7740 | 0.15 | 0.5 | 1.2 | mg/kg, dry wt. | A |
| Silver, Total | 6010B | 1.0 | 3.3 | <1.0 | mg/kg, dry wt. | |
| Sodium, Total | 6010B | 50 | 167 | 4,000 | mg/kg, dry wt. | |
| Thallium, Total | 7841 | 0.15 | 0.50 | 2.4 | mg/kg, dry wt. | |
| Zinc, Total | 6010B | 0.50 | 1.7 | 170 | mg/kg, dry wt. | |
| % Solids | | N/A | N/A | 100 | % | |

LOD = Limit of Detection LOQ = Limit of Quantitation

# = Results between LOD and LOQ
A = Matrix Spike Recovery was outside of control limits
B = Matrix Duplicate recovery was outside of control limits

The laboratory analyses reported above were determined in accordance with approved EPA Methodology and the latest edition of STANDARD METHODS.

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Our Wisconsin Registration ID Number is 632023810.
* Mercury analysis was performed by Great Lakes Analytical of Buffalo Grove, IL.

Submitted by:

Dairyland Power Cooperative Chemical Services Laboratory

Tad Schwartzhoff, Analytical Chemist II.

DAIRYLAND Power
COOPERATIVE - LA CROSSE, WISCONSIN

**Chemical Services Laboratory**
3251 East Ave. South
La Crosse, WI 54601
(608)788-4000

## Chemical Analysis Report Form

**Sample ID:** **JPM Fly Ash**

Report Date: 5/7/03

Sampling Location: Alma, WI
Collected By: Ron Franz
Delivered By: Dave Lesky

Sample Type: Fly Ash
Date Collected: 2/18/03
Date Received: 2/25/03

| Parameter | Method | LOD | LOQ | Result | Units | Notes |
|---|---|---|---|---|---|---|
| Aluminum, Total | 6010B | 5.0 | 17 | 80,300 | mg/kg, dry wt. | |
| Antimony, Total | 6010B | 2.5 | 8.3 | <2.5 | mg/kg, dry wt. | |
| Arsenic, Total | 7060A | 0.10 | 0.33 | 60 | mg/kg, dry wt. | |
| Barium, Total | 6010B | 0.50 | 1.7 | 610 | mg/kg, dry wt. | A |
| Beryllium, Total | 6010B | 0.050 | 0.17 | 2.6 | mg/kg, dry wt. | |
| Boron, Total | 6010B | 1.3 | 4.2 | 580 | mg/kg, dry wt. | |
| Cadmium, Total | 6010B | 0.25 | 0.83 | 2.5 | mg/kg, dry wt. | A |
| Calcium, Total | 6010B | 50 | 167 | 170,000 | mg/kg, dry wt. | |
| Chromium, Total | 6010B | 0.50 | 1.7 | 47 | mg/kg, dry wt. | |
| Cobalt, Total | 6010B | 2.5 | 8.3 | 22 | mg/kg, dry wt. | A |
| Copper, Total | 6010B | 1.0 | 3.3 | 130 | mg/kg, dry wt. | |
| Iron, Total | 6010B | 1.3 | 4.2 | 39,700 | mg/kg, dry wt. | |
| Lead, Total | 6010B | 2.5 | 8.3 | 30 | mg/kg, dry wt. | A |
| Magnesium, Total | 6010B | 50 | 167 | 33,200 | mg/kg, dry wt. | |
| Manganese, Total | 6010B | 0.50 | 1.7 | 100 | mg/kg, dry wt. | |
| * Mercury, Total | 7471A | 0.040 | 0.13 | <0.040 | mg/kg, dry wt. | B |
| Molybdenum, Total | 6010B | 5.0 | 17 | <5.0 | mg/kg, dry wt. | A |
| Nickel, Total | 6010B | 1.0 | 3.3 | 29 | mg/kg, dry wt. | A |
| Selenium, Total | 7740 | 0.15 | 0.5 | 3.7 | mg/kg, dry wt. | A |
| Silver, Total | 6010B | 1.0 | 3.3 | <1.0 | mg/kg, dry wt. | |
| Sodium, Total | 6010B | 50 | 167 | 10,700 | mg/kg, dry wt. | |
| Thallium, Total | 7841 | 0.15 | 0.50 | <0.15 | mg/kg, dry wt. | |
| Zinc, Total | 6010B | 0.50 | 1.7 | 81 | mg/kg, dry wt. | |
| % Solids | | N/A | N/A | 100 | % | |

LOD = Limit of Detection  LOQ = Limit of Quantitation

# = Results between LOD and LOQ
A = Matrix Spike Recovery was outside of control limits
B = Matrix Duplicate recovery was outside of control limits

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Our Wisconsin Registration ID Number is 632023810.
* Mercury analysis was performed by Great Lakes Analytical of Buffalo Grove, IL.

Submitted by:

Dairyland Power Cooperative Chemical Services Laboratory

Tad Schwartzhoff, Analytical Chemist II.

DAIRYLAND Power
COOPERATIVE - LA CROSSE, WISCONSIN

**Chemical Services Laboratory**
3251 East Ave. South
La Crosse, WI 54601
(608)788-4000

## Chemical Analysis Report Form

**Sample ID:** **Alma 1-5 Fly Ash** Report Date: 5/7/03

Sampling Location: Alma, WI
Collected By: Ron Franz
Delivered By: Dave Lesky

Sample Type: Fly Ash
Date Collected: 2/18/03
Date Received: 2/25/03

| Parameter | Method | LOD | LOQ | Result | Units | Notes |
|---|---|---|---|---|---|---|
| Aluminum, Total | 6010B | 5.0 | 17 | 33,500 | mg/kg, dry wt. | |
| Antimony, Total | 6010B | 2.5 | 8.3 | <2.5 | mg/kg, dry wt. | |
| Arsenic, Total | 7060A | 0.10 | 0.33 | 110 | mg/kg, dry wt. | |
| Barium, Total | 6010B | 0.50 | 1.7 | 900 | mg/kg, dry wt. | A |
| Beryllium, Total | 6010B | 0.050 | 0.17 | 11 | mg/kg, dry wt. | |
| Boron, Total | 6010B | 1.3 | 4.2 | 1,200 | mg/kg, dry wt. | |
| Cadmium, Total | 6010B | 0.25 | 0.83 | 2.1 | mg/kg, dry wt. | A |
| Calcium, Total | 6010B | 50 | 167 | 43,100 | mg/kg, dry wt. | |
| Chromium, Total | 6010B | 0.50 | 1.7 | 52 | mg/kg, dry wt. | |
| Cobalt, Total | 6010B | 2.5 | 8.3 | 23 | mg/kg, dry wt. | A |
| Copper, Total | 6010B | 1.0 | 3.3 | 52 | mg/kg, dry wt. | |
| Iron, Total | 6010B | 1.3 | 4.2 | 51,400 | mg/kg, dry wt. | |
| Lead, Total | 6010B | 2.5 | 8.3 | 50 | mg/kg, dry wt. | A |
| Magnesium, Total | 6010B | 50 | 167 | 8,500 | mg/kg, dry wt. | |
| Manganese, Total | 6010B | 0.50 | 1.7 | 79 | mg/kg, dry wt. | |
| * Mercury, Total | 7471A | 0.040 | 0.13 | 0.38 | mg/kg, dry wt. | B |
| Molybdenum, Total | 6010B | 5.0 | 17 | 8 | mg/kg, dry wt. | A |
| Nickel, Total | 6010B | 1.0 | 3.3 | 73 | mg/kg, dry wt. | A |
| Selenium, Total | 7740 | 0.15 | 0.5 | 1.8 | mg/kg, dry wt. | A |
| Silver, Total | 6010B | 1.0 | 3.3 | <1.0 | mg/kg, dry wt. | |
| Sodium, Total | 6010B | 50 | 167 | 2,700 | mg/kg, dry wt. | |
| Thallium, Total | 7841 | 0.15 | 0.50 | 2.3 | mg/kg, dry wt. | |
| Zinc, Total | 6010B | 0.50 | 1.7 | 96 | mg/kg, dry wt. | |
| % Solids | | N/A | N/A | 100 | % | |

LOD = Limit of Detection LOQ = Limit of Quantitation

# = Results between LOD and LOQ
A = Matrix Spike Recovery was outside of control limits
B = Matrix Duplicate recovery was outside of control limits

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* Mercury analysis was performed by Great Lakes Analytical of Buffalo Grove, IL.

Submitted by:

Dairyland Power Cooperative Chemical Services Laboratory

Tad Schwartzhoff, Analytical Chemist II.

# 2003 ASTM Water Leachate Analyses

*Alma and Genoa Ash Products*

| Parameter | WI DNR Cat. 2 & 3 Limits (mg/L) | WI DNR Category 4 Limits (mg/L) | G-3 Bottom Ash ASTM (mg/L) | Alma Bottom Ash ASTM (mg/L) | G-3 Fly Ash ASTM (mg/L) | JPM Fly Ash ASTM (mg/L) | Alma 1-5 Fly Ash ASTM (mg/L) | Duplicate Alma 1-5 Fly Ash ASTM (mg/L) | Analysis Date | Analysis Method |
|---|---|---|---|---|---|---|---|---|---|---|
| Aluminum | 15 | | 3.7 | 8.5 | 51 | 56 | 33 | 32 | 4/28/03 | 6010B |
| Antimony | 0.012 | | <0.005 | <0.005 | 0.012 | <0.005 | <0.005 | 0.005 | 4/30/03 | 7041 |
| Arsenic | 0.050 | | 0.0045 | 0.0056 | 0.095 | 0.044 | 0.047 | 0.037 | 4/30/03 | 7060A |
| Barium | 4.0 | | 0.20 | 0.30 | 1.7 | 33 | 1.2 | 1.4 | 4/28/03 | 6010B |
| Beryllium | 0.004 | | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | 4/28/03 | 6010B |
| Cadmium | 0.005 | 0.025 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | 4/28/03 | 6010B |
| Chromium | 0.10 | 0.50 | <0.010 | <0.010 | 0.16 | <0.010 | 0.23 | 0.25 | 4/28/03 | 6010B |
| Copper | | | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | 4/28/03 | 6010B |
| Iron | | | <0.025 | <0.025 | 0.048 | 0.066 | <0.025 | <0.025 | 4/28/03 | 6010B |
| Lead | 0.015 | | <0.015 | <0.015 | <0.015 | <0.015 | <0.015 | <0.015 | 4/28/03 | 6010B |
| Manganese | 0.25 | | 0.010 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | 4/28/03 | 6010B |
| Mercury | 0.002 | | <0.002 | <0.002 | <0.0002 | <0.002 | <0.0002 | N/A | 5/9/03 | 7470A |
| Nickel | | | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 | 4/28/03 | 6010B |
| Selenium | 0.10 | 0.25 | <0.003 | <0.003 | 0.067 | <0.003 | 0.034 | 0.037 | 4/30/03 | 7740 |
| Silver | 0.10 | 0.25 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | 4/28/03 | 6010B |
| Thallium | 0.004 | | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | 5/1/03 | 7841 |
| Zinc | | | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | 0.012 | 4/28/03 | 6010B |
| Sulfate (mg/L) | 1250 | 2500 | 240 | 85 | 790 | <1.0 | 410 | 330 | 5/1/03 | 375.4 |
| | | | | | | | | | | |
| pH | | | 9.15 | 9.85 | 10.80 | 11.80 | 11.14 | 11.13 | 4/23/03 | Hydrolab |
| Conductivity (uS) | | | 540 | 300 | 1730 | 3730 | 1520 | 1360 | 4/23/03 | Hydrolab |
| Total Dissolved Solids (mg/L) | | | 0.35 | 0.19 | 1.11 | 2.39 | 0.97 | 0.87 | 4/23/03 | Hydrolab |
| Sulfate (mg/L) | 1250 | 2500 | | | | | | | | |
| Total Hardness (mg/L as CaCO3) | | | 180 | 120 | 900 | 800 | 550 | 450 | 4/28/03 | 6010B |

DAIRYLAND Power
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**Chemical Services Laboratory**
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La Crosse, WI 54601
(608)788-4000

## Chemical Analysis Report Form

**Sample ID:** **Genoa Bottom Ash Composite** Report Date: 5/6/03

Sampling Location: Genoa, WI
Collected By: Tad Schwartzhoff
Delivered By: Tad Schwartzhoff

Sample Type: ASTM D3987-85 Leachate
Leach Date 4/23/03
Date Collected: 2/26/03
Date Received: 2/26/03

| Parameter | Method | LOD | LOQ | Result | Category 2 Limit | Units | Notes |
|---|---|---|---|---|---|---|---|
| Aluminum | 6010B | 0.10 | 0.33 | 3.7 | 15 | mg/L | |
| Antimony | 7041 | 0.005 | 0.017 | <0.005 | 0.012 | mg/L | |
| Arsenic | 7060A | 0.002 | 0.007 | 0.0045 | 0.050 | mg/L | # |
| Barium | 6010B | 0.010 | 0.033 | 0.20 | 4.0 | mg/L | |
| Beryllium | 6010B | 0.0005 | 0.002 | <0.0005 | 0.004 | mg/L | |
| Cadmium | 6010B | 0.005 | 0.017 | <0.005 | 0.005 | mg/L | |
| Chromium | 6010B | 0.010 | 0.033 | <0.010 | 0.10 | mg/L | |
| Copper | 6010B | 0.010 | 0.033 | <0.010 | 1.3 | mg/L | |
| Iron | 6010B | 0.025 | 0.083 | <0.025 | 1.5 | mg/L | |
| Lead | 6010B | 0.015 | 0.050 | <0.015 | 0.015 | mg/L | |
| Manganese | 6010B | 0.005 | 0.017 | 0.010 | 0.25 | mg/L | # |
| *Mercury | 7470A | 0.002 | 0.0067 | <0.002 | 0.002 | mg/L | |
| Nickel | 6010B | 0.020 | 0.067 | <0.020 | 0.20 | mg/L | |
| Selenium | 7740 | 0.003 | 0.010 | <0.003 | 0.10 | mg/L | |
| Silver | 6010B | 0.010 | 0.033 | <0.010 | 0.10 | mg/L | |
| Thallium | 7841 | 0.003 | 0.010 | <0.003 | 0.004 | mg/L | |
| Zinc | 6010B | 0.010 | 0.033 | <0.010 | 25 | mg/L | |
| Sulfate | 375.4 | 1.0 | 3.3 | 240 | 1250 | mg/L | |

LOD = Limit of Detection LOQ = Limit of Quantitation

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B = Matrix Duplicate recovery was outside of control limits

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* Mercury analysis was performed by Great Lakes Analytical of Buffalo Grove, IL.

Submitted by:

Dairyland Power Cooperative Chemical Services Laboratory

Tad Schwartzhoff, Analytical Chemist II.

DAIRYLAND Power
COOPERATIVE - LA CROSSE, WISCONSIN

**Chemical Services Laboratory**
3251 East Ave. South
La Crosse, WI 54601
(608)788-4000

## Chemical Analysis Report Form

**Sample ID:** **Alma Bottom Ash Composite** Report Date: 5/6/03

Sampling Location: Alma, WI
Collected By: Ron Franz
Delivered By: Dave Lesky

Sample Type: ASTM D3987-85 Leachate
Leach Date 4/23/03
Date Collected: 2/24/03
Date Received: 2/25/03

| Parameter | Method | LOD | LOQ | Result | Category 2 Limit | Units | Notes |
|---|---|---|---|---|---|---|---|
| Aluminum | 6010B | 0.10 | 0.33 | 8.5 | 15 | mg/L | |
| Antimony | 7041 | 0.005 | 0.017 | <0.005 | 0.012 | mg/L | |
| Arsenic | 7060A | 0.002 | 0.007 | 0.0056 | 0.050 | mg/L | # |
| Barium | 6010B | 0.010 | 0.033 | 0.30 | 4.0 | mg/L | |
| Beryllium | 6010B | 0.0005 | 0.002 | <0.0005 | 0.004 | mg/L | |
| Cadmium | 6010B | 0.005 | 0.017 | <0.005 | 0.005 | mg/L | |
| Chromium | 6010B | 0.010 | 0.033 | <0.010 | 0.10 | mg/L | |
| Copper | 6010B | 0.010 | 0.033 | <0.010 | 1.3 | mg/L | |
| Iron | 6010B | 0.025 | 0.083 | <0.025 | 1.5 | mg/L | |
| Lead | 6010B | 0.015 | 0.050 | <0.015 | 0.015 | mg/L | |
| Manganese | 6010B | 0.005 | 0.017 | <0.005 | 0.25 | mg/L | |
| *Mercury | 7470A | 0.002 | 0.0067 | <0.002 | 0.002 | mg/L | |
| Nickel | 6010B | 0.020 | 0.067 | <0.020 | 0.20 | mg/L | |
| Selenium | 7740 | 0.003 | 0.010 | <0.003 | 0.10 | mg/L | |
| Silver | 6010B | 0.010 | 0.033 | <0.010 | 0.10 | mg/L | |
| Thallium | 7841 | 0.003 | 0.010 | <0.003 | 1250 | mg/L | |
| Zinc | 6010B | 0.010 | 0.033 | <0.010 | 0.004 | mg/L | |
| Sulfate | 375.4 | 1.0 | 3.3 | 85 | 1250 | mg/L | |

LOD = Limit of Detection LOQ = Limit of Quantitation

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* Mercury analysis was performed by Great Lakes Analytical of Buffalo Grove, IL.

Submitted by:

Dairyland Power Cooperative Chemical Services Laboratory

Tad Schwartzhoff, Analytical Chemist II.

DAIRYLAND Power
COOPERATIVE - LACROSSE, WISCONSIN

**Chemical Services Laboratory**
3251 East Ave. South
La Crosse, WI 54601
(608)788-4000

## Chemical Analysis Report Form

**Sample ID:** **Genoa- 3 Fly Ash**

Report Date: 5/14/03

Sampling Location: Genoa, WI
Collected By: Tad Schwartzhoff
Delivered By: Tad Schwartzhoff

Sample Type: ASTM D3987-85 Leachate
Leach Date 4/23/03
Date Collected: 2/18/03
Date Received: 2/25/03

| Parameter | Method | LOD | LOQ | Result | Category 2 Limit | Units | Notes |
|---|---|---|---|---|---|---|---|
| Aluminum | 6010B | 0.10 | 0.33 | 51 | 15 | mg/L | |
| Antimony | 7041 | 0.005 | 0.017 | 0.012 | 0.012 | mg/L | # |
| Arsenic | 7060A | 0.002 | 0.007 | 0.095 | 0.050 | mg/L | |
| Barium | 6010B | 0.010 | 0.033 | 1.7 | 4.0 | mg/L | |
| Beryllium | 6010B | 0.0005 | 0.002 | <0.0005 | 0.004 | mg/L | |
| Cadmium | 6010B | 0.005 | 0.017 | <0.005 | 0.005 | mg/L | |
| Chromium | 6010B | 0.010 | 0.033 | 0.16 | 0.10 | mg/L | |
| Copper | 6010B | 0.010 | 0.033 | <0.010 | 1.3 | mg/L | |
| Iron | 6010B | 0.025 | 0.083 | 0.048 | 1.5 | mg/L | # |
| Lead | 6010B | 0.015 | 0.050 | <0.015 | 0.015 | mg/L | |
| Manganese | 6010B | 0.005 | 0.017 | <0.005 | 0.25 | mg/L | |
| *Mercury | 7470A | 0.0002 | 0.0007 | <0.0002 | 0.002 | mg/L | |
| Nickel | 6010B | 0.020 | 0.067 | <0.020 | 0.20 | mg/L | |
| Selenium | 7740 | 0.003 | 0.010 | 0.067 | 0.10 | mg/L | # |
| Silver | 6010B | 0.010 | 0.033 | <0.010 | 0.10 | mg/L | |
| Thallium | 7841 | 0.003 | 0.010 | <0.003 | 1250 | mg/L | |
| Zinc | 6010B | 0.010 | 0.033 | <0.010 | 0.004 | mg/L | |
| Sulfate | 375.4 | 1.0 | 3.3 | 790 | 1250 | mg/L | |

LOD = Limit of Detection
LOQ = Limit of Quantitation

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* Mercury analysis was performed by Great Lakes Analytical of Buffalo Grove, IL.

Submitted by:

Dairyland Power Cooperative Chemical Services Laboratory

Tad Schwartzhoff, Analytical Chemist II.

DAIRYLAND Power
COOPERATIVE - LACROSSE, WISCONSIN

**Chemical Services Laboratory**
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La Crosse, WI 54601
(608)788-4000

## Chemical Analysis Report Form

**Sample ID:** **JPM Fly Ash**

Report Date: 5/6/03

Sampling Location: Alma, WI
Collected By: Ron Franz
Delivered By: Dave Lesky

Sample Type: ASTM D3987-85 Leachate
Leach Date 4/23/03
Date Collected: 2/18/03
Date Received: 2/25/03

| Parameter | Method | LOD | LOQ | Result | Category 2 Limit | Units | Notes |
|---|---|---|---|---|---|---|---|
| Aluminum | 6010B | 0.10 | 0.33 | 56 | 15 | mg/L | |
| Antimony | 7041 | 0.005 | 0.017 | <0.005 | 0.012 | mg/L | |
| Arsenic | 7060A | 0.002 | 0.007 | 0.044 | 0.050 | mg/L | |
| Barium | 6010B | 0.010 | 0.033 | 33 | 4.0 | mg/L | |
| Beryllium | 6010B | 0.0005 | 0.002 | <0.0005 | 0.004 | mg/L | |
| Cadmium | 6010B | 0.005 | 0.017 | <0.005 | 0.005 | mg/L | |
| Chromium | 6010B | 0.010 | 0.033 | <0.010 | 0.10 | mg/L | |
| Copper | 6010B | 0.010 | 0.033 | <0.010 | 1.3 | mg/L | |
| Iron | 6010B | 0.025 | 0.083 | 0.066 | 1.5 | mg/L | # |
| Lead | 6010B | 0.015 | 0.050 | <0.015 | 0.015 | mg/L | |
| Manganese | 6010B | 0.005 | 0.017 | <0.005 | 0.25 | mg/L | |
| *Mercury | 7470A | 0.002 | 0.0067 | <0.002 | 0.002 | mg/L | |
| Nickel | 6010B | 0.020 | 0.067 | <0.020 | 0.20 | mg/L | |
| Selenium | 7740 | 0.003 | 0.010 | <0.003 | 0.10 | mg/L | |
| Silver | 6010B | 0.010 | 0.033 | <0.010 | 0.10 | mg/L | |
| Thallium | 7841 | 0.003 | 0.010 | <0.003 | 1250 | mg/L | |
| Zinc | 6010B | 0.010 | 0.033 | <0.010 | 0.004 | mg/L | |
| Sulfate | 375.4 | 1.0 | 3.3 | <1.0 | 1250 | mg/L | |

LOD = Limit of Detection  LOQ = Limit of Quantitation

# = Results between LOD and LOQ
A = Matrix Spike Recovery was outside of control limits
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Submitted by:

Dairyland Power Cooperative Chemical Services Laboratory

Tad Schwartzhoff, Analytical Chemist II.

DAIRYLAND Power
COOPERATIVE - LA CROSSE, WISCONSIN

**Chemical Services Laboratory**
3251 East Ave. South
La Crosse, WI 54601
(608)788-4000

## Chemical Analysis Report Form

**Sample ID:** **Alma 1-5 Fly Ash**

Report Date: 5/14/03

Sampling Location: Alma, WI
Collected By: Ron Franz
Delivered By: Dave Lesky

Sample Type: ASTM D3987-85 Leachate
Leach Date 4/23/03
Date Collected: 2/18/03
Date Received: 2/25/03

| Parameter | Method | LOD | LOQ | Result | Category 2 Limit | Units | Notes |
|---|---|---|---|---|---|---|---|
| Aluminum | 6010B | 0.10 | 0.33 | 33 | 15 | mg/L | |
| Antimony | 7041 | 0.005 | 0.017 | <0.005 | 0.012 | mg/L | |
| Arsenic | 7060A | 0.002 | 0.007 | 0.047 | 0.050 | mg/L | |
| Barium | 6010B | 0.010 | 0.033 | 1.2 | 4.0 | mg/L | |
| Beryllium | 6010B | 0.0005 | 0.002 | <0.0005 | 0.004 | mg/L | |
| Cadmium | 6010B | 0.005 | 0.017 | <0.005 | 0.005 | mg/L | |
| Chromium | 6010B | 0.010 | 0.033 | 0.23 | 0.10 | mg/L | |
| Copper | 6010B | 0.010 | 0.033 | <0.010 | 1.3 | mg/L | |
| Iron | 6010B | 0.025 | 0.083 | <0.025 | 1.5 | mg/L | |
| Lead | 6010B | 0.015 | 0.050 | <0.015 | 0.015 | mg/L | |
| Manganese | 6010B | 0.005 | 0.017 | <0.005 | 0.25 | mg/L | |
| *Mercury | 7470A | 0.0002 | 0.0007 | <0.0002 | 0.002 | mg/L | |
| Nickel | 6010B | 0.020 | 0.067 | <0.020 | 0.20 | mg/L | |
| Selenium | 7740 | 0.003 | 0.010 | 0.034 | 0.10 | mg/L | |
| Silver | 6010B | 0.010 | 0.033 | <0.010 | 0.10 | mg/L | |
| Thallium | 7841 | 0.003 | 0.010 | <0.003 | 1250 | mg/L | |
| Zinc | 6010B | 0.010 | 0.033 | <0.010 | 0.004 | mg/L | |
| Sulfate | 375.4 | 1.0 | 3.3 | 410 | 1250 | mg/L | |

LOD = Limit of Detection
LOQ = Limit of Quantitation

# = Results between LOD and LOQ
A = Matrix Spike Recovery was outside of control limits
B = Matrix Duplicate recovery was outside of control limits

The laboratory analyses reported above were determined in accordance with approved EPA Methodology and the latest edition of STANDARD METHODS.

Dairyland Power Cooperative Chemical Services Laboratory is a Wisconsin Registered Testing Laboratory. Our Wisconsin Registration ID Number is 632023810.

* Mercury analysis was performed by Great Lakes Analytical of Buffalo Grove, IL.

Submitted by:

Dairyland Power Cooperative Chemical Services Laboratory

Tad Schwartzhoff, Analytical Chemist II.

# 2003 EPA Method 1312 (Synthetic) Leachate Analyses

*Alma and Genoa Ash Products*

| Parameter | MPCA Regulatory Limit (mg/L) | G-3 Bottom Ash 1312 (mg/L) | Alma Bottom Ash 1312 (mg/L) | G-3 Fly Ash 1312 (mg/L) | JPM Fly Ash 1312 (mg/L) | JPM Fly Ash Dup. 1312 (mg/L) | Alma 1-5 Fly Ash 1312 (mg/L) | Analysis Date |
|---|---|---|---|---|---|---|---|---|
| Antimony | 0.060 | <0.005 | <0.005 | 0.013 | <0.005 | <0.005 | <0.005 | 4/30/03 |
| Arsenic | 0.50 | 0.0045 | 0.0046 | 0.065 | 0.038 | 0.042 | 0.045 | 4/30/03 |
| Barium | 7.6 | 0.21 | 0.29 | 1.8 | 40 | 40 | 1.3 | 4/28/03 |
| Beryllium | 0.0008 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | 4/28/03 |
| Boron | 6.0 | 0.60 | 1.0 | 14 | 3.3 | 3.1 | 19 | 4/28/03 |
| Cadmium | 0.040 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | 4/28/03 |
| Chromium | 0.33 | <0.010 | <0.010 | 0.17 | <0.010 | <0.010 | 0.24 | 4/28/03 |
| Copper | 10 | <0.010 | <0.010 | 0.024 | <0.010 | <0.010 | <0.010 | 4/28/03 |
| Iron | 3.0 | <0.025 | <0.025 | <0.025 | 0.027 | 0.031 | <0.025 | 4/28/03 |
| Lead | 0.15 | <0.015 | <0.015 | <0.015 | <0.015 | <0.015 | <0.015 | 4/28/03 |
| Manganese | 1.0 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | 4/28/03 |
| Nickel | 1.0 | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 | 4/28/03 |
| Selenium | 0.16 | 0.003 | <0.003 | 0.066 | <0.003 | <0.003 | 0.036 | 4/30/03 |
| Silver | 0.30 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | 4/28/03 |
| Thallium | 0.006 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | 5/1/03 |
| Zinc | 20 | 0.012 | 0.011 | 0.024 | 0.028 | 0.012 | <0.010 | 4/28/03 |
| Sulfate | 2,500 | 240 | 85 | 790 | <1.0 | N/A | 410 | 5/1/03 |
| Mercury | 0.009 | <0.002 | <0.002 | <0.002 | <0.002 | N/A | <0.002 | 5/2/03 |
| | | | | | | | | |
| pH | N/A | 9.20 | 9.85 | 10.97 | 11.90 | 11.92 | 11.2 | 4/22/03 |
| Conductivity (uS) | N/A | 525 | 280 | 1750 | 4080 | 4060 | 1510 | 4/22/03 |
| Total Dissolved Solids (mg/L) | N/A | 0.34 | 0.18 | 1.1 | 2.6 | 2.6 | 1.0 | 4/22/03 |
| Total Hardness (mg/L as CaCO3) | N/A | 180 | 120 | 850 | 900 | 870 | 550 | 4/28/03 |
| Calcium | N/A | 67 | 48 | 340 | 360 | 350 | 220 | 4/28/03 |
| Magnesium | N/A | 3.8 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | 4/28/03 |

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**Chemical Services Laboratory**
3251 East Ave. South
La Crosse, WI 54601
(608)788-4000

## Chemical Analysis Report Form

**Sample ID:** **Genoa Bottom Ash Composite** Report Date: 5/6/03

Sampling Location: Genoa, WI
Collected By: Tad Schwartzhoff
Delivered By: Tad Schwartzhoff

Sample Type: EPA 1312 SPLP Leachate
Leach Date 4/22/03
Date Collected: 2/26/03
Date Received: 2/26/03

| Parameter | Method | LOD | LOQ | Result | MPCA Limit | Units | Notes |
|---|---|---|---|---|---|---|---|
| Antimony | 7041 | 0.005 | 0.017 | <0.005 | 0.060 | mg/L | |
| Arsenic | 7060A | 0.002 | 0.007 | 0.0045 | 0.50 | mg/L | # |
| Barium | 6010B | 0.010 | 0.033 | 0.21 | 7.6 | mg/L | |
| Beryllium | 6010B | 0.0005 | 0.002 | <0.0005 | 0.0008 | mg/L | |
| Boron | 6010B | 0.025 | 0.083 | 0.6 | 6.0 | mg/L | |
| Cadmium | 6010B | 0.005 | 0.017 | <0.005 | 0.040 | mg/L | |
| Chromium | 6010B | 0.010 | 0.033 | <0.010 | 0.33 | mg/L | |
| Copper | 6010B | 0.010 | 0.033 | <0.010 | 10 | mg/L | |
| Iron | 6010B | 0.025 | 0.083 | <0.025 | 3.0 | mg/L | |
| Lead | 6010B | 0.015 | 0.050 | <0.015 | 0.15 | mg/L | |
| Manganese | 6010B | 0.005 | 0.017 | <0.005 | 1.0 | mg/L | |
| Nickel | 6010B | 0.020 | 0.067 | <0.020 | 1.0 | mg/L | |
| Selenium | 7740 | 0.003 | 0.010 | 0.003 | 0.16 | mg/L | # |
| Silver | 6010B | 0.010 | 0.033 | <0.010 | 0.30 | mg/L | |
| Thallium | 7841 | 0.003 | 0.010 | <0.003 | 0.006 | mg/L | |
| Zinc | 6010B | 0.010 | 0.033 | 0.012 | 20 | mg/L | # |
| Sulfate | 375.4 | 1.0 | 3.3 | 240 | 2,500 | mg/L | |
| * Mercury | 7470A | 0.002 | 0.007 | <0.002 | 0.009 | mg/L | |

LOD = Limit of Detection LOQ = Limit of Quantitation

# = Results between LOD and LOQ
A = Matrix Spike Recovery was outside of control limits
B = Matrix Duplicate recovery was outside of control limits

The laboratory analyses reported above were determined in accordance with approved EPA Methodology and the latest edition of STANDARD METHODS.

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* Mercury analysis was performed by Great Lakes Analytical of Buffalo Grove, IL.

Submitted by:

Dairyland Power Cooperative Chemical Services Laboratory

Tad Schwartzhoff, Analytical Chemist II.

DAIRYLAND Power
COOPERATIVE - LACROSSE, WISCONSIN

**Chemical Services Laboratory**
3251 East Ave. South
La Crosse, WI 54601
(608)788-4000

## Chemical Analysis Report Form

**Sample ID:** **Alma Bottom Ash Composite** Report Date: 5/6/03

Sampling Location: Alma, WI
Collected By: Ron Franz
Delivered By: Dave Lesky

Sample Type: EPA 1312 SPLP Leachate
Leach Date 4/22/03
Date Collected: 2/24/03
Date Received: 2/25/03

| Parameter | Method | LOD | LOQ | Result | MPCA Limit | Units | Notes |
|---|---|---|---|---|---|---|---|
| Antimony | 7041 | 0.005 | 0.017 | <0.005 | 0.060 | mg/L | |
| Arsenic | 7060A | 0.002 | 0.007 | 0.0046 | 0.50 | mg/L | # |
| Barium | 6010B | 0.010 | 0.033 | 0.29 | 7.6 | mg/L | |
| Beryllium | 6010B | 0.0005 | 0.002 | <0.0005 | 0.0008 | mg/L | |
| Boron | 6010B | 0.025 | 0.083 | 1.0 | 6.0 | mg/L | |
| Cadmium | 6010B | 0.005 | 0.017 | <0.005 | 0.040 | mg/L | |
| Chromium | 6010B | 0.010 | 0.033 | <0.010 | 0.33 | mg/L | |
| Copper | 6010B | 0.010 | 0.033 | <0.010 | 10 | mg/L | |
| Iron | 6010B | 0.025 | 0.083 | <0.025 | 3.0 | mg/L | |
| Lead | 6010B | 0.015 | 0.050 | <0.015 | 0.15 | mg/L | |
| Manganese | 6010B | 0.005 | 0.017 | <0.005 | 1.0 | mg/L | |
| Nickel | 6010B | 0.020 | 0.067 | <0.020 | 1.0 | mg/L | |
| Selenium | 7740 | 0.003 | 0.010 | <0.003 | 0.16 | mg/L | |
| Silver | 6010B | 0.010 | 0.033 | <0.010 | 0.30 | mg/L | |
| Thallium | 7841 | 0.003 | 0.010 | <0.003 | 0.006 | mg/L | |
| Zinc | 6010B | 0.010 | 0.033 | 0.011 | 20 | mg/L | # |
| Sulfate | 375.4 | 1.0 | 3.3 | 85 | 2,500 | mg/L | |
| * Mercury | 7470A | 0.002 | 0.007 | <0.002 | 0.009 | mg/L | |

LOD = Limit of Detection LOQ = Limit of Quantitation

# = Results between LOD and LOQ
A = Matrix Spike Recovery was outside of control limits
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The laboratory analyses reported above were determined in accordance with approved EPA Methodology and the latest edition of STANDARD METHODS.

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* Mercury analysis was performed by Great Lakes Analytical of Buffalo Grove, IL.

Submitted by:

Dairyland Power Cooperative Chemical Services Laboratory

Tad Schwartzhoff, Analytical Chemist II.

DAIRYLAND Power
COOPERATIVE - LACROSSE, WISCONSIN

**Chemical Services Laboratory**
3251 East Ave. South
La Crosse, WI 54601
(608)788-4000

## Chemical Analysis Report Form

**Sample ID:** **Genoa- 3 Fly Ash**

Report Date: 5/6/03

Sampling Location: Genoa, WI
Collected By: Tad Schwartzhoff
Delivered By: Tad Schwartzhoff

Sample Type: EPA 1312 SPLP Leachate
Leach Date 4/22/03
Date Collected: 2/26/03
Date Received: 2/26/03

| Parameter | Method | LOD | LOQ | Result | MPCA Limit | Units | Notes |
|---|---|---|---|---|---|---|---|
| Antimony | 7041 | 0.005 | 0.017 | 0.013 | 0.060 | mg/L | # |
| Arsenic | 7060A | 0.002 | 0.007 | 0.065 | 0.50 | mg/L | |
| Barium | 6010B | 0.010 | 0.033 | 1.8 | 7.6 | mg/L | |
| Beryllium | 6010B | 0.0005 | 0.002 | <0.0005 | 0.0008 | mg/L | |
| Boron | 6010B | 0.025 | 0.083 | 14 | 6.0 | mg/L | |
| Cadmium | 6010B | 0.005 | 0.017 | <0.005 | 0.040 | mg/L | |
| Chromium | 6010B | 0.010 | 0.033 | 0.17 | 0.33 | mg/L | |
| Copper | 6010B | 0.010 | 0.033 | 0.024 | 10 | mg/L | # |
| Iron | 6010B | 0.025 | 0.083 | <0.025 | 3.0 | mg/L | |
| Lead | 6010B | 0.015 | 0.050 | <0.015 | 0.15 | mg/L | |
| Manganese | 6010B | 0.005 | 0.017 | <0.005 | 1.0 | mg/L | |
| Nickel | 6010B | 0.020 | 0.067 | <0.020 | 1.0 | mg/L | |
| Selenium | 7740 | 0.003 | 0.010 | 0.066 | 0.16 | mg/L | |
| Silver | 6010B | 0.010 | 0.033 | <0.010 | 0.30 | mg/L | |
| Thallium | 7841 | 0.003 | 0.010 | <0.003 | 0.006 | mg/L | |
| Zinc | 6010B | 0.010 | 0.033 | 0.024 | 20 | mg/L | # |
| Sulfate | 375.4 | 1.0 | 3.3 | 790 | 2,500 | mg/L | |
| * Mercury | 7470A | 0.002 | 0.007 | <0.002 | 0.009 | mg/L | |

LOD = Limit of Detection
LOQ = Limit of Quantitation

# = Results between LOD and LOQ
A = Matrix Spike Recovery was outside of control limits
B = Matrix Duplicate recovery was outside of control limits

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* Mercury analysis was performed by Great Lakes Analytical of Buffalo Grove, IL.

Submitted by:

Dairyland Power Cooperative Chemical Services Laboratory

Tad Schwartzhoff, Analytical Chemist II.

DAIRYLAND Power
COOPERATIVE - LACROSSE, WISCONSIN

**Chemical Services Laboratory**
3251 East Ave. South
La Crosse, WI 54601
(608)788-4000

## Chemical Analysis Report Form

**Sample ID:** **JPM Fly Ash**

Report Date: 5/6/03

Sampling Location: Alma, WI
Collected By: Ron Franz
Delivered By: Dave Lesky

Sample Type: EPA 1312 SPLP Leachate
Leach Date 4/22/03
Date Collected: 2/18/03
Date Received: 2/25/03

| Parameter | Method | LOD | LOQ | Result | MPCA Limit | Units | Notes |
|---|---|---|---|---|---|---|---|
| Antimony | 7041 | 0.005 | 0.017 | <0.005 | 0.060 | mg/L | |
| Arsenic | 7060A | 0.002 | 0.007 | 0.038 | 0.50 | mg/L | |
| Barium | 6010B | 0.010 | 0.033 | 40 | 7.6 | mg/L | |
| Beryllium | 6010B | 0.0005 | 0.002 | <0.0005 | 0.0008 | mg/L | |
| Boron | 6010B | 0.025 | 0.083 | 3.3 | 6.0 | mg/L | |
| Cadmium | 6010B | 0.005 | 0.017 | <0.005 | 0.040 | mg/L | |
| Chromium | 6010B | 0.010 | 0.033 | <0.010 | 0.33 | mg/L | |
| Copper | 6010B | 0.010 | 0.033 | <0.010 | 10 | mg/L | |
| Iron | 6010B | 0.025 | 0.083 | 0.027 | 3.0 | mg/L | # |
| Lead | 6010B | 0.015 | 0.050 | <0.015 | 0.15 | mg/L | |
| Manganese | 6010B | 0.005 | 0.017 | <0.005 | 1.0 | mg/L | |
| Nickel | 6010B | 0.020 | 0.067 | <0.020 | 1.0 | mg/L | |
| Selenium | 7740 | 0.003 | 0.010 | <0.003 | 0.16 | mg/L | |
| Silver | 6010B | 0.010 | 0.033 | <0.010 | 0.30 | mg/L | |
| Thallium | 7841 | 0.003 | 0.010 | <0.003 | 0.006 | mg/L | |
| Zinc | 6010B | 0.010 | 0.033 | 0.028 | 20 | mg/L | # |
| Sulfate | 375.4 | 1.0 | 3.3 | <1.0 | 2,500 | mg/L | |
| * Mercury | 7470A | 0.002 | 0.007 | <0.002 | 0.009 | mg/L | |

LOD = Limit of Detection
LOQ = Limit of Quantitation

# = Results between LOD and LOQ
A = Matrix Spike Recovery was outside of control limits
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The laboratory analyses reported above were determined in accordance with approved EPA Methodology and the latest edition of STANDARD METHODS.

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* Mercury analysis was performed by Great Lakes Analytical of Buffalo Grove, IL.

Submitted by:

Dairyland Power Cooperative Chemical Services Laboratory

Tad Schwartzhoff, Analytical Chemist II.

DAIRYLAND Power
COOPERATIVE - LACROSSE, WISCONSIN

**Chemical Services Laboratory**
3251 East Ave. South
La Crosse, WI 54601
(608)788-4000

## Chemical Analysis Report Form

**Sample ID:** **Alma 1-5 Fly Ash**

Report Date: 5/6/03

Sampling Location: Alma, WI
Collected By: Ron Franz
Delivered By: Dave Lesky

Sample Type: EPA 1312 SPLP Leachate
Leach Date 4/22/03
Date Collected: 2/18/03
Date Received: 2/25/03

| Parameter | Method | LOD | LOQ | Result | MPCA Limit | Units | Notes |
|---|---|---|---|---|---|---|---|
| Antimony | 7041 | 0.005 | 0.017 | <0.005 | 0.060 | mg/L | |
| Arsenic | 7060A | 0.002 | 0.007 | 0.045 | 0.50 | mg/L | |
| Barium | 6010B | 0.010 | 0.033 | 1.3 | 7.6 | mg/L | |
| Beryllium | 6010B | 0.0005 | 0.002 | <0.0005 | 0.0008 | mg/L | |
| Boron | 6010B | 0.025 | 0.083 | 19 | 6.0 | mg/L | |
| Cadmium | 6010B | 0.005 | 0.017 | <0.005 | 0.040 | mg/L | |
| Chromium | 6010B | 0.010 | 0.033 | 0.24 | 0.33 | mg/L | |
| Copper | 6010B | 0.010 | 0.033 | <0.010 | 10 | mg/L | |
| Iron | 6010B | 0.025 | 0.083 | <0.025 | 3.0 | mg/L | |
| Lead | 6010B | 0.015 | 0.050 | <0.015 | 0.15 | mg/L | |
| Manganese | 6010B | 0.005 | 0.017 | <0.005 | 1.0 | mg/L | |
| Nickel | 6010B | 0.020 | 0.067 | <0.020 | 1.0 | mg/L | |
| Selenium | 7740 | 0.003 | 0.010 | 0.036 | 0.16 | mg/L | |
| Silver | 6010B | 0.010 | 0.033 | <0.010 | 0.30 | mg/L | |
| Thallium | 7841 | 0.003 | 0.010 | <0.003 | 0.006 | mg/L | |
| Zinc | 6010B | 0.010 | 0.033 | <0.010 | 20 | mg/L | |
| Sulfate | 375.4 | 1.0 | 3.3 | 410 | 2,500 | mg/L | |
| * Mercury | 7470A | 0.002 | 0.007 | <0.002 | 0.009 | mg/L | |

LOD = Limit of Detection

LOQ = Limit of Quantitation

# = Results between LOD and LOQ
A = Matrix Spike Recovery was outside of control limits
B = Matrix Duplicate recovery was outside of control limits

The laboratory analyses reported above were determined in accordance with approved EPA Methodology and the latest edition of STANDARD METHODS.

Dairyland Power Cooperative Chemical Services Laboratory is a Wisconsin Registered Testing Laboratory. Our Wisconsin Registration ID Number is 632023810.

* Mercury analysis was performed by Great Lakes Analytical of Buffalo Grove, IL.

Submitted by:

Dairyland Power Cooperative Chemical Services Laboratory

Tad Schwartzhoff, Analytical Chemist II.

# Appendix C
# Select Previous DPC Ash Studies

## Table of Contents

- Executive Summary and Report. Fly Ash Characterization Study Alma Madgett Generating Station Units 1-6. Dairyland Power Cooperative Alma, Wisconsin. October 1979. Prepared by Warzyn Engineering, Inc.
- Supplemental Fly Ash Characterization Report. Fly Ash Conditioning with Low Moisture Content. Alma Madgett Generating Station Units 1-6. Dairyland Power Cooperative Alma, Wisconsin. November 1980. Prepared by Warzyn Engineering, Inc.

**Executive Summary and Report. Fly Ash Characterization Study Alma Madgett Generating Station Units 1-6. Dairyland Power Cooperative Alma, Wisconsin. October 1979. Prepared by Warzyn Engineering, Inc.**

EXECUTIVE SUMMARY

FLY ASH CHARACTERIZATION STUDY
ALMA MADGETT GENERATING STATION UNITS 1-6
DAIRYLAND POWER COOPERATIVE
ALMA, WISCONSIN

C 8181

## EXECUTIVE SUMMARY

FLY ASH CHARACTERIZATION STUDY
ALMA/MADGETT GENERATING STATION
UNITS 1-6
DAIRYLAND POWER COOPERATIVE
ALMA, WISCONSIN

### INTRODUCTION AND SCOPE

The purpose of this study was to investigate the physical and chemical properties of the Dairyland Power Cooperative Alma/Madgett Generating Station Units 1 through 6 fly ashes as they relate to disposal site operations and licensing. The electrical generating capacity of existing Alma Units 1-5 (209 megawatts) is being supplemented with the construction of Unit No. 6 (350 megawatts) for a total generating capacity of 559 megawatts. The ash disposal requirement for the Alma Units 1-6 between the years 1979 and 2015 is projected to range from 60,000 tons to 147,000 tons per year.

Since the Alma Unit No. 6 is not yet operational, samples representative of Unit 6 were obtained from the Lansing Generating Station Unit #4, Lansing, Iowa which burns the same coal type (Wyoming sub-bituminous Belle Ayr-AMAX Coal Company) in the same boiler type (dry bottom pulverized fuel fired) as that proposed at Alma No. 6. Alma Units 1-5 burn a mixture of Illinois-Kentucky bituminous and Montana sub-bituminous coals in dry bottom pulverized fuel fired furnaces. Samples representative of existing Alma Units 1-5 were collected over an extended period from the fly ash precipitator hoppers. Fly ash from Alma Units 1-5 were collectively evaluated as a single ash source.

This study also included physical and chemical tests on a mixture of the Lansing Unit 4 and Alma Units 1-5 fly ashes in a 60/40 percent ratio, the anticipated respective ash production ratio, to examine the characteristics of the waste material if blending and co-disposal of the fly ashes is deemed necessary.

## FLY ASH COMPOSITION

Analyses of the Alma Units 1-5 and Lansing Unit 4 fly ashes indicate the following bulk composition:

| Parameter | Alma #1-5 | Lansing #4 |
|---|---|---|
| Silica, $SiO_2$ | 46.20% | 30.91% |
| Alumina, $Al_2O_3$ | 19.89 | 17.36 |
| Titania, $TiO_2$ | 0.81 | 1.52 |
| Ferric Oxide, $Fe_2O_3$ | 18.65 | 6.41 |
| Calcium Oxide, CaO | 6.93 | 30.09 |
| Magnesium Oxide, MgO | 1.54 | 5.11 |
| Potassium Oxide, $K_2O$ | 1.95 | 0.36 |
| Sodium Oxide, $Na_2O$ | 1.12 | 2.22 |
| Sulfur Trioxide, $SO_3$ | 2.08 | 4.27 |
| Phos. Pentoxide, $P_2O_5$ | 0.28 | 0.69 |
| Strontium Oxide, SrO | 0.00 | 0.23 |
| Barium Oxide, BaO | 0.15 | 0.72 |
| Undetermined | 0.40 | 0.11 |

Values reported as %, ignited basis.

A major distinction between the two fly ashes is the high calcium content in the Lansing Unit 4 ash. When water is added to the fly ash, calcium combines with silica, alumina and sulfate to form stable minerals having cementitious qualities. Calcium is a key ingredient contributing to the Lansing Unit 4 pozzolanic activity and resulting hardening properties. The lower calcium content of the Alma Units 1-5 ash is responsible for the lower overall strengths.

Since coal is generally a heterogeneous material containing a wide variety of minerals, elements become concentrated in the fly ash residue after combustion of the organic material. Trace metals in the coal will also be present in the fly ash. Inorganic mass spectrophotometric analysis for trace metal distribution indicates there are generally few elements absent in the Alma Nos. 1-5 and Lansing No. 4 fly ashes. Moreover, the concentrations of trace elements present were very similar among fly ashes tested. Although the coal sources for the different units are quite different, few trace elements show significant concentration differences between the fly ashes.

The discussion to follow summarizes the physical characteristics and the chemical leaching properties of the Alma Units 1-5 and Lansing Unit 4 fly ashes as received by Warzyn Engineering Inc. For brevity the term 60/40 is used to describe a mix of 60 percent Lansing No. 4 and 40 percent Alma Nos. 1-5 fly ashes. Also the terms Alma No. 6 and Lansing No. 4 are used interchangeably.

## PHYSICAL PROPERTIES

### Proctor Compaction

The moistened fly ash can be compacted by Modified Proctor methods. The maximum densities that may be attained are as follows: The Alma Units 1-5 fly ash has a maximum density of 93 lbs./cu.ft. at a moisture content of 21 percent. A density of 119.7 lbs./cu.ft. at 11 percent moisture was determined for the Lansing Unit 4 fly ash. The 60/40 mixture has a maximum density of 109 lbs./cu.ft. at 15 percent moisture.

Dry, uncompacted weights were also obtained. The Alma Unit 1-5 fly ash has an approximate weight of 59 lbs./cu.ft., the Lansing Unit 4 fly ash has an approximate weight of 69 lbs./cu.ft., and the 60/40 mixture is 63 lbs./cu.ft.

Tests were also performed on fly ash that had been allowed to set after the addition of optimum moisture. It was found that Lansing Unit 4 had a maximum density of 102 lbs./cu.ft. at 18 percent moisture and the 60/40 mixture had a 98 lb./cu.ft. maximum density at 23 percent moisture.

### Setting Properties

Setting tests were performed on the Alma Unit 1-5 and Lansing Unit 4 fly ashes and on the 60/40 mixture. Two approaches to the test for setting were used. In the first approach 2 inch compression test cubes were broken and in the second approach pocket penetrometer readings were taken on slurry mixes.

The Alma Unit 1-5 fly ash in both procedures failed to produce setting. The cubes did not hold their shape and the slurries did not set. The addition of lime caused a very slow setting, not noticeable within six hours of test.

The Lansing Unit 4 fly ash cube strengths increased rapidly to 2300 PSI at 3 hours with further increases to 3200 PSI after 36 hours. The time and rate at which the various slurries obtained a 4.5 TSF reading on the penetrometer varied considerably. At 20 percent moisture the reading increased rapidly from the initial addition of water to a 4.5 TSF reading in 6 minutes. At 50 percent moisture, the 4.5 TSF reading was not reached until 18 minutes after the water addition. At 30 and 40 percent moistures, the set was zero for approximately 6 minutes, then it quickly increased to 4.5 TSF at approximately 10 minutes. Temperature readings were taken on the compacted and slurry mixes. Ten minutes after the addition of water to the fly ash the highest temperature measured was 57° C at 14 percent moisture.

The 60/40 mixture of fly ash cubes had rapid strength increases to 1100 PSI at 3 hours and further increases to 1350 PSI after 36 hours. The 4.5 TSF penetrometer reading was variable as in the Lansing Unit 4 slurry. The 20 percent moisture slurry attained the 4.5 TSF reading in 7 minutes. At 50 percent moisture, the 4.5 TSF reading was not reached until 32 minutes after the water addition.

Pocket penetrometer readings were taken on uncompacted Lansing Unit 4 and the 60/40 mixture fly ash and they were found not to set up without the compaction. The fly ashes were prepared at the optimum moisture contents and observed for several hours.

Specific Gravity

The specific gravities, by a modified soil test procedure, are 2.47 for Alma Units 1-5 fly ash, 2.54 for Lansing Unit 4 fly ash, and 2.63 for the 60/40 mixture.

Permeability

A permeability test was performed on a compacted Lansing Unit #4 fly ash sample at 94 percent of the Modified Proctor density. This is typical for compacted soils. The hydraulic conductivity, as determined in the falling head permeameter, is 4 to 5 x $10^{-9}$ cm./sec. Permeability tests were also performed on the Alma 1-5 fly ash. One test was at 97 percent and one at 100 percent of the maximum density. The results verified that the Unit 1-5 fly ash is more permeable; the 97 percent compaction test having a hydraulic conductivity of 6 to 7 x $10^{-6}$ cm./sec. and the 100 percent compaction permeability of 3 to 4 x $10^{-6}$ cm./sec. The results of the permeability test for the 60/40 mixture of fly ash are 3 to 5 x $10^{-9}$ cm./sec. at 100 percent compaction and 1 to 3 x $10^{-8}$ cm./sec. at 92 percent compaction.

Strength Characteristics

Unconfined compressive strength tests were performed under two conditions. One method was on compacted samples and the other on fly ash and water mixtures of slurry consistency, which then set up.

Only one test was performed on the Alma Units 1-5 fly ash. This was a compacted sample at maximum density which yielded a seven day strength of 175 PSI. Other test samples of this fly ash were not stable enough to test. A sample prepared with 5 percent lime and compacted at 21 percent moisture had a seven day strength of 550 PSI.

The Lansing Unit 4 results varied from 1500 PSI to 5000 PSI for seven day compacted material. The highest strength was at the same moisture content that produced the maximum density. The 5000 PSI strength is comparable to a high-early strength concrete. The 28 day strength tests on compacted material had a maximum of 1900 PSI at a moisture content of near that which produced the maximum density. A slurry was obtained at a moisture content greater than 20 percent by weight of dry fly ash. At seven days a cylinder of each moisture content (25, 30, 40, 50 and 60 percent) was broken in compression. The range of strengths was from 1120 PSI to 3210 PSI, with the maximum strength at a moisture content of 30 percent. The maximum 28 day unconfined strength tests on the Lansing Unit 4 fly ash slurry was 3100 PSI at 40 percent moisture.

The 60/40 mixture of fly ash also had the strength tests performed. The maximum for the compacted material was 1150 PSI at 19 percent moisture at seven days and 1290 PSI at 15 percent moisture at 28 days. The results on the slurry samples had a maximum of 1340 PSI for seven days and 1918 PSI for 28 days with both having 30 percent moisture.

Grain Size

The grain size of the Lansing Unit 4 fly ash is very uniform at a grain size diameter of 0.02 millimeter. This is in the silt category according to ASTM D2487. The grain size of the fly ash from Alma Units 1-5 is predominantly silt with some clay and a trace of sand size particles.

Erosion Resistance Tests

A series of tests were performed to determine the physical durability of the fly ash materials to erosion and to gather data on the quality of the resulting runoff. The erosion tests were conducted in several stages of increasing water velocities and volumes ranging from a light water misting to simulation of high impact rainfall using an inverted lawn sprinkler.

The erosion tests indicate that the Alma 1-5, Lansing 4 and the 60/40 ash mixture of Lansing 4/Alma 1-5 were similar under relatively mild water application velocities using fertilizer sprayers and an open 3/4" diameter hose. Typical erosion rates were on the order of $10^{-3}$ to $10^{-4}$ tons per acre per inch of water applied.

Differences between the fly ashes became apparent under more rigorous testing using an inverted lawn sprinkler at maximum pressure. The Alma 1-5 ash showed significant erosion in the areas impacted by the water stream producing depressions of 1/4" to 3/4" deep. The durability of the Lansing 4 ash was considerably better due to its superior hardening characteristics compared to the Alma 1-5 fly ash. Some horizontal cracking and separation of the Lansing #4 ash was noted between layers of the compacted ash and erosion occurred where the force of the water broke up these thinner horizontal layers. The 60/40 ash mixture of Lansing #4/Alma #1-5 was considered the most durable to erosion and exhibited minimal breakdown under water applications substantially more severe than that subjected to the individual ashes. All of the fly ashes and ash mixtures tested appeared to be substantially more resistant to erosion than would be anticipated from a natural soil of comparable grain distribution.

Miscellaneous Tests

Dust control tests were performed to obtain an idea of the moisture required to control problems with vehicle loading and surface winds. A 3 percent moisture content appears to be satisfactory for control of dust during vehicle loading and a 15 percent moisture content appears necessary to keep a 22 miles per hour wind from blowing dust from the surface of a landfill site.

A standard grout consistency funnel was used to determine fluidity period of slurry consistency mixes.

Setting of slurries is practically non-existent for periods needed for pumping transport of approximately 30 minutes. After 30 minutes, setting takes place quite rapidly. The minimum moisture condition necessary for this condition is: 60 percent for Lansing No. 4 and also for Alma Nos. 1-5, and 70 percent for the 60/40 mix.

The workability of all the fly ashes varies with the moisture content. Up to 15 percent moisture the fly ash should be satisfactory for working with standard earth-moving equipment. A moisture condition between 20 and 60 percent may be more difficult to handle due to a paste consistency which develops. Above 60 percent the fly ash appears to be in the pumpable category.

Upon observing all phases of testing, there appears to be a slight condition of efflorescence at all moisture contents for all fly ashes tested.

Freezing temperatures following the addition of 10-20 percent water to the 60/40 mixture does not appear to preclude setting.

## CHEMICAL TESTS

Various tests were performed for the purpose of assessing the characteristics of leachates derived from the Alma Generating Station waste materials. Leachates were generated from the fly ash samples by both the shake-flask and column leaching methods.

### Shake Flask Tests

The shake flask test procedure involved the rigorous stirring of 100 grams of fly ash with 1 liter of distilled water for a period of 48 hours. Following filtration, the leachates were analyzed for 33 parameters.

Principal cationic species in the Lansing Unit 4 fly ash leachate were calcium, sodium, and strontium in concentrations up to 500 mg/l. Curing of the fly ash for one week at optimum moisture prior to testing appeared to shift the major anionic forms from carbonate and bicarbonate to hydroxide and carbonate ions. The involvement of calcium in the hardening reactions also appears to reduce the leaching of this element from the cured fly ash which in turn also reduces the leachate pH.

The shake flask leachate characteristics of Alma 1-5 fly ash are somewhat different from the Lansing Unit 4. Total dissolved solids, indicated by specific conductance, were about 1/3 of that observed in the Lansing Unit 4 fly ash. Sulfate, which was virtually absent in the Lansing Unit 4 ash leachate, is a major anionic species in the Alma 1-5 leachate at concentrations up to 620 mg/l. The Alma Units 1-5 leachate also shows significantly lower strontium concentrations than were observed in the Lansing Unit 4 leachate.

The shake flask tests performed on a 60/40 mixture of Lansing No. 4/Alma No. 1-5 fly ashes results in a leachate which is more similar to the Lansing No. 4 than the Alma No. 1-5. Relatively few parameters were "well-behaved", leaching from the mixed ash sample in the same proportions as those observed in the individual unmixed ash leachates. A significant effect of mixing the fly ashes is the reduction of sulfate leaching from the Alma No. 1-5 fly ash.

Trace metals were generally absent in the shake flask leachates at the detection limits utilized. Barium, mercury and selenium were trace metals typically detected and at concentrations exceeding the drinking water standards.

Column Tests

Column leaching tests were performed on 1' to 4' thicknesses of Lansing No. 4, Alma Nos. 1-5 and a 60/40 fly ash mixture (Lansing #4/Alma Nos. 1-5) in 5 1/2" diameter plexiglass columns. The fly ash was compacted in the columns in 2" to 3" lifts at slightly above optimum moisture and allowed to cure for one week before testing began. A total of 6 columns were constructed in which a head of deionized water was maintained over the waste material and the column effluents analyzed for up to 33 parameters.

Due to the extremely low permeability of the Lansing Unit 4 fly ash ($10^{-9}$ cm./sec.) no leaching data is available from the columns containing 1' and 2' thicknesses of this ash. Visual observations indicate that moisture had percolated through the Lansing Unit 4 fly ash to a depth of approximately 4" to 6" below the surface. No leachate has been produced from these columns since testing began in late May and early June, 1979.

Alma Units 1-5 Fly Ash

Three columns containing Alma Units 1-5 fly ash in thicknesses ranging from 1' to 4' were tested. Leachate samples were collected representing a maximum of 41 pore volume displacements to evaluate long term leaching characteristics of Alma Units 1-5 ash.

Major constituents of the Alma Units 1-5 column leachates include sodium and potassium sulfates, hydroxides, and carbonates. In general, order of magnitude concentration decreases are typical within the first five pore volume displacements with gradual decreases thereafter. As high sodium and potassium concentrations decline, increases in calcium and strontium occur and contribute to a significant percentage of the cations present. The availability of sulfate and, to a lesser extent, chloride anions appear to be controlling factors in the leaching process.

The maximum concentrations of each element observed in the leachate from the three Alma Units 1-5 columns do not increase with increasing fly ash thickness. An equilibrium appears to be developed in the fly ash leachate after infiltrating relatively short thicknesses through the waste material. Although the equilibrium developed appears to limit the maximum concentrations of each element observed in the leachate, the thickness of the waste material governs the duration for which these maximum concentrations are found.

Leaching of elements from the Alma Units 1-5 fly ash does not occur in proportion to their availability. Those parameters which comprise the bulk of the ash composition leach in the greatest concentrations but at the smallest percentages compared to the total amounts of these

elements available in the column. Trace metal leaching is generally discouraged due to the high pH of the leachates except for those elements which form soluble hydroxides. Arsenic, chromium, nitrate, selenium and sulfate typically exceeded drinking water standards within the first several pore volume displacements.

Runoff Quality

Surface water runoff samples were collected at regular intervals in conjunction with the physical testing for erodability of the various fly ashes. The runoff water was recirculated over a 3 square foot surface area of fly ash to evaluate the quality of the resulting runoff water after lengthy exposure to the fly ash.

The analysis of the runoff leachates for the Lansing Unit 4, Alma Units 1-5 and the 60/40 ash mixture indicate that sodium and potassium sulfates, carbonates and bicarbonates were major constituents of the leachate for all three fly ashes tested. Compared to the shake flask leaching tests, major cations remained the same while anions shifted from predominantly hydroxide and carbonates in the shake flask tests to carbonates and bicarbonates in the runoff water.

While sulfate anions were insignificant in the shake flask tests for the Lansing No. 4 ash and the 60/40 ash mixture, sulfate was a major constituent of all runoff leachates. The migration (efflorescence) of sodium sulfate to the fly ash surface after exposure to the atmosphere for several days is a major factor in the leaching of these ions.

In general, trace metals were below detection limits or drinking water standards after lengthy recirculation simulating more than 300 ft. of exposure to the fly ash surface. Parameters which exceeded the EPA drinking water standards were chromium for Alma Units 1-5, arsenic, fluoride, selenium and sulfate for the Lansing Unit 4 ash and chromium and selenium for the 60/40 ash mixture.

## DISCUSSION AND RECOMMENDATIONS

The investigation of the waste materials to be produced at the Alma Generating Station has indicated that these fly ashes can be disposed of in an environmentally safe manner. The additon of water to the Alma Unit 6 fly ash initiates pozzolanic reactions similar to Portland cement concrete to form a hardened mass. Calcium reacts with the water to form lime which reacts with the silica and alumina to form stable minerals having cementitious qualities.

It is recommended that the fly ash materials be dry pumped to the disposal area or hauled in covered trucks at 3% moisture to minimize dusting. At the disposal site, the material may be stored in protected areas or immediately placed in its final position with additional spreading and compaction. If hauled to the disposal site in open trucks, the fly ash should be uniformly moistened to a 3% moisture content prior to loading to minimize dusting during transport.

At the disposal site, it is recommended that the Alma Units 1-5 not be disposed of routinely by itself. It should be mixed with the fly ash produced from Alma Unit 6 at some minimum percentage to improve its overall stability. It appears that the addition of lime to the Alma Units 1-5 fly ash results in very slow setting, but a hard stable end product.

Because of the favorable physical properties encountered at both low and high moisture contents, either of two disposal methods are possible for the Alma Unit 6 and the 60/40 ash mixture. The methods are: 1. Compaction at low moisture contents with the fly ash at an earth-like consistency and/or 2. The ponding of a fly ash slurry.

The low moisture content disposal method involves end dumping the fly ash from trucks, leveling the ash piles, wetting the fly ash and compacting with additional wetting as necessary. The leveled thickness of each lift of fly ash may be 3'. After leveling the ash, a sufficient quantity of water is sprayed on the surface to bring the fly ash to optimum moisture. This moisture content should be 10 to 13% for the Alma Unit 6 fly ash and 16 to 19% for the 60/40 ash mixture, although it is not critical. Moisture contents above 15 and 20%, respectively, may cause more difficult handling conditions until setting is underway.

Because of the low support capability of the moistened fly ash, a crust should be allowed to form before using the compaction equipment. This compaction and possibly final leveling should be done with large rubber-tired dozers.

If the fly ash is to be used as a lining material, it is recommended that the ash be placed and compacted in a 3' thickness. This layer should then be quickly covered with a 5 to 10' lift of fly ash by standard disposal procedures. This will provide the best conditions for low permeability in prevention of shrinkage cracks. It is also recommended that this work be performed with the air temperatures in the range of 35 to 50° F.

The slurry method of disposal, in general, involves the preparation of retaining structures at the site, mixing water with the fly ash at the site and pumping to the location of final placement. The location where water is mixed with the fly ash should be as close as possible to the area where final end placement will occur. Minimizing the transportation distance and time between the addition of water and final placement will allow disposal of the slurry at minimum moisture contents and eliminate the necessity for collection and handling of excess water. A wide range of moisture contents (30-60%, dry weight basis) appear to exist whereby the fly ash exhibits a slurry consistency and absorbs all moisture in the hydration reactions. Because of the lack of significant hardening of the Alma Units 1-5 fly ash, it is recommended that this ash not be disposed of by itself in a slurry consistency.

At the disposal site, the fly ash should be thoroughly blended with 60% water to form a slurry suitable for pumping. At the 60% moisture content, the Lansing Unit 4 of the 60/40 ash mixture should allow for 10 to 15 minutes of placement time before difficulties are encountered in pumping. Beyond this time, the fly ash becomes increasingly viscous and hardening occurs within about 20 minutes. At 60% moisture, no excess water is anticipated. In the event that excess water should appear within the disposal area, it is recommended that this water be retained within the structure and used for subsequent disposal operations.

Due to the hardening characteristics of the Alma Unit 6 fly ash and the 60/40 mixture, disposal of the Alma 6 ash individually or blending with Alma Nos. 1-5 would be the preferred disposal method from the standpoint of minimizing chemical leaching. The extremely low permeability of this ash ($10^{-9}$ cm./sec.) is such that the generation of leachate from infiltrating surface water is not anticipated with maintenance of proper slopes to promote runoff. Moreover, the durability of this ash to erosion appears to be substantially greater than natural soils of comparable grain size distribution. Should it become necessary to dispose of Alma Units 1-5 ash individually for short periods, we recommend that the Alma Units 1-5 ash be contained within berms of the Alma Unit 6 or 60/40 ash mixture, followed by a layer of 60/40 on top.

The recommended procedure for disposal of runoff wastewater from the site would be re-use of this water for either dust control or raising the moisture content of the fly ash to initiate its pozzolanic activity and hardening reactions. Due to the appearance of several trace metals in significant concentrations, the discharge of runoff to surface and groundwaters is discouraged.

Groundwater quality monitoring of the disposal site should be concentrated in areas under and down gradient of the ash fill area to establish the immediate impact of the site on local water quality. Suction lysimeters would be useful to obtain samples in the unsaturated zone above the groundwater table. Parameters which should be monitored routinely at all well locations would include calcium, sodium, potassium, sulfate, total and phenolphthalein alkalinity, chloride, aluminum and silica. Trace elemental analyses should include boron, strontium, and those parameters which are listed as drinking water standards.

**Supplemental Fly Ash Characterization Report. Fly Ash Conditioning with Low Moisture Content. Alma Madgett Generating Station Units 1-6. Dairyland Power Cooperative Alma, Wisconsin. November 1980. Prepared by Warzyn Engineering, Inc.**

SUPPLEMENTAL FLY ASH CHARACTERIZATION REPORT
FLY ASH CONDITIONING WITH LOW MOISTURE CONTENT
ALMA MADGETT GENERATING STATION
UNITS 1 THROUGH 6
DAIRYLAND POWER COOPERATIVE
ALMA, WISCONSIN
C 8181

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November 26, 1980
C 8181

Dairyland Power Cooperative
2615 East Avenue South
LaCrosse, WI 54601

Attention: Mr. Dan Crady

Re: Supplemental Fly Ash Characterization Report
Fly Ash Conditioning with Low Moisture Content
Alma Madgett Generating Station
Units 1 through 6
Dairyland Power Cooperative
Alma, Wisconsin

Gentlemen:

As requested, we have performed physical tests to determine general characteristics for handling and disposal purposes on samples of low moisture conditioned fly ash representing mixtures of JPM No. 1 fly ash and Alma No. 1 through No. 5 fly ash. This report supplements earlier reports dated October 12, 1979 and September 3, 1980.

This work completes the requested physical and chemical testing. We recommend that larger scale tests be performed to establish the most suitable equipment types for use in the full-scale ash conditioning operation.

Thank you for your cooperation in this investigation. If you have any questions, please do not hesitate to contact us.

Very truly yours,

WARZYN ENGINEERING INC.

Clifton E.R. Lawson / ww

Clifton E.R. Lawson, P.E.
Principal/Chief Materials Engineer

CERL/dkp
[WEI-4-1]
(6 copies)
cc: Stanley Consultants (3 copies)
Mr. Pat Mullin

SUPPLEMENTAL FLY ASH CHARACTERIZATION REPORT
FLY ASH CONDITIONING WITH LOW MOISTURE CONTENT
ALMA MADGETT GENERATING STATION
UNITS 1 THROUGH 6
DAIRYLAND POWER COOPERATIVE
ALMA, WISCONSIN

## INTRODUCTION AND SYNOPSIS

The basic report in this series dated October 12, 1979, entitled "Fly Ash Characterization Study" described the general physical characteristics of a specific mix of fly ash to be produced at the Alma Station. In that report, 60% of Alma Unit No. 6 (JPM No. 1) fly ash was mixed with 40% of fly ash from Units No. 1 through No. 5. Both the low moisture physical properties and some of the high moisture physical properties were described in the earlier report.

Later, it was apparent that other percentage mixtures of fly ash might be produced and disposed of at this plant, either as a high moisture slurry or as a slightly moisture conditioned material.

The original request for determining physical characteristics of fly ash mixes in the slightly moistened condition, that is, the "conditioned" state, was given to our firm in the spring of 1980. The work in the laboratory commenced shortly thereafter, but soon was interrupted by a change in priorities, requiring that the slurry states be given immediate investigation, including determining retarder effects.

It was found that the rapid setting of the mixes, due to high calcium content, required the use of retarders. Therefore, the report dated September 3, 1980, specifically addressed itself to determining the amount and type of retarder most suitable for facilitating the handling and disposal of fly ash in a slurry state.

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After the slurry work was completed, Dairyland Power Cooperative decided to continue the physical tests on the conditioning treatment, and it is this work that is reported herein.

Different fly ash sample sources were used from time to time, due to no JPM fly ash being available in the early stage of the investigation and difficulty in obtaining adequate sample amounts from one source. This apparently did not affect the results, but did require some check tests to verify sample similarity.

The general fly ash conditioning program was directed towards determining the mixing and handling characteristics of broadly different percentages of JPM No. 1 mixed with Alma No. 1-5 fly ash. The main observation emphases were on the basic physical characteristics dealing with: resulting dust produced, density, compressive strength and permeability characteristics of the mixes. Various delay times between conditioning and physical testing were incorporated into the testing program to simulate interim storage in a conditioned stock pile, followed by subsequent transportation and compaction in a landfill.

In summary, it was found that low moisture (5 - 15%) conditioning of fly ash will reduce the potential for dust at least tenfold, but it will not eliminate it (with the conditioning methods used in this study).

The resulting compacted densities, strengths and permeabilities of the compacted mixes appear to be very suitable for landfill disposal. The permeability information shows that it is necessary to have a large fraction of the final mix composed of high calcium fly ash, such as JPM No. 1, in order to keep permeability at a low level generally suitable for landfill liner purposes.

It would appear from this study that it is necesary to experiment with bench scale mixer models, at least 1/10 of full scale, to determine the machinery type most suitable for blending of low moisture with the fly ash, both to minimize the dust potential, and to minimize problems in the handling of the material.

## MATERIALS TESTED

### A. High Calcium Fly Ash

Initial physical tests were performed using on-hand stocks of Lansing Unit No. 4 high calcium fly ash, as was used in the basic report dated October 12, 1979. These stocks soon ran out and another high calcium fly ash from Neal Unit No. 4 (Iowa Public Service) was utilized for the bulk of the study. It was necessary to add 8%, by weight, of a dolimitic quick lime to this fly ash to duplicate the rapid setting characteristics of the Lansing No. 4 fly ash in slurry form. Both the Lansing No. 4 and Neal No. 4 fly ash samples were considered "not fresh".

In June of 1980, the first samples of JPM No. 1 fly ash became available. Initial setting tests were performed on this fly ash, indicating it would set considerably more rapidly than earlier materials tested. Larger stocks became available after July 10, 1980. Noting the considerably more rapid setting characteristic of the fresh JPM No. 1 fly ash, Dairyland Power Cooperative decided to duplicate some of the already completed conditioning tests, using JPM No. 1 fly ash including set retarder in the mix water. The purpose of these check tests was to verify that the earlier work fully represents JPM No. 1 properties. Fortunately, the check tests show that most of the earlier test work is valid, probably because the fly ash types are from the same coal source (Belle Ayre) and similar boiler

types. The variation in setting rates between old and fresh fly ash is believed to be due to the effects of atmospheric carbon dioxide combining with the free calcium in the older fly ash, somewhat slowing the rate of setting that otherwise occurs in fresh fly ash.

B. Retarder

The fresh high calcium JPM No. 1 fly ash was found to set and harden so rapidly after conditioning, that a set retarder was considered necessary for this method of disposal. Therefore, a set retarder was utilized for all physical tests with this material. Based upon the earlier report, dated September 3, 1980, it was decided to use 1%, by weight, of sulfite liquor, based upon the total dry weight of fly ash. Since the sulfite liquor was furnished at 57% concentration, approximately 2% of this liquid was added to the conditioning water. Please note, the percentage of retarder added was based upon the total weight of combined fly ash types, not the amount of high calcium fly ash in the mix.

C. Low Calcium Fly Ash

The first part of the test work utilized a mix containing low calcium fly ash from Alma Units No. 1-5, as furnished for the basic study reported on October 12, 1979. This supply ran out quickly.

Most of the study then utilized an Illinois coal fly ash obtained from commercial sources of concrete admixture suppliers, since the Alma No. 1-5 fly ash was not available. After July 10, 1980, low calcium fly ash was again available from the Alma plant, but it consisted of only an approximate mix, compared to ultimate production ratios of Units 1 through 4. There was no fly ash available from Unit 5. Results of tests do not appear to be affected by these changes in sources for low calcium fly ash.

D. Mix Ratios

In accordance with the instructions of Stanley Consultants, the design engineers for the project, mix ratios of the high calcium fly ash to the low calcium fly ash, expressed as a ratio, were varied between 10/90 and 100/0, respectively. The ratios initially considered were 10/90, 20/80, 40/60, 60/40, 80/20, and 100/0. Later in the program, it became apparent that 30/70 is a more probable final mix ratio that would be in the disposal site. Thus, some of the final tests were performed using this mix ratio also.

## LABORATORY PROCEDURES FOR PHYSICAL TESTS

A. Moisture Conditioning Procedure

In the spring of 1980, under the general direction of Stanley Consultants, various types of laboratory mixers were experimented with on a laboratory scale to determine which method would be most suitable for thoroughly blending low moisture percentages with high calcium fly ash. The method of water application was found to be very important in properly distributing it with the fly ash sample. It was found that bulk-placing water in the fly ash, by pouring it directly into the fly ash, was not satisfactory due to the rapid uptake of the moisture in local zones of fly ash only. It was very difficult to then distribute this moisture to the rest of the dry fly ash. Apparently, hydration (chemical reaction of the water with the calcium oxide) occurs rapidly and, for all practical purposes, takes a considerable portion of the moisture into chemical combination so that it is not available for moistening purposes. Also, the rapid development of adhesive characteristics in the moist fly ash causes great difficulties in blending the zones of high moisture fly ash in with the dry fly

ash. The high moisture portions of the fly ash adhere tenaciously to the tools and the container. Considerable mechanical effort is required to keep tools clean and distribute this pasty, moist section of fly ash.

Conventional blenders (food blenders) were found to be inadequate, since the slightly moistened material clung to on the side of the container and no longer was in contact with the propeller blades. Hand mixing with spoons was found to be quite time consuming, not uniform, and generally not suitable for test reproducibility.

It has been our observation that the moisture conditioning of high calcium fly ash, into a state similar to moist earth, not so wet as to cause a slurry, requires dynamic break-up of the fly ash clumps and wiping of the mixing parts against each other. Therefore, we developed a small laboratory ball-mill using a small power concrete mixer. A five-gallon plastic pail was inserted into the throat of the concrete mixer to serve as the container for the mixing operation. One inch by one inch angle irons were bolted to the inside of the plastic pail (3) on a diagonal to the axis. Three steel ball bearings, 1 1/4" diameter, were also placed in the container. The angle of the axis upon which the container rotated was adjusted so that the steel ball bearings would be carried up the sides of the container on the angles and dropped partway along the sides, so as to provide maximum pulverization of moist fly ash clumps and dynamic cleaning of the mixer interior. Speed of rotation was approximately 40 rpm.

A plastic cover was snapped on the top of the container, after fly ash was placed therein. A 1" diameter hole in the center of the cover permitted the injection of water. The water was added using a conventional paint sprayer, providing a fine mist, as the mixer was rotating. All of

the water generally could be added within the first minute of operation. Ten pounds of fly ash was used with each batch and mixing time was five minutes, except for certain mixes, as noted, that ran somewhat longer, due to apparent non-uniform blending in five minutes.

The general observations of dust coming from the moisture injection hole, stickiness of the mix within the mixer and general difficulty or ease of sample removal has been recorded in the laboratory notes. These notes are summarized in the figures, provided with this report.

B. Dust Potential Test

Using the basic recommendations of ASTM Test Designation D 2009-65, a drop-test procedure was developed to provide a consistent handling scheme to intentionally develop air-borne dust within a container. This air-borne dust was then drawn off by vacuum and collected on filter paper, which was subsequently weighed to determine the dust amount. The general configuration of the test apparatus and procedures are shown on Figure C 8181-A44.

C. Setting and Hardening

The low moisture conditioned fly ash was generally in an earth-like consistency after the mixing. A portion of this was placed in a plastic container and observed for general hardening action, utilizing the pocket penetrometer device fitted with a 16 square centimeter base attachment. Readings were taken with this penetrometer periodically after mixing, as was temperature (where a temperature rise appeared obvious). This setting test is not a precise measure of set, since there is a certain amount of natural shear strength available within the low moisture conditioned fly ash that affects readings. In particular, after moisture is added, a capillary attraction takes place between particles, somewhat masking the hardening that is also occurring. A general increase of penetrometer reading with time was noted in most tests.

The approximate set time and then one or two near final readings are recorded in the figures attached hereto, showing something of the general rate of hardening that occurs. No attempt is made to document exact rate of setting.

D. Densities

Densities of the freshly-mixed low moisture fly ash were obtained approximately 10 minutes after removal from the mixer. Compacted density was obtained by compacting the freshly conditioned fly ash into a Proctor mold according to Modified Proctor procedure (ASTM D 1557) with no additional moisture added. Loose density was measured by lightly tamping the mix into a container by hand to duplicate approximate density that would occur in a truck.

One series of tests permitted the moisture conditioned fly ash to remain in a loose (covered to prevent moisture loss) condition for four hours prior to compaction. In this case, no additional moisture was added. This was intended to duplicate storage in stock pile prior to compaction.

However, one of the early tests at the start of the basic program in 1979, as well as tests for delayed compaction for permeability, permitted longer delays in the stock pile, followed by compaction to achieve maximum density. In this case there was so much loss of moisture due to hydration action that more moisture was required prior to compaction, as one would do for many soil types.

E. Permeability

Permeability testing was performed by first compacting freshly conditioned fly ash, at the available moisture condition in the Proctor mold, followed by a seven day moist curing. Thereafter, conventional falling head permeability tests were performed. The length of time for

these tests varied from two weeks to six weeks, depending upon results observed. In some cases, swelling of the test mixes occurred for the first few weeks, followed thereafter by a drop in the falling head readings. These special conditions are noted on the lab test summary figures attached hereto.

F. Compressive Strength

It was not possible to use any of the permeability samples for compressive strength, as had been planned when the work program was established, due to the damage that occurred to samples in removing them from the molds. Therefore, separate 4" diameter samples were compacted in the Proctor molds, immediately ejected and then cured in a moist condition for seven days. Compressive strengths were determined in a compression test machine, without use of leveling caps.

G. Miscellaneous Tests

When JPM No. 1 fly ash was being tested, 1% of the total fly ash weight of sulfite liquor retarder was used. To determine the general effect of lesser retarder percentages, one series of mixing ease, setting and hardening tests was performed at varying retarder percentages on three different ratios of high calcium to low calcium fly ash. The time for initial setting was recorded for this test program.

Loose and maximum densities of the Neal No. 4 fly ash were also performed with no lime added to the fly ash, to determine if the lime addition affected densities.

Varying of blending time, as originally described in our proposed program letter of February 8, 1980, was not generally performed. It was found that blending time short of that required to produce a uniform blend resulted in obviously unsatisfactory conditioning of the fly ash. Excessive

dust, lumping, sticking of the wet fly ash to the mixer, etc. were such obvious problems that it was decided not to investigate variation of blending time in this investigation. It was concluded that excessive dust would occur if there is non-uniform blending of the moisture with the fly ash.

## DUSTING POTENTIAL TEST RESULTS

See the attached Figures C 8181-A45 through A48. The results of the dust potential tests, according to the procedure described earlier in this report, are summarized on these sheets. Two tests were performed without any moisture addition, one on the Alma No. 1-5 fly ash and the other on the Neal No. 4 with 8% quick lime, as shown on C 8181-A45. These results also should be compared to the 5% moisture conditioning results on Figure C 8181-A47, which show the dust potential test for JPM No. 1 with 1% retarder after 24 hours of delay in performing the test. Moisture absorbed by hydration, for all practical purposes, dried the 5% moisture mixes so that considerable dusting occurred. The general range of dust collected for the zero moisture content fly ash and the 5%, 24 hour delay test should be considered as a base reference when comparing the dust potential tests for other moisture contents and mixes of fly ash.

In summary, the Neal No. 4 fly ash with 8% quick lime at various mixtures with Alma No. 1-5, as well as the JPM No. 1 with 1% retarder in various mix ratios, show approximately the same degree of dust reduction when conditioned. These tests also show at least a tenfold reduction in air-borne dust with low moisture conditioning. The wide scatter of test results cannot be explained. It is felt that the test is very crude, and

only a general order of magnitude for accuracy of results is expected. Even with this general order of magnitude of results, it is apparent that dust reduction by the addition of 5, 10 or 15% moisture is roughly the same for any of the mixes or moisture contents.

It is apparent that 5% moisture conditioning is not adequate if the JPM No. 1 with 1% retarder fly ash mixes are held in a stockpile for 24 hours. However, the 10 and 15% moisture conditioning appears to be reasonably effective, 24 hours after conditioning. This slight difference is explained by the loss of free moisture to hydration of the calcium oxide in the reactive fly ash. It is interesting to note the changing percentage of high calcium fly ash in the mixes did not seem to have a noticeable effect on the outcome of the dust potential test, immediately or after 24 hours of delay.

In summation, this test series indicates air-borne dust (when dropped) can be considerably reduced, but not eliminated, if the fly ash and moisture are blended in a manner similar to the laboratory mixing. Our experience indicates the success of blending the moisture with the fly ash is very sensitive to many factors. Therefore, it is considered feasible to construct a blender that will reduce the air-borne dust potential considerably more than the reduction achieved by the method utilized in the laboratory investigation. Whether a practical, economical full-scale mixer can be built is another matter.

It is evident from this test work that JPM No. 1 fly ash does require a retarder in the conditioning water to prevent rapid set.

## HANDLING OBSERVATIONS

During the blending of low moisture with the fly ash mixes and thereafter, in the setting and hardening tests, as well as other tests requiring conditioned fly ash, observations were made regarding general handling characteristics of the conditioned fly ash. As hardening, or setting took place, generally measured with the pocket penetrometer, notations were made, and then summarized on Figure C 8181-A49 through A52. These sheets include measurements of temperature rise above room temperature. The temperature readings shown indicate the maximum measured temperature rise, which generally was measured somewhat after the first indication of setting. Arbitrarily, a pocket penetrometer reading of 0.05 tons per square foot (plus or minus) was utilized to determine the time for inital set. This is not necessarily related to any standard setting test, but indicates the early obvious beginning of hardening.

### A. Mixing

Observations during mixing indicate no significant relationship between moisture content and mixing problems other than 5% moisture appears to have somewhat more dust problems than the 15% moisture content. Also, more sticky conditions, lumpy conditions, etc. were observed at the higher moisture content mixes.

The mixes containing highest calcium, that is the 80/20 or the 100/0 mixes, tended to show more temperature rise (and more rapid setting and hardening, although not universally so) than the mixes with lower calcium content. Apparently, the added lime in Neal No. 4 fly ash is required to speed up set (in lab tests) of slurries, but the added lime has little effect in conditioning laboratory tests in the low moisture (5-15%) range.

Observations of the mixing show that the full scale mixer operation should provide moisture to the fly ash in a fine spray, with the ability to contact each fly ash particle, without the need for significant mechanical blending to transfer the moisture from particle to particle. If the moisture is applied too rapidly, resulting in excessive moisture in small zones, clumps develop. These clumps will stay this way, unless mechanically broken up. It appears that the fly ash, of its own weight and impact in a rotary mixer, will not adequately break up clumps. This is why a ball mill or other positive blending device with impact appears to be required.

The mixer must be totally enclosed so that free dust is not likely to escape before it contacts the moisture.

A moisture content somewhat higher than 15% could be considered for conditioning provided a running slurry does not develop. In some cases (in previous test work) 20% moisture was too low to create a slurry, yet may be adequate for creating a soil-like conditioned situation.

B. Hardening Characteristics

Whether the high calcium fly ash is Neal No. 4 with 8% lime, Neal No. 4 with no lime added, or JPM No. 1, hardening takes place gradually after conditioning. The exception is the high moisture JPM No. 1 blends, which require set retarder to prevent immediate set accompanied by rapid temperature increase and what is considered to be excessive hardening after one hour or thereabouts. The retarded JPM No. 1, and other high calcium fly ash mixes, apparently tend to remain sufficiently uncemented that they can be handled with earth-moving equipment within approximately one day of the conditioning, provided the mixes are not compacted.

Figure C 8181-A52 shows an experiment with JPM No. 1 fly ash and three different mix ratios with a variation in the percentage of retarder used. It is apparent that approximately 0.10% of retarder is suitable for the 10/90 mixes, whereas approximately 0.5 to 1% retarder is needed for the 100/0 mix (100% JPM No. 1 fly ash). In effect, the percentage of retarder required for properly conditioned mixes is similar to the percentage retarder required for slurries. From the previous tests with slurries, it is also probable that high temperature fly ash conditioning requires even greater percentage retarder to avoid the rapid set and hardening that is characteristic of the higher temperature fly ash.

Data available from Figure C 8181-A55, for the Lansing No. 4 fly ash without a retarder, in a large sample (30 pounds), shows significant temperature rise can occur inside this conditioned material, taking approximately 4.2% of the moisture by hydration in the first hour. Fresh JPM No. 1 fly ash is expected to be even more active than the Lansing No. 4 shown on this Figure. Thus, a retarder is considered necessary to slow the hydration rate and thus slow the rate of set.

C. Summary of Handling Observations

Successful conditioning of fly ash requires a special mixer, possibly of a design not yet available on the market. However, when adequately blended, the conditioned fly ash, at any ratio of high calcium to low calcium, can be conveniently handled within a period of 24 hours after conditioning, perhaps more, depending upon retarder percentage used.

A general interpretation of the test data indicates that approximately 1% sulfite liquor is required for conditioning, as measured against the proportion of JPM No. 1 fly ash in the mix. Again, this is a room

temperature requirement. Use more retarder at high temperatures (and less at low temperatures) to reduce the hardening rate and thus permit convenient handling.

## DENSITY TEST RESULTS

Both loose densities and compacted densities were determined, as described earlier herein. The test data is summarized on Figures C 8181-53 through 55. Modified Proctor Compaction Method (ASTM D 1557) is used for determining maximum density, except as noted.

By reviewing the data in the referenced sheets, it is apparent that by increasing percentages of high calcium fly ash, both the loose densities and the compacted densities increase. Moisture content does not seem to have a significant effect in either the loose or compacted densities. There are some variations in maximum densities achieved, probably due to hydration effects removing the available water that otherwise would be usable for lubrication during compaction. Thus, the maximum densities shown should be considered the general range only.

Neal No. 4 fly ash appears to develop roughly the same loose or compacted densities whether or not quick lime is added.

The 48 hour delayed compaction work, Figure C 8181-A55, shows slightly lower compacted densities, than would be achieved without delay, but not significantly so. However, the permeability test performed on a conditioned (15% moisture content) fly ash mix of 60/40 ratio shows roughly the same results as for materials compacted immediately. (See the next section.)

In summary, consider the dry unit weight of fly ash in a conditioned form, when loaded in the truck to be about 30 to 60 pounds per cubic foot, probably averaging 50 pounds per cubic foot. Compacted densities vary from 75 to 125 pounds per cubic foot, probably averaging 105 pounds per cubic foot. Add to these figures the weight of water included.

## PERMEABILITY TEST RESULTS

The results of permeability tests are shown on Figures C 8181-A56 and A57. These tests are on compacted specimens using mixes of Neal No. 4 with 8% lime (as the high calcium fly ash) and Illinois fly ash (as the low calcium fly ash). Check tests using mixes of JPM No. 1 with 1% retarder also are shown.

The data sheets show the densities to which the specimens were compacted prior to the permeability test, followed by the densities measured after the permeability test is complete. In some cases, swelling occurred during the testing. However, most of the changes in density were increases, especially when high calcium percentages are included in the mix. These density increases appear to be the result of the chemical combination of water with the calcium (hydration).

It is evident from the test information that permeability of the various mixes decreases with increasing density. This may be an incidental relationship since the test data also show that the permeability decreases with increasing percentage of high calcium fly ash. Related data, for density test results, show that the mixes with a higher percentage of calcium oxide develop higher densities when compacted.

There is no significant difference in permeability resulting from the use of Neal No. 4 fly ash, versus JPM No. 1 fly ash with retarder. Densities using JPM No. 1 fly ash apparently are significanly higher for unexplained reasons.

In order to obtain approximately $1 \times 10^{-7}$ cm/sec permeability, one should have a mix of at least 60/40 of JPM No. 1 fly ash to Illinois fly ash compacted to Modified Proctor Density.

If a delay in compaction occurs after conditioning, as shown on Figure A55, apparently the resulting permeability of the compacted mix is not significantly different than for samples compacted immediately after conditioning.

## COMPRESSIVE STRENGTH TEST RESULTS

Figure C 8181-A55 summarizes compressive strength tests performed on various mixes and conditioning moisture contents using JPM No. 1 fly ash with 1% retarder as the high calcium fly ash. Compaction was according to Modified Proctor Method, ASTM D 1557.

The compressive strengths after seven days of curing are considerably stronger than those obtained using slurries mixed at higher moisture contents (see Report dated September 3, 1980).

Compression test results compare roughly with earlier compression tests using Lansing No. 4 fly ash and Alma No. 1-5 fly ash mixes at 21% moisture content. However, earlier, Lansing No. 4 fly ash, when compacted, yielded somewhat higher compressive strengths than those obtained with 100% JPM No. 1 fly ash.

General order of magnitude of compressive strengths developed with compacted conditioned fly ash mixes increase with increasing percentage of high calcium fly ash in the mix. Moisture content differences do not appear to be important.

## EFFLORESCENCE OBSERVATIONS

Efflorescence, on samples that have been exposed to the atmosphere for a considerable period of time after conditioning, but not exposed to any additional water, was generally non-existent in the series of tests reported in this study. The low availability of free water in these mixes is believed to be the major reason for the lack of efflorescence.

## CONCLUSIONS AND RECOMMENDATIONS

In summation, low moisture conditioning produces an earth-like fly ash mix which has reduced potential for dust by an order of magnitude (i.e., a ten-fold reduction). The moisture conditioning, by the methods utilized in the laboratory, does not fully eliminate the dust potential. It is considered probable that better blending methods can be developed which would further reduce the air-borne dust by more thorough blending of moisture with the fly ash. Partial blending of moisture with fly ash results in a dust potential almost as severe as if no conditioning whatsoever were attempted. Thus, emphasis on thorough blending of the moisture with the fly ash is a prime finding of this investigation.

From our observations, it would appear that the blending equipment requires complete enclosure, with moisture application in fine mist form impinging directly upon the individual fly ash particles and further moisture distribution by mechanical mixing being kept to a minimum, since

it is difficult. The moisture apparently adheres tenaciously to the particles it initially contacts. Transferring this moisture to other fly ash particles is very difficult. The mixer definitely requires impact or mechanical scraping to accomplish this blending. Merely dumping the fly ash around and around in a drum mixing device, such as a concrete mixer, is not considered suitable for low moisture content ash conditioning. The machinery required should have a blending capability similar to a rod or ball mill.

The completely conditioned fly ash produces slight dust if it is not dropped free-fall. Therefore, the handling equipment should be designed with a minimum of free-fall of the fly ash in transfer. Belt conveyors, both up and down, might be considered, as well as vibrating chutes, or augers encased in split housings.

Little hardening is expected of consequence if the conditioned fly ash is not compacted. It is always possible that conditioned fly ash may receive an excessive (accidental) amount of moisture during the mixing or transfer operation resulting in severe hardening, similar to weak concrete. Therefore, all equipment must be capable of ready disassembly and jack hammer removal of hardened fly ash. Redundancy is recommended.

Significant amounts of energy are required for adequate laboratory blending. We recommend that model mixers, roughly 1/10 full-scale, be tested for suitability, with energy measurements scaled upward to the full-scale design size. It appears that the difficulty of combining moisture with dry fly ash from the dampened zone of fly ash will take much more energy than for a conventional concrete mix of the same weight.

The end product after low moisture conditioning, an earth-like material, is readily handled in conventional earth-moving equipment and probably requires only a minimum of dust protection, such as canvas covers over dump trucks. When compacted to near maximum density, very low permeabilities can be created with the freshly conditioned fly ash. If a delay of one day or more is involved between the mixing and the compaction, it will be necessary to add some moisture at the disposal site to facilitate compaction. Resulting density, strength and permeability will be similar to the freshly compacted conditioned fly ash.

Long delays between the ash conditioning mixing and compaction also will require addition of moisture to the fly ash to minimize dust problems, due to the loss of moisture by hydration combining of water with calcium oxide. It is recommended that a water distribution truck, or hose, be available at the disposal site to wet down loose fly ash areas to minimize the air borne dust picked up by wind.

In summary, low moisture conditioning of fly ash, if accomplished with adequate blending equipment, appears to have merit for creating a material that can be handled in a manner similar to damp earth. The high calcium fly ash does not set significantly within 24-48 hours (uncompacted) provided adequate percentages of retarder are used with JPM No. 1 fly ash.

Respectfully submitted,

WARZYN ENGINEERING INC.

Clifton E.R. Lawson/ww

Clifton E.R. Lawson, P.E.
Principal/Chief Materials Engineer

CERL/dkp
[WEI-4-1]

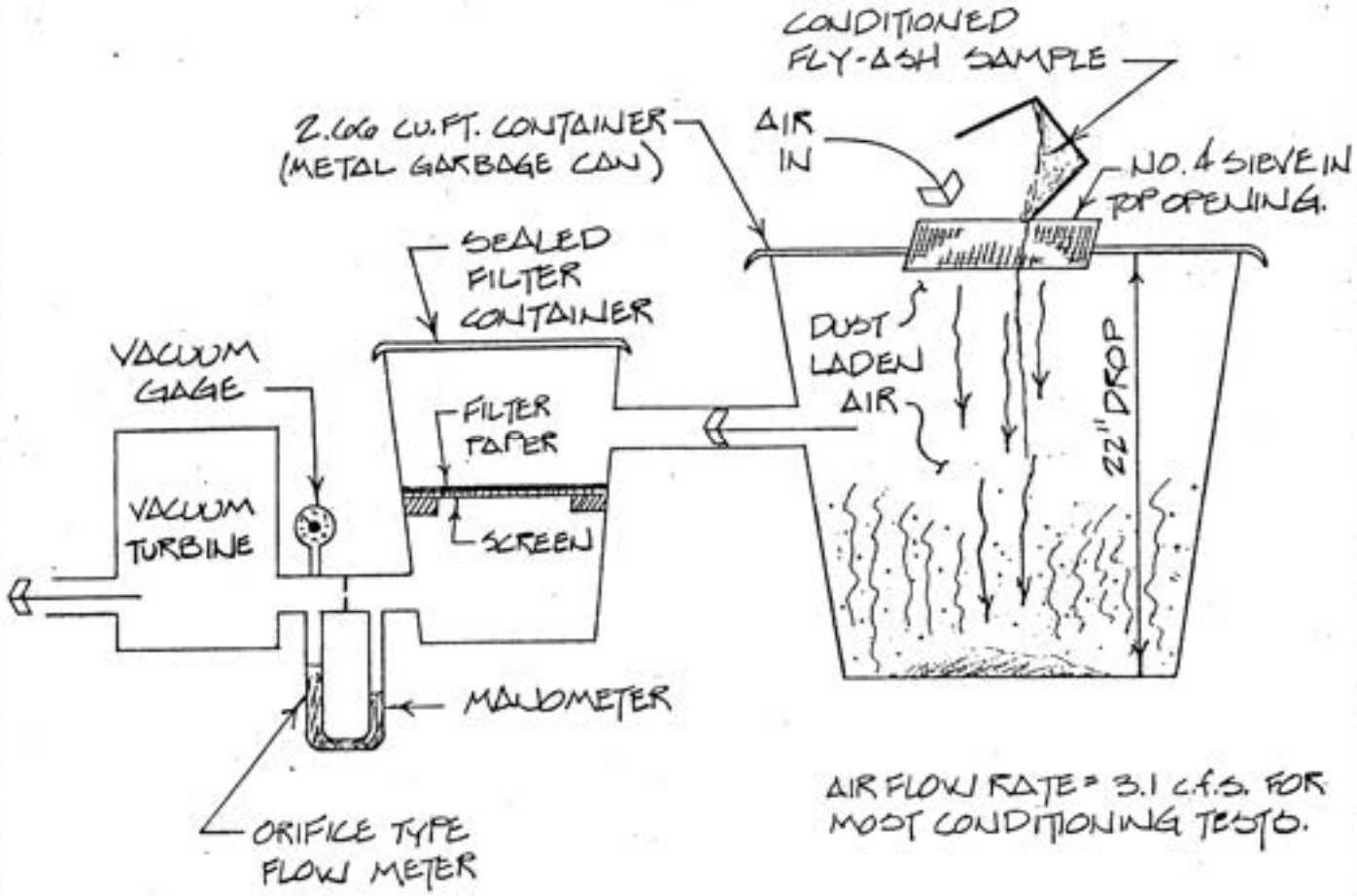
WARZYN
ENGINEERING INC

# FLY ASH

## DUST POTENTIAL TEST APPARATUS

(AFTER ASTM METHOD D 2009-65)

- 1/30 CU.FT. OF MOISTURE CONDITIONED FLY ASH IS POURED INTO CONTAINER THROUGH SIEVE.
- AIR DRAWN OFF FOR 10 SECONDS.
- FILTER PAPER COLLECTS ALL AIRBORN FLY ASH.




AIR FLOW RATE = 3.1 c.f.s. FOR MOST CONDITIONING TESTS.

| | | | | |
|---|---|---|---|---|
| WARZYN ENGINEERING INC | DUST POTENTIAL TEST APPARATUS<br>JPM #1/ALMA #1-5 LOW MOISTURE CONDITIONING<br>ALMA MADGETT STATION<br>DAIRYLAND POWER COOPERATIVE | | | |
| DWN JDP | CHK'D CL | APP'D Wm. W. Wuelle | DATE 11-6-80 | CB181-A44 |

FLY ASH CONDITIONING WITH LOW MOISTURE CONTENT

TEST SERIES

IMMEDIATE DUST POTENTIAL

WESTERN ASH TYPE

Neal #4 w/8% Lime

| MIX RATIO | MOISTURE CONTENT (%) 5 | 10 | 15 |
|---|---|---|---|
| | Weight of Dust Collected From Dropping 1/30 Cu.Ft. Freshly Conditioned Fly Ash Mix, Grams. Drop Height = 22 inches. | | |
| 0/100 (Alma #1-5) | 6.1911 Grams at Zero Moisture Content | | |
| 100/0 (Neal #4 w/8% Lime) | 1.1969 Grams at Zero Moisture Content | | |
| 10/90 | 0.3132 | 0.06910,0.3523 *0.2452 | 0.1721 |
| 20/80 | 0.0891 | 0.5980 | 0.2413 |
| 40/60 | 0.1216 | 0.0861 | 0.3875 |
| 60/40 | 0.2347 | 0.111 *0.3316 | 0.1797 |
| 80/70 | 0.4719 | 0.0328 | 0.2028 |
| 100/0 | 0.1597 | 0.0488 *0.3718 | 0.2034 |

REMARKS:

For Neal #4 Without Lime, See C 8181-A48

See Figure C 8181-A44 For Diagram For Test Set-Up.

* For JPM #1 Fly Ash Without Retarder.

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Figure C 8181-A45

WARZYN ENGINEERING INC

FLY ASH CONDITIONING WITH LOW MOISTURE CONTENT

TEST SERIES

IMMEDIATE DUST POTENTIAL

WESTERN ASH TYPE

JPM #1 w/8% Retarder

| MIX RATIO | MOISTURE CONTENT (%) 5 | 10 | 15 |
|---|---|---|---|
| | Weight of Dust Collected from Dropping 1/30 Cu.Ft. Freshly Conditioned Fly Ash Mix, Grams. Drop Height = 22 inches. | | |
| 10/90 | 0.1386 | *0.2452 | 0.3021 |
| 30/70 | | No Reading but Minor Dust Observed | |
| 40/60 | 0.0699 | *0.3516 | 0.0829 |
| 100/0 | 0.7436 | 0.5885<br>*0.3718 | 0.0140 |

REMARKS:

* For JPM #1 Fly Ash Without Retarder.

See Figure C 8181-A44 for Diagram for Test Set-Up.

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Figure C 8181-A46

WARZYN ENGINEERING INC

FLY ASH CONDITIONING WITH LOW MOISTURE CONTENT

TEST SERIES

DUST POTENTIAL 24 HRS. AFTER CONDITIONING

WESTERN ASH TYPE

JPM #1, w/1% Retarder

| MIX RATIO | MOISTURE CONTENT (%) 5 | 10 | 15 |
|---|---|---|---|
| | Weight of Dust Collected From Dropping 1/30 Cu.Ft. 24 Hr. Old Conditioned Fly Ash Mix, Grams. Drop Height = 22 inches. | | |
| 10/90 | 4.8257 | 0.3121 | 0.2362 |
| 20/80 | 5.0137 | 0.4243 | 0.4866 |
| 40/60 | 5.4359 | 1.5309 | 0.5034 |
| 60/40 | 2.9999 | 1.2261 | 0.2668 |
| 80/20 | 6.9787 | 0.4905 | 0.2166 |
| 100/0 | 4.8750 | 0.6492 | 0.1951 |

See Figure C 8181-A44 for Diagram for Test Set-Up.



Figure C 8181-A47

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ENGINEERING INC

FLY ASH CONDITIONING WITH LOW MOISTURE CONTENT

TEST SERIES

IMMEDIATE DUST POTENTIAL

WESTERN ASH TYPE

Neal #4, No Lime Added

| MIX RATIO | MOISTURE CONTENT (%) 5 | 10 | 15 |
|---|---|---|---|
| | Weight of Dust Collected From Dropping 1/30 Cu.Ft. Freshly Conditioned Fly Ash Mix, Grams. Drop Height = 22 inches. | | |
| 10/90 | | 0.3523 | |
| 20/80 | | 0.0777 | |
| 40/60 | | 0.1541 | |
| 60/40 | | 0.1884 | |
| 80/20 | | 0.000 (7 Minute Mix) | |
| 90/10 | | 0.2870 | |
| 100/0 | | 0.0863 | |

See Figure C 8181-A44 for Diagram for Test Set-Up.

Figure C 8181-A48

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WARZYN ENGINEERING INC

FLY ASH CONDITIONING WITH LOW MOISTURE CONTENT

TEST SERIES

MIXING EASE, SETTING AND HARDENING

WESTERN ASH TYPE

Neal #4 w/8% Lime

| MIX RATIO | MOISTURE CONTENT (%) 5 | 10 | 15 |
|---|---|---|---|
| 10/90 | Very Dusty, Poor Mixing<br>Set @ 35 Min.(5°C)<br>24 Hrs. to 0.1 TSF | Dusty, OK Mix<br>35 Min. (2° C)<br>24 Hrs. to 0.5 TSF | Mix OK, Slight Sticky<br>45 Min.<br>4 Hrs. to 0.2 TSF |
| 20/80 | Little Dust, Mix OK,<br>Set @ 25 Min. (10°C)<br>24 Hrs. to 1.25 TSF | Sticky, Poor Mix rate<br>30 Min.<br>24 Hrs. to 1.8 TSF | Mix OK, Slight Sticky<br>15 Min.<br>2 1/2 Hrs. to 0.22 TSF |
| 40/60 | Little Dust Mix OK,<br>Set @ 30 Min.<br>No Reading Final | Good Mixing<br>20 Min. (19°C)<br>24 Hrs. to 2.2 TSF | Mix Ok, Lumpy, Sticky<br>15 Min.<br>24 Hrs. to 0.28 TSF |
| 60/40 | Dusty, Mix OK,<br>Set @ 45 Min. (12°C)<br>5 Hrs. to 1.25 TSF | Good Mixing<br>20 Min. (10°C)<br>24 Hrs. to 3.5 TSF | Mix OK, Lumps, Sticky<br>15 Min. (9°C)<br>1 Hr. to 0.28 TSF |
| 80/20 | Minor Dust, Mixed Well<br>Set @ 45 Min. (18°C)<br>No Final Reading | Good Mixing<br>30 Min. (10°C)<br>2 Hrs. to 0.2 TSF | Good Mix, Slight Sticky<br>5 Min. (18°C)<br>1 Hr.-15 Min. to 0.28 |
| 100/0 | Mixed OK<br>Set @ 30 Min. (16°C)<br>4 Hrs. to 3.0 TSF | Mix OK, But Warm<br>5 Min. (28°C)<br>45 Min. to 1.75 TSF<br>5 Hrs. to 4.5 TSF | OK Mix, But Lumpy<br>5 Min. (16°C)<br>20 Min. to 0.28 |

These mixes for 5 minutes.

KEY: Mixing Conditions
Set Time, (Temp. Rise)
Rate of Hardening

Figure C 8181-A49

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pag

WARZYN ENGINEERING INC

FLY ASH CONDITIONING WITH LOW MOISTURE CONTENT

TEST SERIES

MIXING EASE, SETTING AND HARDENING

WESTERN ASH TYPE

Neal #4 No Lime Added

| MIX RATIO | MOISTURE CONTENT (%) 5 | 10 | 15 |
|---|---|---|---|
| 10/90 | | Mixed Poorly, Some Dry Zones<br>2 Hrs. Set (1°C)<br>19 Hrs. to 0.05 TSF | |
| 20/80 | | Good Mix<br>10 Min. Set (2°C)<br>18 Hrs. to 0.20 | |
| 40/60 | | Good Mix<br>5 Min. Set (6°C)<br>2 Hrs. to 1.7 TSF<br>17 Hrs. to 4.5 + TSF | |
| 60/40 | | Mix OK, Sticks to Mixer<br>5 Min. Set (16°C)<br>1 Hr. to 0.12 TSF<br>16 Hrs. to 4.5 + TSF | |
| 80/20 | | Mix OK, Sticks in Mixer<br>Immediate Set (20°C)<br>15 Min. to 1.5 TSF<br>1 Hr. to 4.5 TSF | |
| 90/10 | | Not Well Mixed, Clumps<br>5 Min. Set (20°C)<br>1 Hr. to 1.0 TSF<br>2 Hrs. to 4.5 TSF | |
| 100/0 | | Lumpy Mix, Sticks In Mixer<br>Immediate Set (25°C)<br>15 Min. to 1.75 TSF<br>40 Min. to 4.5 + TSF | |

These Mixes for 7 Minutes,
Except 90/10 for 5 Minutes.

KEY: Mixing Comments
Set Time (Temp. Rise)
Rate of Hardening

Figure C 8181-A50

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FLY ASH CONDITIONING WITH LOW MOISTURE CONTENT

TEST SERIES

MIXING EASE, SETTING AND HARDENING

WESTERN ASH TYPE

JPM No. 1 w/1% Retarder
(Except as Noted)

| MIX RATIO | MOISTURE CONTENT (%) 5 | 10 | 15 |
|---|---|---|---|
| 10/90 | Mixes Poorly, Sticky<br>1 Hr. Set<br>2 Hrs. to 0.05 TSF | * Mixes Poorly, Dusty<br>45 Min. Set (5°C)<br>2 Hrs. to 0.16<br>Little Change | Mixed OK, Dusty First Min.<br>2 Hr. Set<br>No Final Reading |
| 30/70 | | Mixes Good<br>Set @ 50 Min.<br>4 Hrs. to 0.18 TSF | |
| 40/60 | Dusty While Mixing<br>2 Hrs. Set<br>No Final Reading | * Poor Mixing, Dusty<br>10 Min. Set (20°C)<br>45 Min. to 0.28 | Mix OK, Dusty First Min.<br>30 Min. Set<br>1 Hr. to 0.60 TSF |
| 100/0 | Minor Mixing Prob.<br>5 Min. Set (6°C)<br>1 Hr. 15 Min. to 0.28 TSF | Mixes OK<br>3 Min. Set (6°C)<br>No Final Reading | Poor Mix, Sticky<br>5 Min. Set (3°C)<br>2 Hrs. to 1.0 TSF |
| 100/0 | | * Hard Lumps in Mix, Warm<br>3 Min. Set (34°C)<br>15 Min. to 0.28 | |

These mixes for 5 minutes.

KEY: See C 8181-A50

REMARKS:

*[For JPM #1 Without Retarder]

Figure C 8181-A51

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pag

WARZYN ENGINEERING INC

FLY ASH CONDITIONING WITH LOW MOISTURE CONTENT

TEST SERIES

MIXING EASE, SETTING AND HARDENING

WESTERN ASH TYPE

Variable Retarder, JPM #1 Fly Ash Mix

AT 10% MOISTURE CONTENT (%)
RETARDER, PERCENT OF DRY FLY ASH

| MIX RATIO | 0.05 | 0.1 | 0.5 |
|---|---|---|---|
| 10/90 | 10 Min. Set<br>2 Hrs. to 0.15 TSF<br>17 Hrs. to 2.45 TSF | 20 Min. Set<br>2 Hrs. to 0.16 TSF<br>17 Hrs. to 0.13 TSF | 10 Min. Set<br>1 1/2 Hrs. to 0.18 TSF<br>17 Hrs. to 0.27 TSF |
| 40/60 | Immediate Set<br>1 Hr. to 1.6 TSF<br>16 Hr. to 5.0 TSF | Immediate Set<br>1 Hr. to 1.0 TSF<br>16 Hrs. to 2.4 TSF | 15 Min. Set<br>1 1/2 Hr. to 0.20 TSF<br>6 1/2 Hr.s to 2.4 TSF |
| 100/0 | Immediate Set<br>15 Min. to 2.5 TSF<br>45 Min. to 4.5 TSF<br>1 Hr. to > 4.5 TSF | 5 Min. Set<br>20 Min. to 1.6 TSF<br>30 Min. to > 4.5 TSF | 1 to 2 Hr. Set<br>4 1/2 Hr. to 1.0 TSF<br>6 Hr. to 1.2 TSF |

These mixes for 5 minutes.

KEY: Set Time / Rate of Hardening

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pag

Figure C 8181-A52

WARZYN ENGINEERING INC

FLY ASH CONDITIONING WITH LOW MOISTURE CONTENT

TEST SERIES

DENSITY SUMMARY

(lbs./cu.ft.)

WESTERN ASH TYPE

JPM #1 w/1% Retarder
Neal #4 w/8% Lime

| MIX RATIO | MOISTURE CONTENT (%) 5 | | 10 | | 15 | |
|---|---|---|---|---|---|---|
| 10/90 | 34.5 / 50.0 | 92.9 | 33.9 / 47.0 | [76.4] 76.1 / 98.8 (104) | 30.5 / 49.6 | 96.8 |
| 20/80 | 51.1 | 94.0 | 54.1 | [76.9] 103.6 | 52.4 | 99.9 |
| 30/70 | | | JPM #1 48.3 | 95.5 | | |
| 40/60 | 40.0 / 48.2 | [78.8] / 100.3 | *39.5 / 51.7 | [86.5] 86.5 / 103.1 | 37.2 / 57.2 | [89.0] / 104.6 |
| 60/40 | 49.7 | 101.7 | 53.9 | 102.3 | 59.5 | 106.1 |
| 80/20 | 50.8 | 100.3 | 52.6 | 106.6 | 60.8 | 110.6 |
| 100/0 | 65.4,63.5 / 53.8 | [122.5] / 104.6 | *56.2 / 60.2 / 64.0 | [125.2] 110.0 / 107.7 | 76.7 / 62.7 | [124.7] / 111.4 |

* JPM #1 - No Retarder

KEY: Loose, Note 2 / Loose, Note 3 — [Note 1] Modified Proctor, Note 2 / Modified Proctor, Note 3 (Note 4)

Note 1, JPM #1 w/1% Retarder, Standard Proctor, After 4 Hour Delay
Note 2, JPM #1 w/1% Retarder
Note 3, Neal No. 4 w/8% Lime
Note 4, Neal No. 4, w/8% Lime After 4 Hr. Delay

WARZYN ENGINEERING INC

Figure C 8181-A53

[WEI 9-18]

FLY ASH CONDITIONING WITH LOW MOISTURE CONTENT

TEST SERIES

DENSITY SUMMARY

(lbs./cu.ft.)

WESTERN ASH TYPE

Neal #4 - No Lime Added

| MIX RATIO | MOISTURE CONTENT (%) 5 | 10 | | 15 |
|---|---|---|---|---|
| 10/90 | | 46.1 | 100.4 | |
| 20/80 | | 54.1 | 98.5 | |
| 40/60 | | 58.0 | 106.4 | |
| 60/40 | | 58.9 | 112.9 | |
| 80/20 | | 63.4 | 107.5 | |
| 90/10 | | 54.4 | 108.8 | |
| 100/0 | | 62.9 | 101.2 | |

KEY: Loose Immediate Modified Proctor

[WEI 9-18]
pag

Figure C 8181-A54

WARZYN ENGINEERING INC

LONG DELAYED COMPACTION AND PERMEABILITY
SUMMARY OF TEST DATA

15% Moisture Conditioning (August 1979)
Fly Ash 60/40 Mix (Lansing #4/Alma #1-5)

First Day

30 lb. sample mixed with 15% water, temperature rise 20°C to 57°C. Appeared granular soil-like condition.

One hour later, oven dry moisture determined to be 10.8%, (4.2% hydrated).

Cover sample, allow to sit for two days; still soil-like.

Third Day

Performed Standard Proctor compaction test, by adding % moisture shown.

| | | | | |
|---|---|---|---|---|
| Moisture (%) | 9 | 12 | 15 | 18 |
| Dry Density (lb./cu.ft.) | 91.9 | 95.2 | 97.8 | 95.6 |

Permeability test run at 15% moisture compacted at 91.6 lb/cu.ft., or 98% compaction. $K = 3 \text{ to } 7 \times 10^{-7}$ cm/sec.

Summary

15% conditioning moisture did not cause serious setting problems (provided mix was not compacted) with storage for two days prior to final compaction.

[WEI 9-18]
pag

Figure C 8181-A55

WARZYN
ENGINEERING INC

FLY ASH CONDITIONING WITH LOW MOISTURE CONTENT

TEST SERIES

PERMEABILITY, COMPACTED

(cm./sec.)

WESTERN ASH TYPE

Neal #4 w/8% Lime

| MIX RATIO | MOISTURE CONTENT (%) 5 | 10 | 15 |
|---|---|---|---|
| 10/90 | $1 \times 10^{-5}$ / @ 95.7 to 95.7 | $3$ to $4 \times 10^{-6}$ / @ 97.9 to 91.8 | $5$ to $7 \times 10^{-6}$ / @ 96.7 to 97.2 |
| 20/80 | $1 \times 10^{-5}$ / @ 93.7 to 93.7 | $6$ to $9 \times 10^{-7}$ / @ 103.6 to 101.8 | $3$ to $4 \times 10^{-6}$ / @ 99.9 to 99.9 |
| 40/60 | $5$ to $7 \times 10^{-7}$ / @ 100.3 to 102.6 | $1$ to $2 \times 10^{-7}$ / @ 102.8 to 102.3 | $2$ to $3 \times 10^{-7}$ / @ 104.6 to 104.6 |
| 60/40 | $1 \times 10^{-6}$ to $4 \times 10^{-7}$ (Reducing with Time) / @ 101.7 to 107.2 | $1 \times 10^{-7}$ to $8 \times 10^{-8}$ / @ 102.3 to 104.0 | $1 \times 10^{-7}$ / @ 106.2 to 106.2 |
| 80/20 | $1 \times 10^{-7}$ / @ 100.3 to 107.0 | $2 \times 10^{-7}$ to $5 \times 10^{-8}$ / @ 106.6 to 105.8 | $1 \times 10^{-7}$ to $5 \times 10^{-8}$ / @ 110.6 to 110.6 |
| 100/0 | $2 \times 10^{-7}$ / @ 104.6 to 114.9 | $5$ to $8 \times 10^{-8}$ / @ 107.7 to 111.5 | $5$ to $6 \times 10^{-8}$ / @ 111.8 to 111.4 |

KEY: Permeability / @ Initial density to final density (P.C.F.)

NOTE: Samples compacted 10 minutes after mixing with water, then cured 7 days and tested.

[WEI 9-18]
pag

Figure C 8181-A56

WARZYN ENGINEERING INC

FLY ASH CONDITIONING WITH LOW MOISTURE CONTENT

TEST SERIES

PERMEABILITY, COMPACTED

(cm./sec.)

WESTERN ASH TYPE

JPM #1 w/1% Retarder

| MIX RATIO | MOISTURE CONTENT (%) 5 | 10 | 15 |
|---|---|---|---|
| 10/90 | $5 \times 10^{-6}$ @ 89.7 to 96.9 Final | $4$ to $5 \times 10^{-6}$ @ 76.1 to 78.7 | |
| 40/60 | $5 \times 10^{-7}$ @ 96.6 to 115.8 | $7$ to $8 \times 10^{-7}$ @86.5 to 91.1 | $4 \times 10^{-7}$ @87.4 to 95.6 |
| 100/0 | *$2 \times 10^{-9}$ @114.9 to 140.6 | *$1 \times 10^{-9}$ @112.4 to 122.1 | $2 \times 10^{-9}$ @101.0 ** |

KEY: Permeability
@ Compacted Density and Final Density Shown (#/Cu. Ft.)

Samples Compacted 10 Minutes After Mixing in Water.

7 Day Cure Prior to Test

* Considerable Swell Noted for 3 Weeks Prior to Obtaining a Reading in Correct Direction.

** A slurry sample at 30% moisture obtained $6 \times 10^{-9}$ @ 104.9 lbs./cu.ft.

[WEI 9-18]
pag

Figure C 8181-A57

WARZYN ENGINEERING INC

FLY ASH CONDITIONING WITH LOW MOISTURE CONTENT

TEST SERIES

COMPRESSIVE STRENGTH

(P.S.I.)

WESTERN ASH TYPE

JPM #1 w/1% Retarder

| MIX RATIO | MOISTURE CONTENT (%) 5 | 10 | 15 |
|---|---|---|---|
| 10/90 | | Crumbled @ 87.3 | 22 @ 89.7 |
| 20/80 | | Crumbled @ 88.9 | 136 @ 90.8 |
| 40/60 | | 361 @ 90.0 | 631 @ 95.5 |
| 60/40 | | 641 @ 94.9 | 1894 @ 104.9 |
| 80/20 | | 1122 @ 118.2 | 996 @ 104.6 |
| 100/0 | 517 @ 113.1 | 1321 @ 114.5 | 891 @ 119.7 |

KEY: Compressive Strength After 7 Days @ Density Noted, PCF.

[WEI 9-18]
pag

Figure C 8181-A58

WARZYN ENGINEERING INC

# Appendix D
# Final Cover Water Balance Calculations

744 Heartland Trail (53717-8923) P. O. Box 8923 (53708-8923) Madison, WI (608) 831-4444 FAX: (608) 831-3334 VOICE: (608) 831-1989

| PROJECT/PROPOSAL NAME | PREPARED | | CHECKED | | PROJECT/PROPOSAL NO. |
|---|---|---|---|---|---|
| Dairyland Power | By: GMP | Date: 06/27/03 | By: BJK | Date: 11/03 | 3081.58 |

# HELP MODEL ANALYSIS

## Purpose:

To determine the water budget for post-closure landfill conditions. This information will be used to determine the efficiency of the proposed cover for the DPC Phase IV Landfill compared to the standard NR 504 final cover and the final cover in DPC's Plan of Operation conditional approval.

## Methodology:

A computer program was used to simulate the performance of the proposed cover. The Hydrologic Evaluation of Landfill Performance (HELP) Model is an analytical computer water balance program developed for the USEPA by the U.S. Army Engineer Waterways Experiment Station in Vicksburg, Mississippi (Schroeder et al., 1994). The program was developed to model the movement and quantity of water across, into, through, and out of various landfill liner and cover design configurations. The HELP model estimates these movements and quantities by interpreting the combined effects of precipitation, runoff, percolation, evapotranspiration, moisture storage, and lateral drainage. Landfill systems, including various combinations of vegetation, cover soil, waste layers, drainage layers, and relatively impermeable barrier soil layers, as well as geomembrane liners, may be modeled.

Default climatological data for La Crosse, Wisconsin, were used for the open conditions. The default data were used to synthetically generate 1 to 10 years of climatological data for the landfill.

For the purpose of determining the water balance, the model reported values in inches per unit area per year. The HELP model simulation was performed using an area of 1 acre. To determine the average annual volume, the unit rates are multiplied by the total landfill area in acres and converted to gallons per day.

## Assumptions:

To set up and run the HELP model, several assumptions need to be made based on the existing site conditions and the proposed design. These assumptions were kept constant between runs to allow a true comparison between final cover designs. The assumptions that were used for modeling the landfill are as follows:

744 Heartland Trail (53717-8923) P. O. Box 8923 (53708-8923) Madison, WI (608) 831-4444 FAX: (608) 831-3334 VOICE: (608) 831-1989

| PROJECT/PROPOSAL NAME | PREPARED | | CHECKED | | PROJECT/PROPOSAL NO. |
|---|---|---|---|---|---|
| Dairyland Power | By: GMP | Date: 06/27/03 | By: BJK | Date: 11/03 | 3081.58 |

- The evaporation zone depth is 8 inches.
- The maximum leaf index is 3.5.
- The slope and drainage length for the liner are 25 percent and 140 feet.
- The percent of area from which runoff is possible is 100 percent.
- The runoff curve number used was 69, based on the surface water design calculations in the Plan of Operation.

## Open Conditions:

The layers used to model the landfill are as follows:

*Option A: NR 504.07 Cover*

| LAYER | THICKNESS (inches) | DESCRIPTION | LAYER TYPE | MATERIAL TEXTURE | USCS* SOIL CLASSIFICATION |
|---|---|---|---|---|---|
| 1 | 6 | Topsoil | Vertical percolation | 9 | ML |
| 2 | 18 | Rooting zone | Vertical percolation | 22 | ML |
| 3 | 12 | Drainage layer | Lateral drainage | 5 | SM |
| 4 | 24 | Clay barrier | Barrier soil | 16 | Liner soil |

Note:
* Unified Soil Classification System.

*Option B: Approved Plan of Operation Cover*

| LAYER | THICKNESS (inches) | DESCRIPTION | LAYER TYPE | MATERIAL TEXTURE | USCS* SOIL CLASSIFICATION |
|---|---|---|---|---|---|
| 1 | 6 | Topsoil | Vertical percolation | 9 | ML |
| 2 | 18 | Rooting zone | Vertical percolation | 22 | ML |
| 3 | 12 | Drainage layer | Lateral drainage | 5 | SM |
| 4 | .06 | Geomembrane | Flexible membrane | 35 | -- |
| 5 | .24 | GCL | Barrier soil | 17 | -- |
| 6 | 12 | Fine-grained soil | Vertical percolation | 22 | ML |
| 7 | 12 | Sand capillary break | Vertical percolation | 5 | SM |

Note:
* Unified Soil Classification System.

744 Heartland Trail (53717-8923) P. O. Box 8923 (53708-8923) Madison, WI (608) 831-4444 FAX: (608) 831-3334 VOICE: (608) 831-1989

| PROJECT/PROPOSAL NAME | PREPARED | | CHECKED | | PROJECT/PROPOSAL NO. |
|---|---|---|---|---|---|
| Dairyland Power | By: GMP | Date: 06/27/03 | By: BJK | Date: 11/03 | 3081.58 |

*Option C: Proposed Cover*

| LAYER | THICKNESS (inches) | DESCRIPTION | LAYER TYPE | MATERIAL TEXTURE | USCS* SOIL CLASSIFICATION |
|---|---|---|---|---|---|
| 1 | 6 | Topsoil | Vertical percolation | 9 | ML |
| 2 | 18 | Rooting zone | Vertical percolation | 22 | ML |
| 3 | 12 | Drainage layer | Lateral drainage | 2 | CL |
| 4 | .06 | Geomembrane | Flexible membrane | 35 | -- |
| 5 | 24 | Ash barrier | Barrier soil | 30 | -- |

Note:
* Unified Soil Classification System.

## Results:

The results of the HELP model simulations are summarized in Table 1. The detailed outputs are attached.

## References:

Schroeder, P.R., T.S., Dozier, P.A., Zappi, B.M., McEnroe, J.W., Sjostrom, and R.L., Peyton. 1994a. The Hydrologic Evaluation of Landfill Performance (HELP) model: User's guide for Version 3. EPA/600/9-94/168a. U.S. Environmental Protection Agency Risk Reduction Engineering Laboratory, Cincinnati, Ohio.

Schroeder, P.R., T.S., Dozier, P.A., Zappi, B.M., McEnroe, J.W., Sjostrom, and R.L., Peyton. 1994b. The Hydrologic Evaluation of Landfill Performance (HELP) model: Engineering documentation for Version 3. EPA/600/9-94/168a. U.S. Environmental Protection Agency Risk Reduction Engineering Laboratory, Cincinnati, Ohio.

**Table D-1**
**Water Budget – Average Annual Totals (inches)**
**DPC Phase IV Landfill**

| SIMULATION NUMBER | COVER DESIGN | YEARS EVALUATED | PRECIPITATION | RUNOFF | EVAPO-TRANSPIRATION | FINAL COVER LATERAL DRAINAGE | LEAKAGE THROUGH FINAL COVER | MOISTURE STORAGE WITH COVER | COVER EFFICIENCY (percent) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | NR 504.07 | 10 | 29.93 | 1.575 | 22.565 | 4.678 | 1.00288 | 0.104 | 96.6 |
| 2 | Approved Plan of Operation | 10 | 29.93 | 1.575 | 22.565 | 5.681 | 0.00015 | 0.082 | 99.9995 |
| 3 | Proposed cover | 10 | 29.93 | 1.575 | 22.565 | 5.678 | 0.00056 | 0.107 | 99.9981 |

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**               HELP MODEL VERSION 3.03  (31 DECEMBER 1994)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
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PRECIPITATION DATA FILE:      C:\HELP\DATA4.D4
TEMPERATURE DATA FILE:        C:\HELP\DATA7.D7
SOLAR RADIATION DATA FILE:    C:\HELP\DATA13.D13
EVAPOTRANSPIRATION DATA:      C:\HELP\DATA11.D11
SOIL AND DESIGN DATA FILE:    C:\HELP\DATA10.D10
OUTPUT DATA FILE:             C:\HELP\OUT1.OUT


TIME:   9:27     DATE:   6/27/2003


******************************************************************************

     TITLE:  Dairyland Power NR 504

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   9
          THICKNESS                  =      6.00   INCHES
          POROSITY                   =      0.5010 VOL/VOL
          FIELD CAPACITY             =      0.2840 VOL/VOL
          WILTING POINT              =      0.1350 VOL/VOL
          INITIAL SOIL WATER CONTENT =      0.3074 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =  0.190000006000E-03 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
                 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

LAYER 2
---

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 22

| | | | |
|---|---|---|---|
| THICKNESS | = | 18.00 | INCHES |
| POROSITY | = | 0.4190 | VOL/VOL |
| FIELD CAPACITY | = | 0.3070 | VOL/VOL |
| WILTING POINT | = | 0.1800 | VOL/VOL |
| INITIAL SOIL WATER CONTENT | = | 0.2917 | VOL/VOL |
| EFFECTIVE SAT. HYD. COND. | = | 0.189999992000E-04 | CM/SEC |

LAYER 3
---

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 5

| | | | |
|---|---|---|---|
| THICKNESS | = | 12.00 | INCHES |
| POROSITY | = | 0.4570 | VOL/VOL |
| FIELD CAPACITY | = | 0.1310 | VOL/VOL |
| WILTING POINT | = | 0.0580 | VOL/VOL |
| INITIAL SOIL WATER CONTENT | = | 0.1380 | VOL/VOL |
| EFFECTIVE SAT. HYD. COND. | = | 0.100000005000E-02 | CM/SEC |
| SLOPE | = | 25.00 | PERCENT |
| DRAINAGE LENGTH | = | 140.0 | FEET |

LAYER 4
---

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 16

| | | | |
|---|---|---|---|
| THICKNESS | = | 24.00 | INCHES |
| POROSITY | = | 0.4270 | VOL/VOL |
| FIELD CAPACITY | = | 0.4180 | VOL/VOL |
| WILTING POINT | = | 0.3670 | VOL/VOL |
| INITIAL SOIL WATER CONTENT | = | 0.4270 | VOL/VOL |
| EFFECTIVE SAT. HYD. COND. | = | 0.100000001000E-06 | CM/SEC |

GENERAL DESIGN AND EVAPORATIVE ZONE DATA
---

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

| | | | |
|---|---|---|---|
| SCS RUNOFF CURVE NUMBER | = | 69.00 | |
| FRACTION OF AREA ALLOWING RUNOFF | = | 100.0 | PERCENT |
| AREA PROJECTED ON HORIZONTAL PLANE | = | 1.000 | ACRES |
| EVAPORATIVE ZONE DEPTH | = | 8.0 | INCHES |
| INITIAL WATER IN EVAPORATIVE ZONE | = | 2.184 | INCHES |
| UPPER LIMIT OF EVAPORATIVE STORAGE | = | 3.844 | INCHES |

| | | | |
|---|---|---|---|
| LOWER LIMIT OF EVAPORATIVE STORAGE | = | 1.170 | INCHES |
| INITIAL SNOW WATER | = | 0.000 | INCHES |
| INITIAL WATER IN LAYER MATERIALS | = | 19.000 | INCHES |
| TOTAL INITIAL WATER | = | 19.000 | INCHES |
| TOTAL SUBSURFACE INFLOW | = | 0.00 | INCHES/YEAR |

## EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
LACROSSE WISCONSIN

| | | |
|---|---|---|
| MAXIMUM LEAF AREA INDEX | = | 3.50 |
| START OF GROWING SEASON (JULIAN DATE) | = | 130 |
| END OF GROWING SEASON (JULIAN DATE) | = | 275 |
| AVERAGE ANNUAL WIND SPEED | = | 10.00 MPH |
| AVERAGE 1ST QUARTER RELATIVE HUMIDITY | = | 73.00 % |
| AVERAGE 2ND QUARTER RELATIVE HUMIDITY | = | 68.00 % |
| AVERAGE 3RD QUARTER RELATIVE HUMIDITY | = | 74.00 % |
| AVERAGE 4TH QUARTER RELATIVE HUMIDITY | = | 76.00 % |

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR LACROSSE WISCONSIN

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 0.94 | 0.89 | 1.96 | 3.05 | 3.61 | 4.15 |
| 3.83 | 3.70 | 3.47 | 2.08 | 1.50 | 1.07 |

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR LACROSSE WISCONSIN

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 14.00 | 19.70 | 30.90 | 47.20 | 59.40 | 68.50 |
| 73.00 | 70.90 | 61.60 | 50.40 | 35.30 | 21.50 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR LACROSSE WISCONSIN

STATION LATITUDE = 43.75 DEGREES

**********

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 10

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| **PRECIPITATION** | | | | | | |
| TOTALS | 0.78 | 0.76 | 1.64 | 2.92 | 4.47 | 3.61 |
| | 4.25 | 4.01 | 3.05 | 2.04 | 1.29 | 1.11 |
| STD. DEVIATIONS | 0.23 | 0.45 | 0.69 | 1.16 | 2.17 | 1.89 |
| | 2.26 | 2.04 | 1.73 | 1.06 | 0.88 | 0.38 |
| **RUNOFF** | | | | | | |
| TOTALS | 0.091 | 0.163 | 0.550 | 0.634 | 0.001 | 0.014 |
| | 0.000 | 0.049 | 0.000 | 0.000 | 0.007 | 0.066 |
| STD. DEVIATIONS | 0.097 | 0.311 | 0.430 | 0.741 | 0.002 | 0.043 |
| | 0.000 | 0.155 | 0.000 | 0.000 | 0.021 | 0.101 |
| **EVAPOTRANSPIRATION** | | | | | | |
| TOTALS | 0.455 | 0.624 | 1.399 | 2.425 | 3.099 | 3.126 |
| | 3.920 | 2.645 | 2.368 | 1.305 | 0.759 | 0.438 |
| STD. DEVIATIONS | 0.093 | 0.135 | 0.341 | 0.735 | 1.165 | 1.048 |
| | 1.245 | 1.230 | 0.877 | 0.476 | 0.225 | 0.106 |
| **LATERAL DRAINAGE COLLECTED FROM LAYER 3** | | | | | | |
| TOTALS | 0.1503 | 0.0352 | 0.0203 | 0.1220 | 0.4405 | 0.6630 |
| | 0.6050 | 0.6674 | 0.6018 | 0.5651 | 0.4849 | 0.3228 |
| STD. DEVIATIONS | 0.2156 | 0.0641 | 0.0612 | 0.2362 | 0.4406 | 0.5879 |
| | 0.5757 | 0.4686 | 0.3458 | 0.4827 | 0.3620 | 0.3499 |
| **PERCOLATION/LEAKAGE THROUGH LAYER 4** | | | | | | |
| TOTALS | 0.0613 | 0.0330 | 0.0152 | 0.0357 | 0.0992 | 0.1119 |
| | 0.1127 | 0.1154 | 0.1110 | 0.1110 | 0.0991 | 0.0974 |
| STD. DEVIATIONS | 0.0496 | 0.0438 | 0.0353 | 0.0415 | 0.0221 | 0.0087 |
| | 0.0117 | 0.0070 | 0.0051 | 0.0134 | 0.0351 | 0.0352 |

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

| | | | | | | |
|---|---|---|---|---|---|---|
| **DAILY AVERAGE HEAD ACROSS LAYER 4** | | | | | | |
| AVERAGES | 0.5065 | 0.1319 | 0.0688 | 0.4268 | 1.4913 | 2.3193 |
| | 2.0484 | 2.2597 | 2.1055 | 1.9131 | 1.6963 | 1.0929 |
| STD. DEVIATIONS | 0.7294 | 0.2402 | 0.2073 | 0.8264 | 1.4916 | 2.0567 |
| | 1.9491 | 1.5866 | 1.2097 | 1.6341 | 1.2666 | 1.1847 |

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 10

| | INCHES | | CU. FEET | PERCENT |
|---|---|---|---|---|
| PRECIPITATION | 29.93 | ( 3.273) | 108627.8 | 100.00 |
| RUNOFF | 1.575 | ( 0.9711) | 5716.84 | 5.263 |
| EVAPOTRANSPIRATION | 22.565 | ( 1.7313) | 81909.50 | 75.404 |
| LATERAL DRAINAGE COLLECTED FROM LAYER 3 | 4.67832 | ( 2.38029) | 16982.312 | 15.63349 |
| PERCOLATION/LEAKAGE THROUGH LAYER 4 | 1.00288 | ( 0.12671) | 3640.464 | 3.35132 |
| AVERAGE HEAD ACROSS TOP OF LAYER 4 | 1.338 | ( 0.681) | | |
| CHANGE IN WATER STORAGE | 0.104 | ( 0.9731) | 378.64 | 0.349 |

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 10

| | (INCHES) | (CU. FT.) |
|---|---|---|
| PRECIPITATION | 3.09 | 11216.699 |
| RUNOFF | 1.056 | 3834.6309 |
| DRAINAGE COLLECTED FROM LAYER 3 | 0.07585 | 275.31897 |
| PERCOLATION/LEAKAGE THROUGH LAYER 4 | 0.004530 | 16.44289 |
| AVERAGE HEAD ACROSS LAYER 4 | 7.960 | |
| SNOW WATER | 1.68 | 6098.3999 |

| | |
|---|---|
| MAXIMUM VEG. SOIL WATER (VOL/VOL) | 0.4696 |
| MINIMUM VEG. SOIL WATER (VOL/VOL) | 0.0960 |

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FINAL WATER STORAGE AT END OF YEAR 10

| LAYER | (INCHES) | (VOL/VOL) |
|---|---|---|
| 1 | 1.8192 | 0.3032 |
| 2 | 5.5664 | 0.3092 |
| 3 | 1.6358 | 0.1363 |
| 4 | 10.2480 | 0.4270 |
| SNOW WATER | 0.000 | |

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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**               HELP MODEL VERSION 3.03  (31 DECEMBER 1994)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:      C:\HELP\DATA4.D4
TEMPERATURE DATA FILE:        C:\HELP\DATA7.D7
SOLAR RADIATION DATA FILE:    C:\HELP\DATA13.D13
EVAPOTRANSPIRATION DATA:      C:\HELP\DATA11.D11
SOIL AND DESIGN DATA FILE:    C:\HELP\DATA8.D10
OUTPUT DATA FILE:             C:\HELP\OUT2.OUT


TIME:   9:33     DATE:   6/27/2003


******************************************************************************

     TITLE:  Dairyland Power DPC Approved

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   9
          THICKNESS                    =      6.00   INCHES
          POROSITY                     =      0.5010 VOL/VOL
          FIELD CAPACITY               =      0.2840 VOL/VOL
          WILTING POINT                =      0.1350 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.3074 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.190000006000E-03 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
                 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

LAYER 2
---

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 22

| | | | |
|---|---|---|---|
| THICKNESS | = | 18.00 | INCHES |
| POROSITY | = | 0.4190 | VOL/VOL |
| FIELD CAPACITY | = | 0.3070 | VOL/VOL |
| WILTING POINT | = | 0.1800 | VOL/VOL |
| INITIAL SOIL WATER CONTENT | = | 0.2917 | VOL/VOL |
| EFFECTIVE SAT. HYD. COND. | = | 0.189999992000E-04 | CM/SEC |

LAYER 3
---

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 5

| | | | |
|---|---|---|---|
| THICKNESS | = | 12.00 | INCHES |
| POROSITY | = | 0.4570 | VOL/VOL |
| FIELD CAPACITY | = | 0.1310 | VOL/VOL |
| WILTING POINT | = | 0.0580 | VOL/VOL |
| INITIAL SOIL WATER CONTENT | = | 0.1480 | VOL/VOL |
| EFFECTIVE SAT. HYD. COND. | = | 0.100000005000E-02 | CM/SEC |
| SLOPE | = | 25.00 | PERCENT |
| DRAINAGE LENGTH | = | 140.0 | FEET |

LAYER 4
---

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

| | | | |
|---|---|---|---|
| THICKNESS | = | 0.06 | INCHES |
| POROSITY | = | 0.0000 | VOL/VOL |
| FIELD CAPACITY | = | 0.0000 | VOL/VOL |
| WILTING POINT | = | 0.0000 | VOL/VOL |
| INITIAL SOIL WATER CONTENT | = | 0.0000 | VOL/VOL |
| EFFECTIVE SAT. HYD. COND. | = | 0.199999996000E-12 | CM/SEC |
| FML PINHOLE DENSITY | = | 1.00 | HOLES/ACRE |
| FML INSTALLATION DEFECTS | = | 1.00 | HOLES/ACRE |
| FML PLACEMENT QUALITY | = | 3 - GOOD | |

LAYER 5
---

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

| | | | |
|---|---|---|---|
| THICKNESS | = | 0.24 | INCHES |
| POROSITY | = | 0.7500 | VOL/VOL |
| FIELD CAPACITY | = | 0.7470 | VOL/VOL |
| WILTING POINT | = | 0.4000 | VOL/VOL |

```
INITIAL SOIL WATER CONTENT  =      0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.   = 0.300000003000E-08 CM/SEC
```

LAYER 6

```
TYPE 1 - VERTICAL PERCOLATION LAYER
    MATERIAL TEXTURE NUMBER  22
THICKNESS                   =     12.00   INCHES
POROSITY                    =      0.4190 VOL/VOL
FIELD CAPACITY              =      0.3070 VOL/VOL
WILTING POINT               =      0.1800 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.3053 VOL/VOL
EFFECTIVE SAT. HYD. COND.   = 0.189999992000E-04 CM/SEC
```

LAYER 7

```
TYPE 1 - VERTICAL PERCOLATION LAYER
    MATERIAL TEXTURE NUMBER   5
THICKNESS                   =     12.00   INCHES
POROSITY                    =      0.4570 VOL/VOL
FIELD CAPACITY              =      0.1310 VOL/VOL
WILTING POINT               =      0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.1298 VOL/VOL
EFFECTIVE SAT. HYD. COND.   = 0.100000005000E-02 CM/SEC
```

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

```
SCS RUNOFF CURVE NUMBER                =     69.00
FRACTION OF AREA ALLOWING RUNOFF       =    100.0     PERCENT
AREA PROJECTED ON HORIZONTAL PLANE     =      1.000   ACRES
EVAPORATIVE ZONE DEPTH                 =      8.0     INCHES
INITIAL WATER IN EVAPORATIVE ZONE      =      2.184   INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE     =      3.844   INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE     =      1.170   INCHES
INITIAL SNOW WATER                     =      0.000   INCHES
INITIAL WATER IN LAYER MATERIALS       =     14.271   INCHES
TOTAL INITIAL WATER                    =     14.271   INCHES
TOTAL SUBSURFACE INFLOW                =      0.00    INCHES/YEAR
```

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
LACROSSE WISCONSIN

| | | |
|---|---|---|
| MAXIMUM LEAF AREA INDEX | = | 3.50 |
| START OF GROWING SEASON (JULIAN DATE) | = | 130 |
| END OF GROWING SEASON (JULIAN DATE) | = | 275 |
| AVERAGE ANNUAL WIND SPEED | = | 10.00 MPH |
| AVERAGE 1ST QUARTER RELATIVE HUMIDITY | = | 73.00 % |
| AVERAGE 2ND QUARTER RELATIVE HUMIDITY | = | 68.00 % |
| AVERAGE 3RD QUARTER RELATIVE HUMIDITY | = | 74.00 % |
| AVERAGE 4TH QUARTER RELATIVE HUMIDITY | = | 76.00 % |

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR LACROSSE WISCONSIN

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 0.94 | 0.89 | 1.96 | 3.05 | 3.61 | 4.15 |
| 3.83 | 3.70 | 3.47 | 2.08 | 1.50 | 1.07 |

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR LACROSSE WISCONSIN

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 14.00 | 19.70 | 30.90 | 47.20 | 59.40 | 68.50 |
| 73.00 | 70.90 | 61.60 | 50.40 | 35.30 | 21.50 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR LACROSSE WISCONSIN

STATION LATITUDE = 43.75 DEGREES

**********

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 10

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| PRECIPITATION | | | | | | |
| TOTALS | 0.78 | 0.76 | 1.64 | 2.92 | 4.47 | 3.61 |
| | 4.25 | 4.01 | 3.05 | 2.04 | 1.29 | 1.11 |

| | | | | | | |
|---|---|---|---|---|---|---|
| STD. DEVIATIONS | 0.23 | 0.45 | 0.69 | 1.16 | 2.17 | 1.89 |
| | 2.26 | 2.04 | 1.73 | 1.06 | 0.88 | 0.38 |

RUNOFF

| | | | | | | |
|---|---|---|---|---|---|---|
| TOTALS | 0.091 | 0.163 | 0.550 | 0.634 | 0.001 | 0.014 |
| | 0.000 | 0.049 | 0.000 | 0.000 | 0.007 | 0.066 |
| STD. DEVIATIONS | 0.097 | 0.311 | 0.430 | 0.741 | 0.002 | 0.043 |
| | 0.000 | 0.155 | 0.000 | 0.000 | 0.021 | 0.101 |

EVAPOTRANSPIRATION

| | | | | | | |
|---|---|---|---|---|---|---|
| TOTALS | 0.455 | 0.624 | 1.399 | 2.425 | 3.099 | 3.126 |
| | 3.920 | 2.645 | 2.368 | 1.305 | 0.759 | 0.438 |
| STD. DEVIATIONS | 0.093 | 0.135 | 0.341 | 0.735 | 1.165 | 1.048 |
| | 1.245 | 1.230 | 0.877 | 0.476 | 0.225 | 0.106 |

LATERAL DRAINAGE COLLECTED FROM LAYER 3

| | | | | | | |
|---|---|---|---|---|---|---|
| TOTALS | 0.2397 | 0.0929 | 0.0606 | 0.1506 | 0.4959 | 0.7490 |
| | 0.7090 | 0.7773 | 0.7111 | 0.6786 | 0.5899 | 0.4266 |
| STD. DEVIATIONS | 0.2378 | 0.0944 | 0.0911 | 0.2552 | 0.4550 | 0.5983 |
| | 0.5868 | 0.4756 | 0.3497 | 0.4876 | 0.3738 | 0.3642 |

PERCOLATION/LEAKAGE THROUGH LAYER 5

| | | | | | | |
|---|---|---|---|---|---|---|
| TOTALS | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| STD. DEVIATIONS | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

PERCOLATION/LEAKAGE THROUGH LAYER 7

| | | | | | | |
|---|---|---|---|---|---|---|
| TOTALS | 0.0020 | 0.0018 | 0.0019 | 0.0019 | 0.0019 | 0.0018 |
| | 0.0019 | 0.0019 | 0.0018 | 0.0019 | 0.0018 | 0.0018 |
| STD. DEVIATIONS | 0.0004 | 0.0004 | 0.0004 | 0.0004 | 0.0004 | 0.0004 |
| | 0.0004 | 0.0004 | 0.0004 | 0.0004 | 0.0004 | 0.0004 |

---

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

---

DAILY AVERAGE HEAD ACROSS LAYER 5

| | | | | | | |
|---|---|---|---|---|---|---|
| AVERAGES | 0.8081 | 0.3484 | 0.2051 | 0.5267 | 1.6789 | 2.6204 |
| | 2.4002 | 2.6316 | 2.4876 | 2.2974 | 2.0636 | 1.4444 |
| STD. DEVIATIONS | 0.8039 | 0.3540 | 0.3084 | 0.8929 | 1.5405 | 2.0930 |
| | 1.9868 | 1.6101 | 1.2234 | 1.6507 | 1.3076 | 1.2330 |

**********

**********

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 10

| | INCHES | | CU. FEET | PERCENT |
|---|---|---|---|---|
| PRECIPITATION | 29.93 | ( 3.273) | 108627.8 | 100.00 |
| RUNOFF | 1.575 | ( 0.9711) | 5716.84 | 5.263 |
| EVAPOTRANSPIRATION | 22.565 | ( 1.7313) | 81909.50 | 75.404 |
| LATERAL DRAINAGE COLLECTED FROM LAYER 3 | 5.68111 | ( 2.46024) | 20622.424 | 18.98449 |
| PERCOLATION/LEAKAGE THROUGH LAYER 5 | 0.00015 | ( 0.00007) | 0.531 | 0.00049 |
| AVERAGE HEAD ACROSS TOP OF LAYER 5 | 1.626 | ( 0.704) | | |
| PERCOLATION/LEAKAGE THROUGH LAYER 7 | 0.02238 | ( 0.00487) | 81.239 | 0.07479 |
| CHANGE IN WATER STORAGE | 0.082 | ( 1.0111) | 297.75 | 0.274 |

**********

```
*******************************************************************************
              PEAK DAILY VALUES FOR YEARS    1 THROUGH   10
  ------------------------------------------------------------------------
                                             (INCHES)      (CU. FT.)
                                            ----------   -------------
     PRECIPITATION                            3.09         11216.699

     RUNOFF                                   1.056         3834.6309

     DRAINAGE COLLECTED FROM LAYER  3         0.07979        289.65002

     PERCOLATION/LEAKAGE THROUGH LAYER  5     0.000003         0.00976

     AVERAGE HEAD ACROSS LAYER  5             8.375

     PERCOLATION/LEAKAGE THROUGH LAYER  7     0.000105         0.38248

     SNOW WATER                               1.68          6098.3999

     MAXIMUM VEG. SOIL WATER (VOL/VOL)                 0.4696

     MINIMUM VEG. SOIL WATER (VOL/VOL)                 0.0960
*******************************************************************************
```

**********

FINAL WATER STORAGE AT END OF YEAR 10

| LAYER | (INCHES) | (VOL/VOL) |
|---|---|---|
| 1 | 1.8192 | 0.3032 |
| 2 | 5.5664 | 0.3092 |
| 3 | 1.7553 | 0.1463 |
| 4 | 0.0000 | 0.0000 |
| 5 | 0.1770 | 0.7500 |
| 6 | 3.5334 | 0.2945 |
| 7 | 1.4660 | 0.1222 |
| SNOW WATER | 0.000 | |

**********
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******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**               HELP MODEL VERSION 3.03  (31 DECEMBER 1994)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:      C:\HELP\DATA4.D4
TEMPERATURE DATA FILE:        C:\HELP\DATA7.D7
SOLAR RADIATION DATA FILE:    C:\HELP\DATA13.D13
EVAPOTRANSPIRATION DATA:      C:\HELP\DATA11.D11
SOIL AND DESIGN DATA FILE:    C:\HELP\DATA6.D10
OUTPUT DATA FILE:             C:\HELP\OUT3.OUT


TIME:   9:40     DATE:   6/27/2003


******************************************************************************

     TITLE:  Dairyland Power DPC Proposed

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   9
          THICKNESS                  =      6.00   INCHES
          POROSITY                   =      0.5010 VOL/VOL
          FIELD CAPACITY             =      0.2840 VOL/VOL
          WILTING POINT              =      0.1350 VOL/VOL
          INITIAL SOIL WATER CONTENT =      0.3074 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =  0.190000006000E-03 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
                 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

```
                    LAYER  2
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  22
THICKNESS                    =     18.00   INCHES
POROSITY                     =      0.4190 VOL/VOL
FIELD CAPACITY               =      0.3070 VOL/VOL
WILTING POINT                =      0.1800 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.2917 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.189999992000E-04 CM/SEC


                    LAYER  3
                    --------

          TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER   2
THICKNESS                    =     12.00   INCHES
POROSITY                     =      0.4370 VOL/VOL
FIELD CAPACITY               =      0.0620 VOL/VOL
WILTING POINT                =      0.0240 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.0620 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.579999993000E-02 CM/SEC
SLOPE                        =     25.00   PERCENT
DRAINAGE LENGTH              =    140.0    FEET


                    LAYER  4
                    --------

          TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                    =      0.06   INCHES
POROSITY                     =      0.0000 VOL/VOL
FIELD CAPACITY               =      0.0000 VOL/VOL
WILTING POINT                =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY          =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS     =      1.00   HOLES/ACRE
FML PLACEMENT QUALITY        =  3 - GOOD


                    LAYER  5
                    --------

          TYPE 3 - BARRIER SOIL LINER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                    =     24.00   INCHES
POROSITY                     =      0.5410 VOL/VOL
FIELD CAPACITY               =      0.1870 VOL/VOL
WILTING POINT                =      0.0470 VOL/VOL
```

```
INITIAL SOIL WATER CONTENT  =      0.5410 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.999999997000E-06 CM/SEC
```

## GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

| | | | |
|---|---|---|---|
| SCS RUNOFF CURVE NUMBER | = | 69.00 | |
| FRACTION OF AREA ALLOWING RUNOFF | = | 100.0 | PERCENT |
| AREA PROJECTED ON HORIZONTAL PLANE | = | 1.000 | ACRES |
| EVAPORATIVE ZONE DEPTH | = | 8.0 | INCHES |
| INITIAL WATER IN EVAPORATIVE ZONE | = | 2.184 | INCHES |
| UPPER LIMIT OF EVAPORATIVE STORAGE | = | 3.844 | INCHES |
| LOWER LIMIT OF EVAPORATIVE STORAGE | = | 1.170 | INCHES |
| INITIAL SNOW WATER | = | 0.000 | INCHES |
| INITIAL WATER IN LAYER MATERIALS | = | 20.825 | INCHES |
| TOTAL INITIAL WATER | = | 20.825 | INCHES |
| TOTAL SUBSURFACE INFLOW | = | 0.00 | INCHES/YEAR |

## EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
LACROSSE WISCONSIN

| | | |
|---|---|---|
| MAXIMUM LEAF AREA INDEX | = | 3.50 |
| START OF GROWING SEASON (JULIAN DATE) | = | 130 |
| END OF GROWING SEASON (JULIAN DATE) | = | 275 |
| AVERAGE ANNUAL WIND SPEED | = | 10.00 MPH |
| AVERAGE 1ST QUARTER RELATIVE HUMIDITY | = | 73.00 % |
| AVERAGE 2ND QUARTER RELATIVE HUMIDITY | = | 68.00 % |
| AVERAGE 3RD QUARTER RELATIVE HUMIDITY | = | 74.00 % |
| AVERAGE 4TH QUARTER RELATIVE HUMIDITY | = | 76.00 % |

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR LACROSSE WISCONSIN

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 0.94 | 0.89 | 1.96 | 3.05 | 3.61 | 4.15 |
| 3.83 | 3.70 | 3.47 | 2.08 | 1.50 | 1.07 |

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR LACROSSE WISCONSIN

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 14.00 | 19.70 | 30.90 | 47.20 | 59.40 | 68.50 |
| 73.00 | 70.90 | 61.60 | 50.40 | 35.30 | 21.50 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR LACROSSE WISCONSIN

STATION LATITUDE = 43.75 DEGREES

**********

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 10

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| **PRECIPITATION** | | | | | | |
| TOTALS | 0.78 | 0.76 | 1.64 | 2.92 | 4.47 | 3.61 |
| | 4.25 | 4.01 | 3.05 | 2.04 | 1.29 | 1.11 |
| STD. DEVIATIONS | 0.23 | 0.45 | 0.69 | 1.16 | 2.17 | 1.89 |
| | 2.26 | 2.04 | 1.73 | 1.06 | 0.88 | 0.38 |
| **RUNOFF** | | | | | | |
| TOTALS | 0.091 | 0.163 | 0.550 | 0.634 | 0.001 | 0.014 |
| | 0.000 | 0.049 | 0.000 | 0.000 | 0.007 | 0.066 |
| STD. DEVIATIONS | 0.097 | 0.311 | 0.430 | 0.741 | 0.002 | 0.043 |
| | 0.000 | 0.155 | 0.000 | 0.000 | 0.021 | 0.101 |
| **EVAPOTRANSPIRATION** | | | | | | |
| TOTALS | 0.455 | 0.624 | 1.399 | 2.425 | 3.099 | 3.126 |
| | 3.920 | 2.645 | 2.368 | 1.305 | 0.759 | 0.438 |
| STD. DEVIATIONS | 0.093 | 0.135 | 0.341 | 0.735 | 1.165 | 1.048 |
| | 1.245 | 1.230 | 0.877 | 0.476 | 0.225 | 0.106 |
| **LATERAL DRAINAGE COLLECTED FROM LAYER 3** | | | | | | |
| TOTALS | 0.0671 | 0.0015 | 0.0481 | 0.2873 | 0.8518 | 0.8962 |
| | 0.6192 | 0.8421 | 0.6993 | 0.5761 | 0.5111 | 0.2784 |
| STD. DEVIATIONS | 0.1170 | 0.0033 | 0.1519 | 0.5712 | 0.7434 | 0.9365 |
| | 0.5249 | 0.7151 | 0.6629 | 0.5482 | 0.4928 | 0.3763 |
| **PERCOLATION/LEAKAGE THROUGH LAYER 5** | | | | | | |
| TOTALS | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0001 | 0.0001 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0000 |
| STD. DEVIATIONS | 0.0000 | 0.0000 | 0.0000 | 0.0001 | 0.0001 | 0.0001 |
| | 0.0000 | 0.0001 | 0.0001 | 0.0001 | 0.0000 | 0.0000 |

---

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

---

DAILY AVERAGE HEAD ACROSS LAYER 5

| | | | | | | |
|---|---|---|---|---|---|---|
| AVERAGES | 0.0390 | 0.0010 | 0.0281 | 0.1733 | 0.4972 | 0.5406 |
| | 0.3615 | 0.4916 | 0.4218 | 0.3363 | 0.3083 | 0.1625 |
| STD. DEVIATIONS | 0.0682 | 0.0021 | 0.0887 | 0.3445 | 0.4339 | 0.5649 |
| | 0.3064 | 0.4174 | 0.3999 | 0.3200 | 0.2972 | 0.2197 |

**********

**********

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 10

| | INCHES | | CU. FEET | PERCENT |
|---|---|---|---|---|
| PRECIPITATION | 29.93 | ( 3.273) | 108627.8 | 100.00 |
| RUNOFF | 1.575 | ( 0.9711) | 5716.84 | 5.263 |
| EVAPOTRANSPIRATION | 22.565 | ( 1.7313) | 81909.50 | 75.404 |
| LATERAL DRAINAGE COLLECTED FROM LAYER 3 | 5.67829 | ( 2.60985) | 20612.191 | 18.97507 |
| PERCOLATION/LEAKAGE THROUGH LAYER 5 | 0.00056 | ( 0.00023) | 2.016 | 0.00186 |
| AVERAGE HEAD ACROSS TOP OF LAYER 5 | 0.280 | ( 0.129) | | |
| CHANGE IN WATER STORAGE | 0.107 | ( 0.6512) | 387.21 | 0.356 |

**********

```
*******************************************************************************
              PEAK DAILY VALUES FOR YEARS    1 THROUGH   10
  ------------------------------------------------------------------------
                                             (INCHES)      (CU. FT.)
                                            ----------   -------------
     PRECIPITATION                            3.09         11216.699

     RUNOFF                                   1.056         3834.6309

     DRAINAGE COLLECTED FROM LAYER  3         0.16227        589.04468

     PERCOLATION/LEAKAGE THROUGH LAYER  5     0.000014         0.05028

     AVERAGE HEAD ACROSS LAYER  5             2.936

     SNOW WATER                               1.68          6098.3999

     MAXIMUM VEG. SOIL WATER (VOL/VOL)                 0.4696

     MINIMUM VEG. SOIL WATER (VOL/VOL)                 0.0960
*******************************************************************************
```

**********

FINAL WATER STORAGE AT END OF YEAR 10

| LAYER | (INCHES) | (VOL/VOL) |
|---|---|---|
| 1 | 1.8192 | 0.3032 |
| 2 | 5.5664 | 0.3092 |
| 3 | 0.7478 | 0.0623 |
| 4 | 0.0000 | 0.0000 |
| 5 | 12.9840 | 0.5410 |
| SNOW WATER | 0.000 | |

**********
**********

# Appendix E
# Revised Closure Cost Estimates

# Worst-case Site Closure Scenario (Cell 3)

## Assumptions

- Cell 3 closure is the worst-case closure scenario. Closure of Cell 3 includes a portion of Cells 1, 2A, and 2B due to the intermediate slopes for a total of approximately 12.4 acres (542,300 SF).
- Proper drainage grades are established upon closure of Cell 3, and no additional grading costs are encountered.
- The conditioned and compacted ash component of the final cover is not yet placed. Imported fine-grained soil is utilized for construction of the 2-foot-thick barrier component of the final cover.
- Unit prices are based on previous liner and final cover construction projects.

## Final Cover System

| | |
|---|---|
| ▪ Barrier Layer (24 inches thick)<br>40,170 cy x $6.50/cy = | $261,100 |
| ▪ 40 mil VFPE geomembrane<br>542,300 sf x $0.36 = | 195,200 |
| ▪ Granular drainage layer (12 inches thick)<br>60,260 sy x $5.57 = | 335,700 |
| ▪ Vegetative layer (12 inches thick)<br>60,260 sy x $1.26 = | 75,900 |
| ▪ Topsoil (6 inches thick)<br>10,000 cy x $1.50 = | 15,000 |
| ▪ Surface water control system | 50,000 |
| ▪ Seed, fertilize, and mulch<br>12.4 acre x $1,350/acre = | 16,700 |
| Cost: | $949,600 |

## Engineering Fees

| | |
|---|---|
| ▪ Construction plans | $ 20,000 |
| ▪ Construction observation (16 weeks at $5,500 week) | 88,000 |
| ▪ Documentation report | 20,000 |
| Cost: | $ 128,000 |
| Subtotal | $1,077,600 |
| 25% contingencies: | $ 269,400 |
| **Total cost:** | **$1,347,000** |

# J.2
# Saturated Head on the Final Cover Liner

| | | |
|---|---|---|
| PROJECT / LOCATION: DPC CCR Landfill, Alma, Wisconsin | | PROJECT / PROPOSAL NO. |
| SUBJECT: Maximum Head on Final Cover | | |
| PREPARED BY: Z. Bauman | DATE: 12.21.2022 | FINAL ☐ |
| CHECKED BY: A. Graham | DATE: 12.30.2022 | REVISION ☐ |

# MAXIMUM SATURATED DEPTH
## (McENROE'S 1993 METHOD)

**Summary:** Per s. NR 504.07(6)(a), a drainage layer shall consist of a minimum of one foot of sand with a minimum hydraulic conductivity of 1 x $10^{-3}$ cm/sec. This calculation demonstrates the anticipated maximum head in the drainage layer is less than the thickness of the drainage layer, based on anticipated annual rainfall and infiltration into the cover system.

**Inputs:**

| | | | |
|---|---|---|---|
| Inflow rate, r | = | 5.04 | in/month |
| Hyd. cond. of drainage layer, K | = | 0.010 | cm/sec |
| Slope of drainage layer, S | = | 25 | % |
| Drainage distance, L | = | 200 | feet |
| Drainage Layer Thickness | = | 30.48 | cm |

**Calculated Values:**

| | | | |
|---|---|---|---|
| r | = | 4.87E-06 | cm/sec |
| alpha, α | = | 0.2449787 | radians |
| S | = | 0.25 | ft/ft |
| R | = | 0.0083 | (unitless) |

**Results:**

| | | | | | |
|---|---|---|---|---|---|
| For R < 1/4 | A | = | 0.9833 | | |
| | $Y_{max}$ | = | 0.01 | | |
| | Head in Cover Drainage, $y_{max}$ | = | 0.40 | feet | |
| | Head in Cover Drainage, $y_{max}$ | = | **4.81** | inches | **12.00** OK! |

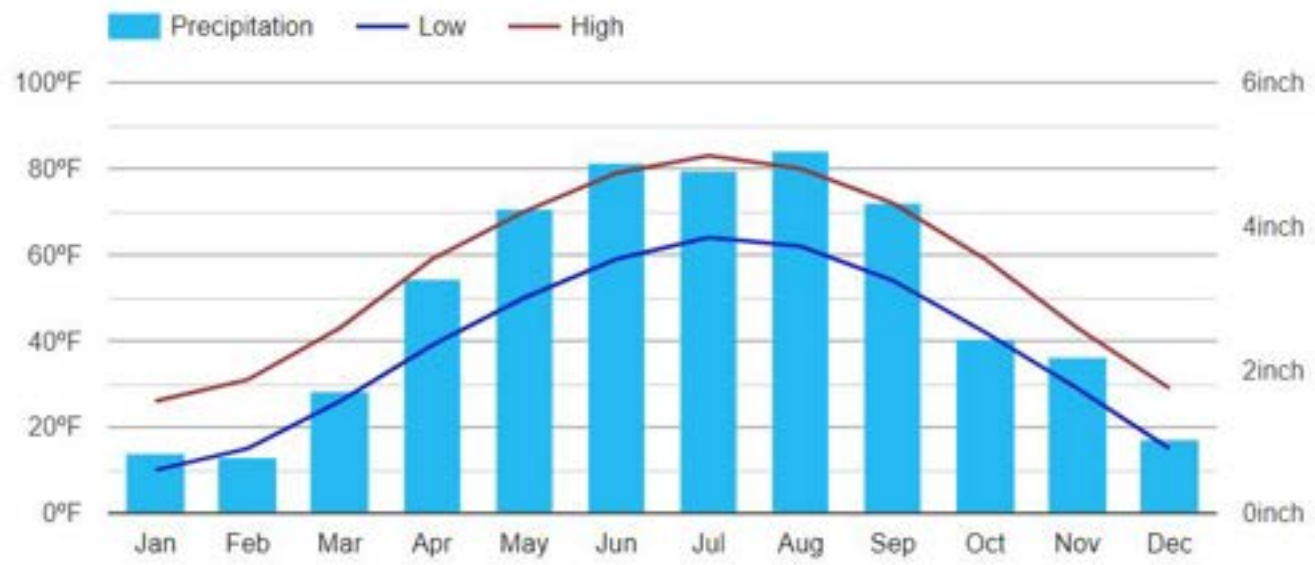
Assumptions:

1. Inflow rate (r ) is based on the largest monthly average rainfall (August) in Alma, Wisconsin from the U.S. Climate Data website.

2. The K value is based on historical hydraulic conductivity test results used at the site for closure construction.

| | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|
| Average high in °F | 83 | 80 | 72 | 59 | 43 | 29 |
| Average low in °F | 64 | 62 | 54 | 42 | 29 | 15 |
| Av. precipitation in inch | 4.77 | 5.04 | 4.32 | 2.44 | 2.18 | 1.03 |
| Av. snowfall in inch | 0 | 0 | 0 | 0 | 2 | 10 |

## Alma Climate Graph - Wisconsin Climate Chart




## Alma weather averages

| | |
|---|---|
| Annual high temperature | 56°F |
| Annual low temperature | 39°F |
| Average annual precip. | 35.46 inch |
| Av. annual snowfall | 36 inch |

Share

### Station Data

Monthly averages Alma
Longitude: -91.9149, Latitude: 44.32
Average weather Alma, WI - 54610

Monthly: 1981-2010 normals

# J.3
# Final Cover Event 2A Interface Stability Evaluation

# Phase IV, Cell 2A, Final Cover Construction Documentation Report WDNR License No. 4126

## Dairyland Power Cooperative
## Alma Off-Site Ash Disposal Facility

**December 2011**

*Prepared For*
*Dairyland Power Cooperative*
*La Crosse, Wisconsin*


Todd W. Martin
Solid Waste Team Leader

Curtis D. Madsen, P.E.
Senior Project Manager

Nicholas Bower
Environmental Specialist





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# Interface Slope Stability Calculation

# INTERFACE SLOPE STABILITY

## Table of Contents


- Purpose/Methodology/Assumptions/Results/References
- Calculations

744 Heartland Trail
Madison, WI 53717
Tel. (608) 831-4444 • Fax (608) 831-3334



| PROJECT / PROPOSAL NAME / LOCATION: DPC Phase IV, Cell 2A<br>Final Cover Construction | | PROJECT / PROPOSAL NO. |
|---|---|---|
| SUBJECT: Interface Slope Stability | | 02250.25.002 |
| PREPARED BY: T. Halena | DATE: 8/04/11 | FINAL ☐ |
| CHECKED BY: S. Inman | DATE: 08/06/11 | REVISION ☐ |

# INTERFACE SLOPE STABILITY

## Purpose:

The purpose of this analysis is to evaluate the stability of the final cover system against slippage along the critical interfaces of the geomembrane and adjacent soil.

## Methodology:

The cover system interface stability was evaluated following the procedure outlined in Giroud and Beach (1989). Giroud and Beach derived an equation using a classical two-wedge analysis that determines the magnitude of tension forces developed in the geosynthetics from the weight of the soil cover. This equation has been modified by Druschel and Underwood (1993) to include hydrostatic pressures in the cover soil, and by Bourdeau, Ludlow, and Simpson (1993) to include adhesion between the critical interfaces.

## Assumptions:

### Final Cover Design

The final cover system components consist of the following, from top to bottom:

- a 6-inch-thick topsoil layer
- a 1.5-foot-thick soil cover (general fill) layer (rooting zone layer)
- a 1-foot-thick sand drainage layer
- a 40-mil textured LLDPE geomembrane
- a 2-foot-thick conditioned and compacted fly ash layer

### Soil Strength Parameters

Soil strength parameters were assumed from typical engineering values and previous test results)

### Interface Strength Parameters

Direct shear testing was performed on the sand/40-mil LLDPE textured geomembrane and the fly ash/40-mil LLDPE textured geomembrane interfaces to determine site specific values for these interfaces and the associated strength parameters. Each interface was evaluated for confining pressures of 200, 600, and 1,000 pounds per square foot. The sand was lightly tamped into the box for direct shear testing. The fly ash was a blend of approximately 65 percent (by weight) JPM fly ash and approximately 35 percent (by weight) ALMA-I5 fly ash and was

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|---|---|---|
| SUBJECT: Interface Slope Stability | | 02250.25.002 |
| PREPARED BY: T. Halena | DATE: 8/04/11 | FINAL ☐ |
| CHECKED BY: S. Inman | DATE: 08/06/11 | REVISION ☐ |

remolded at 11 percent moisture content. The interface was soaked and loading was applied for 24 hours prior to interface testing.

Direct shear testing was performed on the above-described cover system in accordance with ASTM D6243/D5321. Interface strength parameters (friction angle and adhesion) were measured at the peak strength and residual (large displacement) strength. The testing results are summarized below.

| FINAL COVER INTERFACE | PEAK FRICTION ANGLE (degrees) | PEAK ADHESION (psf) | RESIDUAL FRICTION ANGLE (degrees) | RESIDUAL ADHESION (psf) |
|---|---|---|---|---|
| Sand/40-mil LLDPE textured geomembrane | 33.2 | 86 | 30.4 | 48 |
| Fly ash/40-mil LLDPE textured geomembrane | 61.0 | 389 | 22.2 | 93 |

**Slope Stability Analysis**

The Giroud and Beach stability method assumes the following:

- Slope failures slide as a block.
- The slope toe is buttressed where the cover soil on the slope meets the smaller inclined cover soil at the toe of slope.
- The cover soil is free draining and has a uniform thickness.

*Geometry*

The critical geometry for the designed landfill is shown on Sheet 4 of 10 and is described as follows:

- Slope angle = 14 degrees (4H:1V slope)
- Slope height = 26 feet

*Seepage Thickness*

The seepage thickness within the final cover system was estimated assuming that the 1-foot-thick sand drainage layer, the 1.5-foot-thick soil cover (general fill) layer, and the 6-inch-thick topsoil layer are fully saturated, which is the worst-case scenario. The geomembrane acts as an

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| CHECKED BY: S. Inman | DATE: 08/06/11 | REVISION ☐ |

impermeable barrier which allows no seepage through to the interface with the underlying fly ash layer.

*Soil Characteristics*

The soil characteristics are from typical engineering values:

- Cover soil internal friction angle = 30 degrees
- Cohesion = 0 lbs/ $ft^2$
- Cover soil unit weight = 115 lbs/$ft^3$

## Results:

The cover system analysis indicates a minimum factor of safety of 1.70. The factor of safety is above the design factor of safety of 1.3, as specified in NR 514.07 (1) (b). The computer printouts for the analyses are attached.

## References:

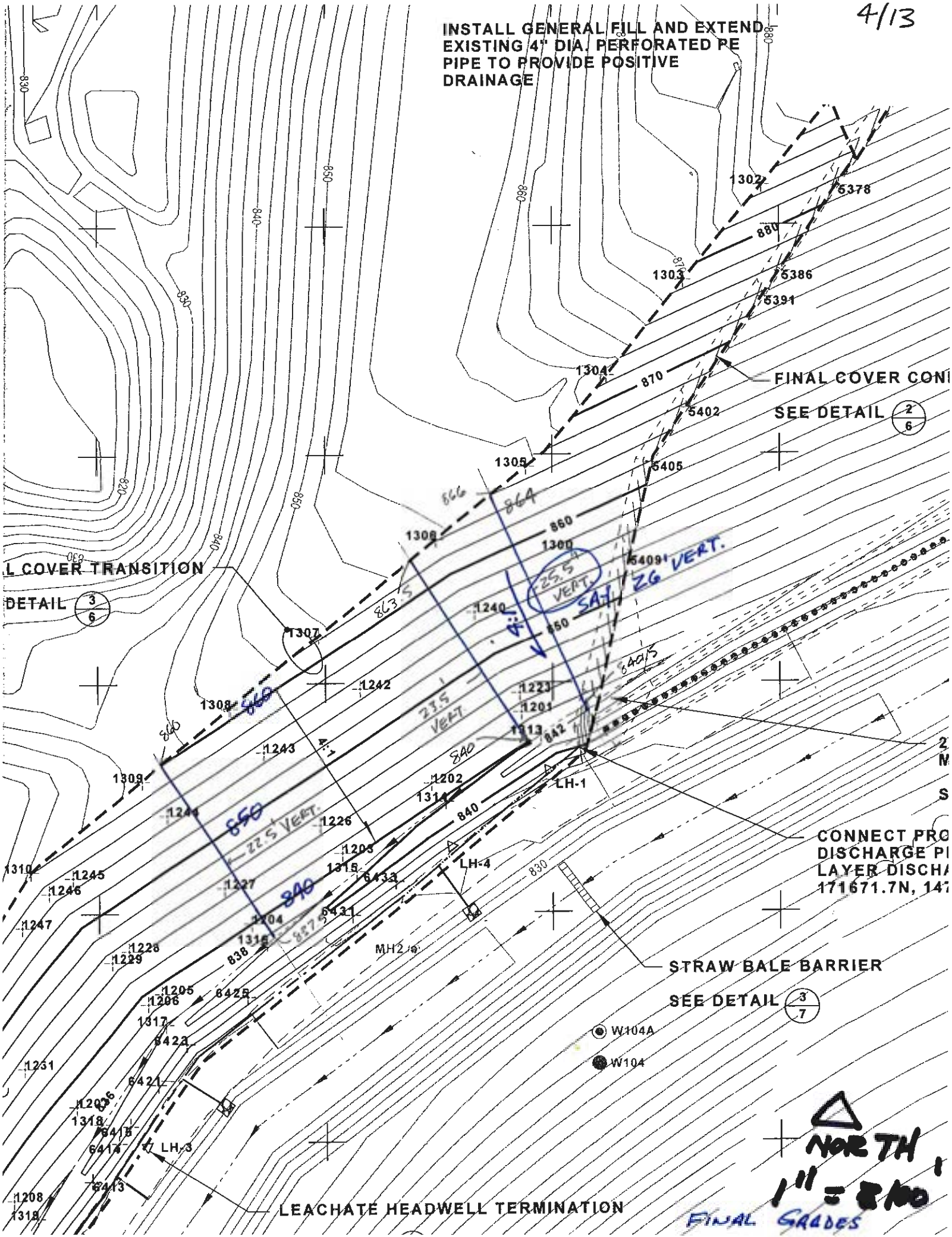
Bourdeau, P.L., Ludlow, S.J., and Simpson, B.E., (1993) Stability of Soil-Covered Geosynthetic-Lined Slopes: A Parametric Study, presented at the Geosynthetics 1993 Conference in Vancouver, Canada.

Druschel, S.J. and Underwood, E.R., (1993) Design of Lining and Cover System Sideslopes, presented at the Geosynthetics 1993 Conference in Vancouver, Canada.

Giroud, J.P. and Beach, J.F., (1989) Stability of Soil Layers on Geosynthetic Lining Systems, presented at the Geosynthetics 1989 Conference in San Diego, California.

RMT, Inc., (2009), Phase IV, Cell 1, Final Cover Documentation Report, WDNR Lic. No. 4126.

4/13


INSTALL GENERAL FILL AND EXTEND EXISTING 4" DIA. PERFORATED PE PIPE TO PROVIDE POSITIVE DRAINAGE
FINAL COVER CONI
SEE DETAIL 2/6
L COVER TRANSITION
DETAIL 3/6
CONNECT PRO
DISCHARGE PI
LAYER DISCHA
171671.7N, 147
STRAW BALE BARRIER
SEE DETAIL 3/7
LEACHATE HEADWELL TERMINATION
LH-1
LH-3
LH-4
MH2
W104A
W104
NORTH
1" = 200'
FINAL GRADES

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| | | |
|---|---|---|
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| SUBJECT: Interface Slope Stability | | 02250.25.005 |
| PREPARED BY: T. Halena | DATE: 8/04/11 | FINAL ☐ |
| CHECKED BY: S. Inman | DATE: 8/06/11 | REVISION ☐ |

## GEOSYNTHETIC TENSION CALCULATION

Location/condition modeled: Waubasha Sand Dr. Layer/Textured GSE Geomem.Interface (Peak Results)

Variables

| | | |
|---|---|---|
| Slope Angle (deg) | 14.0 | |
| Interface Friction Angle (deg) | 33.2 | |
| Adhesion (psf) | 86.0 | Waubasha Sand Drainage Layer/Textured GSE Geomembrane |
| Cover Soil Friction Angle (deg) | 30.0 | |
| Cohesion (psf) | 0 | |
| Slope Height (ft) | 26 | |
| Cover Soil Thickness (ft) | 3.0 | |
| Cover Soil Unit Weight (pcf) | 115.0 | |
| Seepage Thickness (ft) | 3.000 | Assume Full Saturation |

Calculated Values

| | |
|---|---|
| Weight Passive (lb/ft) | 2205 |
| Weight Active (lb/ft) | 34873 |
| Adhesion Force (lb/ft) | 9243 |
| Cohesion Force (lb/ft) | 0 |
| Seepage Toe Weight (lb/ft) | 1196 |
| Seepage Slope Weight (lb/ft) | 18923 |

Geosynthetic Tension (lb/in)

| | |
|---|---|
| FS = 1.0 | -981 |
| FS = 1.2 | -668 |
| FS = 1.5 | -375 |
| FS = 2.0 | -94 |

Geosynthetic Tension = 0 when FS = 2.26

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| | | |
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| SUBJECT: Interface Slope Stability | | 02250.25.005 |
| PREPARED BY: T. Halena | DATE: 8/04/11 | FINAL ☐ |
| CHECKED BY: S. Inman | DATE: 8/06/11 | REVISION ☐ |

## GEOSYNTHETIC TENSION CALCULATION

Location/condition modeled: Textured GSE Geomembrane/Waubasha Sand Dr. Layer Interface (Residual)

Variables

| | | |
|---|---|---|
| Slope Angle (deg) | 14.0 | |
| Interface Friction Angle (deg) | 30.4 | |
| Adhesion (psf) | 48.0 | Waubasha Sand Drainage LayerTextured Geomembrane |
| Cover Soil Friction Angle (deg) | 30.0 | |
| Cohesion (psf) | 0 | |
| Slope Height (ft) | 26 | |
| Cover Soil Thickness (ft) | 3.0 | |
| Cover Soil Unit Weight (pcf) | 115.0 | |
| Seepage Thickness (ft) | 3.000 | Assume Full Saturation |

Calculated Values

| | |
|---|---|
| Weight Passive (lb/ft) | 2205 |
| Weight Active (lb/ft) | 34873 |
| Adhesion Force (lb/ft) | 5159 |
| Cohesion Force (lb/ft) | 0 |
| Seepage Toe Weight (lb/ft) | 1196 |
| Seepage Slope Weight (lb/ft) | 18923 |

Geosynthetic Tension (lb/in)

| | |
|---|---|
| FS = 1.0 | -554 |
| FS = 1.2 | -319 |
| FS = 1.5 | -99 |
| FS = 2.0 | 110 |

**Geosynthetic Tension = 0 when FS = 1.70**

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| | | |
|---|---|---|
| PROJECT / PROPOSAL NAME / LOCATION: DPC Phase IV, Cell 2A Final Cover Construction | | PROJECT / PROPOSAL NO. |
| SUBJECT: Interface Slope Stability | | 02250.25.005 |
| PREPARED BY: T. Halena | DATE: 8/04/11 | FINAL ☐ |
| CHECKED BY: S. Inman | DATE: 8/06/11 | REVISION ☐ |

## GEOSYNTHETIC TENSION CALCULATION

Location/condition modeled: Fly Ash Composite/Textured GSE Geomem. Interface (Peak Results)

Variables

| | | |
|---|---|---|
| Slope Angle (deg) | 14.0 | |
| Interface Friction Angle (deg) | 61.0 | |
| Adhesion (psf) | 389.0 | Composite Fly Ash/Textured Geomembrane |
| Cover Soil Friction Angle (deg) | 30.0 | |
| Cohesion (psf) | 0 | |
| Slope Height (ft) | 26 | |
| Cover Soil Thickness (ft) | 3.0 | |
| Cover Soil Unit Weight (pcf) | 115.0 | |
| Seepage Thickness (ft) | 0.000 | |

Calculated Values

| | |
|---|---|
| Weight Passive (lb/ft) | 2205 |
| Weight Active (lb/ft) | 34873 |
| Adhesion Force (lb/ft) | 41807 |
| Cohesion Force (lb/ft) | 0 |
| Seepage Toe Weight (lb/ft) | 0 |
| Seepage Slope Weight (lb/ft) | 0 |

Geosynthetic Tension (lb/in)

| | |
|---|---|
| FS = 1.0 | -7996 |
| FS = 1.2 | -5762 |
| FS = 1.5 | -4118 |
| FS = 2.0 | -2754 |

Geosynthetic Tension = 0 when FS = >> 9.0 Program Limit!!!

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| | | |
|---|---|---|
| PROJECT / PROPOSAL NAME / LOCATION: DPC Phase IV, Cell 1 Final Cover Construction | | PROJECT / PROPOSAL NO. |
| SUBJECT: Interface Slope Stability | | 02250.25.005 |
| PREPARED BY: T. Halena | DATE: 8/04/11 | FINAL ☐ |
| CHECKED BY: S. Inman | DATE: 8/06/11 | REVISION ☐ |

## GEOSYNTHETIC TENSION CALCULATION

Location/condition modeled: Fly Ash Composite/Textured GSE Geomem. Interface (Residual)

Variables

| | | |
|---|---|---|
| Slope Angle (deg) | 14.0 | |
| Interface Friction Angle (deg) | 22.2 | |
| Adhesion (psf) | 93.0 | Composite Fly Ash/Textured Geomembrane |
| Cover Soil Friction Angle (deg) | 30.0 | |
| Cohesion (psf) | 0 | |
| Slope Height (ft) | 26 | |
| Cover Soil Thickness (ft) | 3.0 | |
| Cover Soil Unit Weight (pcf) | 115.0 | |
| Seepage Thickness (ft) | 0.000 | |

Calculated Values

| | |
|---|---|
| Weight Passive (lb/ft) | 2205 |
| Weight Active (lb/ft) | 34873 |
| Adhesion Force (lb/ft) | 9995 |
| Cohesion Force (lb/ft) | 0 |
| Seepage Toe Weight (lb/ft) | 0 |
| Seepage Slope Weight (lb/ft) | 0 |

Geosynthetic Tension (lb/in)

| | |
|---|---|
| FS = 1.0 | -1408 |
| FS = 1.2 | -1034 |
| FS = 1.5 | -673 |
| FS = 2.0 | -321 |

**Geosynthetic Tension = 0 when FS = 2.90**

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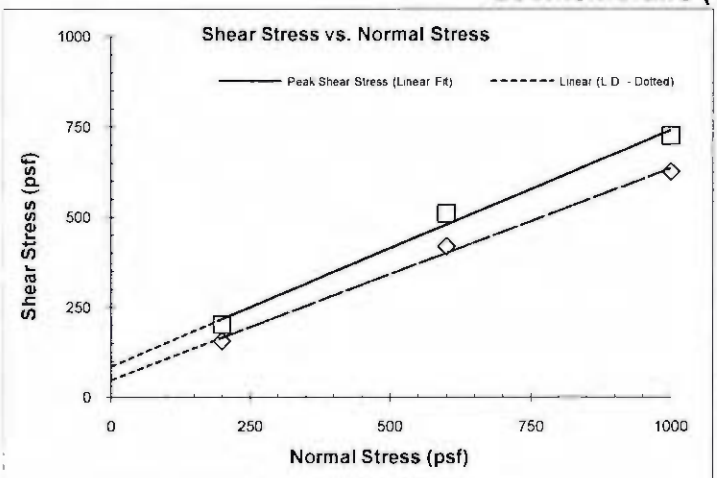
# Interface Friction Test Report

Client: **TRC**
Project: **Dairyland Power - Alma Off-site Cell 2A**
Test Date: 08/02/11-08/02/11

TRI Log#: E2357-20-05
Test Method: ASTM D 5321

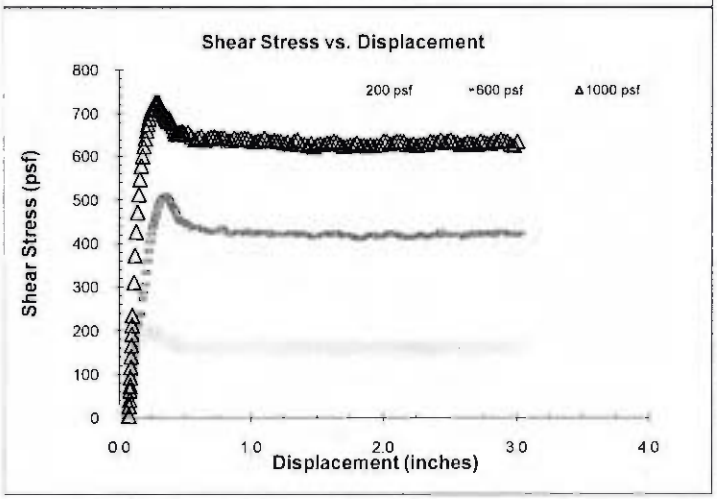
John M. Allen, P.E., 08/02/2011
Quality Review/Date

## Tested Interface: Drainage Layer Sand (Wabasha Pit) vs. GSE 40 mil LLDPE Textured Geomembrane (105153620)




| Test Results | | |
|---|---|---|
| | Peak | Large Displacement (@ 3.0 in.) |
| Friction Angle (degrees): | 33.2 | 30.4 |
| Y-intercept or Adhesion (psf): | 86 | 48 |

Shearing occurred at the interface.




## Test Conditions

Upper Box & Drainage Layer Sand (Wabasha Pit) tamped in place

Lower Box GSE 40 mil LLDPE textured geomembrane

Box Dimensions: 12"x12"x4"

Interface Conditioning: Interface soaked and loading applied for a minimum of 24 hours prior to shear.

Test Condition: Wet

Shearing Rate: 0.04 inches/minute

## Test Data

| Specimen No. | 1 | 2 | 3 |
|---|---|---|---|
| Bearing Slide Resistance (lbs) | 10 | 14 | 18 |
| Normal Stress (psf) | 200 | 600 | 1000 |
| Corrected Peak Shear Stress (psf) | 201 | 510 | 725 |
| Corrected Large Displacement Shear Stress (psf) | 156 | 419 | 626 |
| Peak Secant Angle (degrees) | 45.2 | 40.4 | 36.0 |
| Large Displacement Secant Angle (degrees) | 38.0 | 34.9 | 32.0 |
| Asperity (mils) | 20.4 | 20.6 | 19.0 |

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested. TRI neither accepts responsibility for nor makes claim as to the final use and purpose of the material. TRI observes and maintains client confidentiality. TRI limits reproduction of this report, except in full, without prior approval of TRI.

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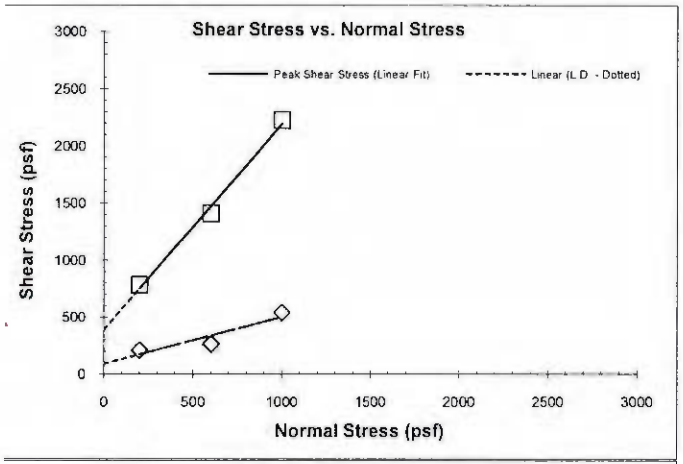
# Interface Friction Test Report

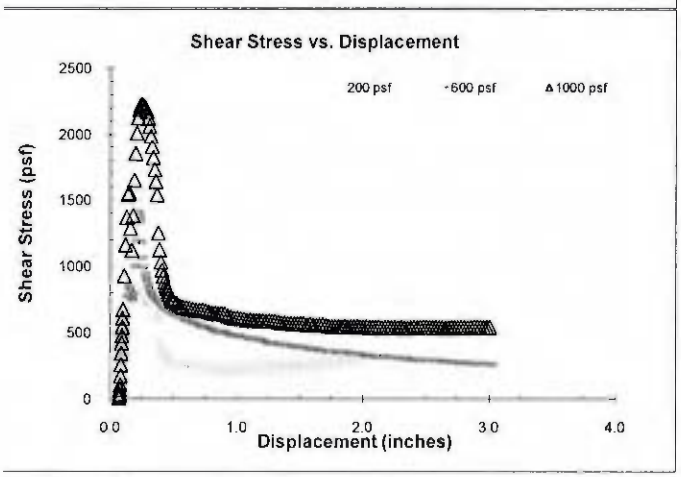
Client: **TRC**
Project: **Dairyland Power - Alma Off-site Cell 2A**
Test Date: 08/02/11-08/03/11

TRI Log#: E2357-20-05
Test Method: ASTM D 5321

John M. Allen, P.E., 08/03/2011
Quality Review/Date

## Tested Interface: Select Fly Ash vs. GSE 40 mil LLDPE Textured Geomembrane (105153620)




### Test Results

| | Peak | Large Displacement (@ 3.0 in.) |
|---|---|---|
| Friction Angle (degrees): | 61.0 | 22.2 |
| Y-intercept or Adhesion (psf): | 389 | 93 |

Shearing occurred at the interface. It was noted that the ash became cemented in the shear box.

### Test Conditions

Upper Box & Lower Box: Select Fly Ash - tamped in place at 11% moisture content; GSE 40 mil LLDPE textured geomembrane

Box Dimensions: 12"x12"x4"

Interface Conditioning: Interface soaked and loading applied for a minimum of 24 hours prior to shear.

Test Condition: Wet

Shearing Rate: 0.04 inches/minute

### Test Data

| Specimen No. | 1 | 2 | 3 |
|---|---|---|---|
| Bearing Slide Resistance (lbs) | 10 | 14 | 18 |
| Normal Stress (psf) | 200 | 600 | 1000 |
| Corrected Peak Shear Stress (psf) | 781 | 1410 | 2226 |
| Corrected Large Displacement Shear Stress (psf) | 212 | 264 | 539 |
| Peak Secant Angle (degrees) | 75.6 | 66.9 | 65.8 |
| Large Displacement Secant Angle (degrees) | 46.7 | 23.7 | 28.3 |
| Asperity (mils) | 24.2 | 22.8 | 22.2 |

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested. TRI neither accepts responsibility for nor makes claim as to the final use and purpose of the material. TRI observes and maintains client confidentiality. TRI limits reproduction of this report, except in full, without prior approval of TRI.

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RMT, Inc.

Constant Head Permeability Test (ASTM D2434)

QC:

QA:

| | | | |
|---|---|---|---|
| Project Name: | DPC | | |
| Project #: | 3081.95 | USCS Description: | Poorly graded sand |
| Sample Name: | Select Granular Fill, Sample #1 | USCS Classification: | SP |
| Visual Descript: | Poorly graded sand | Average $k_v$ = | 8.4E-02 cm./sec. |

| | | | |
|---|---|---|---|
| Sample Diameter (in): | 4.00 | | |
| Sample Height (in): | 4.63 | | |
| Specific Gravity: | 2.70 | | |
| Tare & Wet Soil (g): | 770.00 | | |
| Tare & Dry Soil (g): | 758.80 | Sample Type: | Remolded |
| Tare (g): | 268.98 | Beaker Tare Wt. (g): | 392.32 |
| | Initial Values | | Final Values |
| Mold & Wet Soil (g): | 5024.00 | Mold & Wet Soil (g): | 5216.00 |
| Mold & Dry Soil (g): | 4986.87 | Mold & Dry Soil (g): | 4986.87 |
| Tare of Mold (g): | 3363.00 | Tare of Mold (g): | 3363.00 |
| Wet Density (pcf): | 108.87 | Wet Density (pcf): | 121.46 |
| Dry Density (pcf): | 106.44 | Dry Density (pcf): | 106.44 |
| % Saturation: | 10.59% | % Saturation: | 65.36% |
| % Moisture: | 2.29% | % Moisture: | 14.11% |

| Date YY | MM | DD | Time Sec. | Temp. | Flow Vol Readings | Flow Vol. | Head Bottom | Top | h | $k_v$ * cm/sec |
|---|---|---|---|---|---|---|---|---|---|---|
| 2009 | 9 | 16 | 60 | 26 | 481.5 | 89.18 | 74.50 | 76.10 | 1.6 | 8.4E-02 |
| 2009 | 9 | 16 | 60 | 26 | 481.5 | 89.18 | 74.50 | 76.10 | 1.6 | 8.4E-02 |
| 2009 | 9 | 16 | 60 | 26 | 481.7 | 89.38 | 74.50 | 76.10 | 1.6 | 8.4E-02 |
| 2009 | 9 | 16 | 60 | 26 | 482.1 | 89.78 | 74.50 | 76.10 | 1.6 | 8.4E-02 |

$k_v$ = QL/Aht cm./sec.

Q = 89.38 ml. (ave. measured flow volume)

L = 3.313 in. (flow length)

A = 12.57 sq. cm. (area of sample)

h = 1.60 cm. (ave. head)

t = 60.00 sec. (average run time)

i = 0.19 (average gradient)

$k_v$ = 8.4E-02 cm/sec (ave. k value)

* $k_v$ adjusted for temperature

12/13

RMT, Inc.

Constant Head Permeability Test (ASTM D2434)

QC: HJW

QA: [illegible]

| | | | |
|---|---|---|---|
| Project Name: | Dairyland Power | | |
| Project #: | 3081.95 | USCS Description: | Poorly graded sand |
| Sample Name: | Select Granular Fill, Sample #4 | USCS Classification: | SP |
| Visual Descript: | Poorly graded sand | Average $k_v$ = | 5.1E-02 cm./sec. |

| | | | |
|---|---|---|---|
| Sample Diameter (in): | 4.00 | | |
| Sample Height (in): | 4.63 | | |
| Specific Gravity: | 2.70 | | |
| Tare & Wet Soil (g): | 767.80 | | |
| Tare & Dry Soil (g): | 748.70 | Sample Type: | Remolded |
| Tare (g): | 268.16 | Beaker Tare Wt. (g): | 392.32 |

| | Initial Values | | Final Values |
|---|---|---|---|
| Mold & Wet Soil (g): | 5161.00 | Mold & Wet Soil (g): | 5302.00 |
| Mold & Dry Soil (g): | 5092.27 | Mold & Dry Soil (g): | 5092.27 |
| Tare of Mold (g): | 3363.00 | Tare of Mold (g): | 3363.00 |
| Wet Density (pcf): | 117.85 | Wet Density (pcf): | 127.09 |
| Dry Density (pcf): | 113.35 | Dry Density (pcf): | 113.35 |
| % Saturation: | 22.06% | % Saturation: | 67.32% |
| % Moisture: | 3.97% | % Moisture: | 12.13% |

| Date YY | MM | DD | Time Sec. | Temp. | Flow Vol Readings | Flow Vol. | Head Bottom | Top | h | $k_v$* cm/sec |
|---|---|---|---|---|---|---|---|---|---|---|
| 2009 | 10 | 14 | 60 | 26 | 507.5 | 115.18 | 74.50 | 77.90 | 3.4 | 5.1E-02 |
| 2009 | 10 | 14 | 60 | 26 | 507.5 | 115.18 | 74.50 | 77.90 | 3.4 | 5.1E-02 |
| 2009 | 10 | 14 | 60 | 26 | 507.5 | 115.18 | 74.50 | 77.90 | 3.4 | 5.1E-02 |
| 2009 | 10 | 14 | 60 | 26 | 507.5 | 115.18 | 74.50 | 77.90 | 3.4 | 5.1E-02 |

$k_v$ = QL/Aht cm./sec.

| | | |
|---|---|---|
| Q = | 115.18 | ml. (ave. measured flow volume) |
| L = | 3.313 | in. (flow length) |
| A = | 12.57 | sq. cm. (area of sample) |
| h = | 3.40 | cm. (ave. head) |
| t = | 60.00 | sec. (average run time) |
| i = | 0.40 | (average gradient) |

$k_v$ = 5.1E-02 cm/sec (ave. k value)

* $k_v$ adjusted for temperature

RMT, Inc.

Constant Head Permeability Test (ASTM D2434)

QC: QA:

| | | | |
|---|---|---|---|
| Project Name: | Dairyland Power | | |
| Project #: | 3081.95 | USCS Description: | Poorly graded sand |
| Sample Name: | Select Granular Fill, Sample #6 | USCS Classification: | SP |
| Visual Descript: | Poorly graded sand | Average $K_v$ = | 4.7E-02 cm./sec. |

| | | | |
|---|---|---|---|
| Sample Diameter (in): | 4.00 | | |
| Sample Height (in): | 4.63 | | |
| Specific Gravity: | 2.70 | | |
| Tare & Wet Soil (g): | 3318.60 | | |
| Tare & Dry Soil (g): | 3216.50 | Sample Type: | Remolded |
| Tare (g): | 429.85 | Beaker Tare Wt. (g): | 392.32 |

| | Initial Values | | Final Values |
|---|---|---|---|
| Mold & Wet Soil (g): | 5154.00 | Mold & Wet Soil (g): | 5279.00 |
| Mold & Dry Soil (g): | 5090.70 | Mold & Dry Soil (g): | 5090.70 |
| Tare of Mold (g): | 3363.00 | Tare of Mold (g): | 3363.00 |
| Wet Density (pcf): | 117.39 | Wet Density (pcf): | 125.59 |
| Dry Density (pcf): | 113.24 | Dry Density (pcf): | 113.24 |
| % Saturation: | 20.28% | % Saturation: | 60.33% |
| % Moisture: | 3.66% | % Moisture: | 10.90% |

| Date YY | MM | DD | Time Sec. | Temp. | Flow Vol Readings | Flow Vol. | Head Bottom | Top | h | $K_v$* cm/sec |
|---|---|---|---|---|---|---|---|---|---|---|
| 2009 | 10 | 19 | 60 | 26 | 519.2 | 126.88 | 76.10 | 80.20 | 4.1 | 4.7E-02 |
| 2009 | 10 | 19 | 60 | 26 | 519.5 | 127.18 | 76.10 | 80.20 | 4.1 | 4.7E-02 |
| 2009 | 10 | 19 | 60 | 26 | 519.8 | 127.48 | 76.10 | 80.20 | 4.1 | 4.7E-02 |
| 2009 | 10 | 19 | 60 | 26 | 520.5 | 128.18 | 76.10 | 80.20 | 4.1 | 4.7E-02 |

$K_v$ = QL/Aht cm./sec.

Q = 127.43 ml. (ave. measured flow volume)

L = 3.313 in. (flow length)

A = 12.57 sq. cm. (area of sample)

h = 4.10 cm. (ave. head)

t = 60.00 sec. (average run time)

i = 0.49 (average gradient)

$K_v$ = 4.7E-02 cm/sec (ave. k value)

* $K_v$ adjusted for temperature

# Appendix K: Run-on and Run-off Control System Plan

# Run-On and Run-Off Control System Plan

## Alma Offsite Disposal Facility
## Phase IV Landfill
## Alma, Wisconsin

October 2016
Revised October 2021

**Prepared For:**

Dairyland Power Cooperative
3200 East Avenue South
La Crosse, Wisconsin 54601

**Prepared By:**

TRC
708 Heartland Trail, Suite 3000
Madison, Wisconsin 53717

Jonathan N. Hotstream, P.E., P.G.
Senior Geological Engineer

Todd Martin
Principal Project Manager

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## APPENDICES


Appendix A: Surface Water Run-On Control System Calculations
Appendix B: Surface Water Run-Off Control System Calculations
Appendix C: Relevant October 2002 POO Plan Sheets

## Revision History

| Revision Number | Revision Date | Section Revised | Summary of Revisions |
|---|---|---|---|
| 1 | 10/6/2021 | 1.2, 2.2, 2.3, 3.0, App. B | 5-year periodic revision, revised text and Appendix B |
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# 1.0 Introduction

## 1.1 Purpose and Scope

This Run-On and Run-Off Control System Plan (Plan) was prepared by TRC Environmental Corporation (TRC) on behalf of Dairyland Power Cooperative (DPC) for the Alma Offsite Disposal Facility, Phase IV Landfill (Landfill) where coal combustion residuals (CCR) are disposed. The approximately 32.1 acre Landfill is located in Sections 18 and 19, T21N, R12W, Town of Belvidere, Buffalo County, Wisconsin.

This Plan meets the run-on and run-off control system requirements of the United States Environmental Protection Agency's (USEPA) CCR Rule (Title 40 Code of Federal Regulations (CFR) part 257 Subpart D – "Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments"). This text and its accompanying appendices and plan sheets present the plans and specifications of the run-off and run-on control systems of the Landfill. The plan sheets and the text, with its appendices, complement each other and should be reviewed and used as one document.

# 2.0 Engineering Design Concepts for Controlling Run-On and Run-Off

## 2.1 General

The Landfill design has been developed to provide environmentally sound CCR disposal. The storm water run-on and run-off control systems for the Landfill have been designed and meet the requirements of 40 CFR 257.81.

The supporting calculations for the run-on and run-off design are referenced throughout the text and are included in the appendices. Details and drawings illustrating design layout and specifications are referenced as applicable and presented on the plan sheets and figures. The majority of the calculations provided in the appendices were prepared during the initial permitting of the Phase IV Disposal Area and included in the October 2000 Plan of Operation (POO) in accordance with Wisconsin Administrative Code, Chapters 500 through 520, and conversations with the Wisconsin Department of Natural Resources (WDNR). Plan sheets included in Appendix C are the relevant plan sheets from the October 2000 POO drawing plan set. For the purposes of this Plan, the terms surface water and storm water have been used interchangeably and reflect precipitation routed over land or temporarily stored to manage run-on and run-off. No streams, wetlands, or bodies of water are located in areas that would impact run-on and run-off at the Landfill.

## 2.2 Run-On Control System

### *2.2.1 General*

The run-on control system for the Landfill consists of perimeter berms, diversion berms, downslope flumes, ditching, sedimentation basins, and culverts, designed and constructed to control surface water during both the operational and post-closure periods of the Landfill. The design of the surface water controls have been performed for the operational periods when the combination of surface conditions and contributing acreage would result in the greatest run-off volume, and for the post-closure period. Given the location of the site, the surface water management system was designed utilizing the 100-year, 24-hour storm event at the time of the design, which exceeds the current 25-year, 24-hour storm event required by 40 CFR 257.81(a)(1). Calculations for the surface water run-on control designs are included in Appendix A.

The surface water control system design has been performed to meet the following requirements:

- Run-off curve numbers (RCNs) used in the analysis provide a conservative analysis of the potential land uses of the upland areas. Upland areas within the watershed primarily include wooded areas and agricultural lands. The wooded areas are located on the steeper-sloped areas of the valley and are unlikely to be affected by future land uses. High RCNs for the agricultural lands were selected to represent a conservative fallow condition with exposed bare soil. The RCNs selected for these areas were 86.

- Surface water run-on controls have been designed to divert off-site surface water away from the active fill areas. On-site surface water is routed to sedimentation basins, except surface water in contact with active fill areas, which is treated as leachate.

### 2.2.2 Control of Surrounding Run-On

Surface water from areas west, north, and east of the Landfill currently drain to existing drainage channels that have formed in the valleys near the Landfill. These drainage channels converge at the location of the Landfill, are conveyed around the Landfill by perimeter diversion ditches, and continue to the south in a single drainage ditch. The main drainage ditch then routes the water to the south for approximately 1.5 miles before discharging into the Mississippi River (see Plan Sheet 5 in Appendix C).

Diversion ditches are designed to route off-site surface water around the Landfill in a controlled manner. These ditches are constructed in phases as the Landfill is developed.

During previous construction events, the perimeter drainage ditch along the eastern, western, and northern sides of the Landfill were constructed to route storm water from the east, west, and north around the Landfill. Cells 1, 2, and 3 of the Landfill have been constructed (see Plan Sheet 9 in Appendix C). A temporary drainage ditch/diversion berm was constructed on the northwestern side of the Landfill to route surface water from areas northwest of the Landfill around the Landfill. During Cell 4, Module B development, the remaining surface water controls will be completed (see Plan Sheets 11 and 12 in Appendix C).

Temporary and permanent ditching and diversion berms were designed and constructed to manage the peak flows associated with the 100-year, 24-hour storm event.

### 2.2.3 Diversion Berms

Diversion berms are designed along the final cover system to collect and transfer surface water to the receiving downslope flume or sedimentation basin (see Detail 2 on Plan Sheet 19 in Appendix C). These diversion berms concentrate and control flow, and discharge the non-contact surface water (water that has not come into contact with the CCR) from the Landfill away from the final cover. The swales created by the diversion berms are designed at 2 percent typical slopes along the flow lines. The locations of the surface water diversion berms are shown on Plan Sheet 12 in Appendix C.

Drainage areas for the Landfill are defined by the proposed surface water diversion berms at the site. Run-off computations were performed for the site with the proposed diversion berms in-place and are contained in Appendix A. Figure K-2 in Appendix A shows the post-closure drainage areas for the Landfill.

### 2.2.4 Downslope Flumes

Downslope flumes are included in the design to collect and transfer surface water from the diversion berms on the final cover to the sedimentation basins. Plan Sheet 12 shows the location of the downslope flumes. The downslope flumes have been designed as enclosed pipe flumes to limit erosion and to control the flow as it crosses roads. Downslope flume calculations are included in the culvert design subsection of Appendix A.

### 2.2.5 Ditching

Surface water ditching has been designed to minimize velocities and depths of flow. Velocities for the grass-lined ditching have been limited to 4 feet per second (fps). In areas where velocities exceed 4 fps, permanent erosion matting, or grouted riprap are used to limit erosion and reduce velocities. Ditch sizing calculations are contained in Appendix A. Designed ditch locations are shown on Figure K-3 in Appendix A. The ditching to route surface water around the Landfill and away from the active areas of the Landfill are designed at a minimum 2-foot depth as shown on Detail 8 on Plan Sheet 23 in Appendix A. Ditch sizing calculations for operational and post-closure conditions show that a minimum freeboard of 0.4 feet occurs as the worst case condition in the ditches for the 100-year 24-hour storm event. Therefore, the calculations indicate that run-on to the active areas of the Landfill should not occur for the 25-year 24-hour storm event as required by 40 CFR 257.81(a)(1).

### 2.2.6 Sedimentation Basins

Two permanent sedimentation basins are designed to capture and treat non-contact run-off from the Landfill final cover system. The locations of the permanent sedimentation basins are shown on Plan Sheet 5 in Appendix C. The basins have been designed with a minimum surface area that exceeds the surface area required to settle 0.015 mm particles. The sedimentation basins are designed to accommodate the surface water run-off from a 100-year, 24-hour storm event. The emergency spillways are designed to control the run-off from a storm greater than the 100-year, 24-hour storm event.

### 2.2.7 Culverts

Several culverts are designed to transport non-contact run-off from the Landfill final cover and surrounding areas. The locations of the permanent culverts are shown on Plan Sheet 12 in Appendix C. The culverts have been designed to allow the peak run-off associated with a 100-year, 24-hour storm to pass through it without creating surface water breaching (i.e., berm overflow and run-on into active areas of the Landfill) or excessive backwater levels. Culvert sizing was performed using design charts developed by the U.S. Department of Transportation Federal Highway Administration. Culvert sizing calculations are provided in Appendix A.

### 2.2.8 Temporary Surface Water Controls

In addition to the permanent surface water management features discussed above, temporary surface water controls are also implemented during operation of the Landfill to control surface water from entering the active disposal area and to limit erosion of the final cover. These temporary control features include diversion berms, downslope discharge structure, and culverts. Temporary diversion berms will be constructed as needed along the transition from an active area to an area that has reached final grade, or that has intermediate cover, in order to control surface water from entering the active area. Temporary downslope discharge structures will be used to route non-contact run-off from diversion berms (either temporary or permanent) to the perimeter ditches.

## 2.3 Run-Off Control System

### *2.3.1 General*

The leachate collection and handling system in conjunction with cell delineation berms (see detail 5 on Plan Sheet 17 in Appendix C) and perimeter berms comprise the control system for preventing contact surface water run-off from the active portions of the Landfill. Contact surface water is managed as leachate. The leachate collection system for the Landfill has been designed to provide effective drainage, collection, and removal of leachate from the Landfill.

### *2.3.2 Leachate Collection System*

The primary components of the leachate collection system consist of a drainage layer, leachate collection and transfer piping, cleanouts, manholes, a storage tank, and a load-out facility. The leachate collection system layout is shown on Plan Sheet 5 in Appendix C. The drainage layer is placed over the geomembrane on the base and sidewalls. The drainage layer promotes the efficient transmission of leachate to the leachate collection trenches and pipes. The drainage layer is a minimum of 12 inches thick and has a minimum hydraulic conductivity of $1.0 \times 10^{-2}$ centimeters per second (cm/s).

The leachate collection piping is placed in vee-shaped trenches and consists of 6-inch–diameter perforated high density polyethylene (HDPE) pipe. Pipe bedding material is placed around the perforated pipe and mounded as shown on Plan Sheet 17 in Appendix C.

Leachate collection pipes in each cell are placed parallel to each other in valleys over the herringbone design across the base. These lines drain at a 4 to 6 percent slope to the leachate removal and transfer system.

Temporary cell delineation berms are used along the cell boundaries to control surface water run-off from exiting the active areas of the Landfill. Refer to Detail 5 on Plan Sheet 17 for further details on the temporary cell delineation berm design.

### *2.3.3 Leachate Removal and Transfer System*

The perforated leachate collection piping will transition to 6-inch–diameter nonperforated leachate transfer piping within the Landfill just prior to where the transfer piping penetrates the liner system at the southern toe-of-slope of each cell. The horizontal pipe penetration has been designed to prevent leachate from leaving the Landfill liner system through the liner penetration.

Outside of the limits of CCR, concrete manholes provide a location for transfer piping to manifold into a single perimeter transfer pipe around the southern end of the Landfill, and to provide a location for cleanout access piping.

The combined transfer piping then extends to the leachate storage tank located near the ash processing facility. Leachate collected in the tank is pumped into tanker trucks and transported to a nearby wastewater treatment plan for treatment which complies with 40 CFR 257.81(b). Plan Sheet 5 illustrates the location of the transfer piping, manholes, and the storage tank.

### *2.3.4 Leachate Storage Capacity From a 25-Year 24-Hour Storm Event*

The proposed phasing plans and existing conditions were reviewed to determine the worst-case scenario for leachate generation. This worst-case scenario was used to show that run-off from the active area of the Landfill would not occur from a 25-year 24-hour storm event. Calculations contained in Appendix B show that there is approximately 14,700 cubic feet of leachate storage capacity remaining in the leachate collection system after a 25-year 24-hour storm event. Therefore, sufficient infrastructure is provided to prevent run-off from the active area of the Landfill as required by 40 CFR 257.81(a)(2).

### *2.3.5 Conclusions*

This Plan has demonstrated that the Landfill has a run-on control system and a run-off control system sufficient to prevent flow onto or off of the active portion during a 24-hour 25-year storm event. The Landfill is in compliance with the requirements of 40 CFR 257.81.

## 3.0 Amendment of the Plan and Notification

This Plan was been completed in compliance with the requirements set forth in 40 CFR 257.81. This document has been placed in the operating record, posted to the publicly accessible website, and government notifications have been provided.

A Run-On and Run-Off Control System Plan must be prepared every 5 years from the completion date of this Plan.

The Plan must be amended whenever the periodic review period is reached or if changes in site conditions, either intentionally or unintentionally, occur that will sustainably impact the current written plan in effect.

## 4.0 Engineer's Certification

Pursuant to 40 CFR 257.81 and by means of this certification I attest that:

(i) I am familiar with the requirements of the federal CCR rule (40 CFR 257);

(ii) this Run-On and Run-Off Control System Plan has been prepared in accordance with good engineering practice; and

(iii) this Run-On and Run-Off Control System Plan meets the requirements of 40 CFR 257.81(c).

For the purpose of this document, "certify" and "certification" shall be interpreted and construed to be a "statement of professional opinion." The certification is understood and intended to be an expression of my professional opinion as a Wisconsin licensed professional engineer, based upon knowledge, information, and belief. The statement(s) of professional opinion are not and shall not be interpreted or construed to be a guarantee or a warranty of the analysis herein.

Signature of Registered Professional Engineer

Registration No. 42745-6 State: Wisconsin

# Appendix A: Surface Water Run-On Control System Calculations

Note: For clarification purposes, these run-on calculations estimate "run-off" quantities from areas in and surrounding the Landfill that develop non-contact surface water that is managed to prevent run-on to the active Landfill areas.

- Surface Water Run-off Calculations
  - Purpose/Methodology/Assumptions/Results/References
  - Post-closure Run-off Calculations
  - Operational Run-off Calculations
  - Reference Information
- Diversion Berm, Perimeter Ditch, and Spillway Design Calculations
  - Purpose/Methodology/Assumptions/Results/References
  - Calculations – Post-closure Landfill Conditions
  - Calculations – Operational Landfill Conditions
  - Reference Information
- Culvert/Downslope Flume Design Calculations
  - Purpose/Methodology/Assumptions/Results/References
  - Calculations – Post-closure Landfill Conditions
  - Calculations – Temporary Culverts, Operational Conditions
- Vegetation Information

# Surface Water Run-off Calculations

# Purpose/Methodology/Assumptions/Results/References

744 Heartland Trail (53717-8923) P. O. Box 8923 (53708-8923) Madison, WI (608) 831-4444 FAX: (608) 831-3334 VOICE: (608) 831-1989

| PROJECT/PROPOSAL NAME | PREPARED By: | PREPARED Date: | CHECKED By: | CHECKED Date: | PROJECT/PROPOSAL NO. |
|---|---|---|---|---|---|
| Dairyland Power Cooperative | BJK | 5/97 | BLP | 6/97 | 3081.40 |

# SURFACE WATER RUNOFF CALCULATIONS

## Purpose

The purpose of the surface water runoff calculations was to estimate the amount of surface water runoff and the peak discharge for the 25-year, 24-hour and 100-year, 24-hour storms at the proposed Dairyland Power Landfill. Calculations were performed for the pre- and post-development conditions. Calculations were also performed for operational conditions for the 25-year, 24-hour storm. Once determined, the surface water runoff quantities were compared to determine the effect of the proposed landfill on the existing drainage patterns. The runoff calculations were also used to size diversion ditches, sedimentation basins, culverts, and downslope flumes.

## Methodologies

Surface water runoff calculations consist of delineating drainage areas (watersheds), as shown on the attached figures, estimating runoff characteristics, and calculating the peak and total runoff rate and volume for each drainage area. The methods for computing surface water runoff were based on the methodologies presented in the Technical Release No. 55 - "Urban Hydrology for Small Watersheds" by the United States Soil Conservation Service.

The calculations were performed using the QUICK TR-55 computer program developed by Haestad Methods (Haestad 1989). The program incorporates rainfall quantities, storm distributions, surface runoff characteristics, drainage areas, times of concentration, and travel times to generate a hydrograph from which the volume of surface water runoff and the peak discharge are obtained.

It is noted that the storm water control structures have been designed using a 100-year, 24-hour storm event and a TR-55 Type II storm distribution to determine peak flow rates. Rainfall distributions for the Type II storm event include "nested" higher intensity storm events within those needed for longer durations at the same probability. The resulting peak flows using this design method meet or exceed the peak flows obtained using a 25-year, time of concentration storm event (required by NR 504.09).

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| PROJECT/PROPOSAL NAME | PREPARED By: | PREPARED Date: | CHECKED By: | CHECKED Date: | PROJECT/PROPOSAL NO. |
|---|---|---|---|---|---|
| Dairyland Power Cooperative | BJK | 5/97 | BLP | 6/97 | 3081.40 |

## Assumptions

The following assumptions were made in developing the hydrographs (Note: The figures and values referenced in these assumptions have been included in the references portion of this appendix):

- A 2-year, 24-hour storm event in the vicinity of the landfill is 2.8 inches based on rainfall maps prepared by the U.S. Weather Bureau.
- A 25-year, 24-hour storm event in the vicinity of the landfill equates to 4.9 inches based on rainfall maps prepared by the U.S. Weather Bureau.
- A 100-year, 24-hour storm event in the vicinity of the landfill equates to 6.1 inches based on rainfall maps prepared by the U.S. Weather Bureau.
- A Type II rainfall distribution was used, based on SCS storm distribution maps provided in the TR-55 manual.
- Cover types for the pre-development conditions, from which runoff curve numbers were determined, were based on USGS topographic maps and an aerial photograph.
- For the post-development landfill conditions, a runoff curve number of 74 was assumed, based on values provided in the TR-55 manual.
- Based on the USDA-SCS General Soil Map for Buffalo County, Wisconsin, the primary soil formations present include the Dubuque silt loam and the Fayette silt loam. These soils are a Type B soil, based on tables provided in the TR-55 manual.
- Runoff curve numbers for the non-landfill areas ranged from 55 to 86, based on values provided in the TR-55 manual. Refer to the attached calculations for the breakdown and description of each of the curve numbers used for the various drainage areas.

## Results

The table below summarizes the results of the surface water runoff analyses and provides a comparison of the pre- and post-development conditions:

| STORM | TOTAL RUNOFF (acre-ft) | | | PEAK DISCHARGE (cfs) | | |
|---|---|---|---|---|---|---|
| | PRE- | POST- | Δ | PRE- | POST- | Δ |
| 25-year | 153 | 148 | (5) | 1,170 | 1,028 | (142) |
| 100-year | 232 | 225 | (7) | 1,895 | 1,622 | (273) |

Based on the results of the surface water runoff calculations, the proposed landfill is not anticipated to have an adverse impact on the existing surface water at the site. Total runoff volumes to the existing drainageways are not anticipated to change in the pre- and post-development conditions. Peak runoff volumes to the existing drainageways for post-

744 Heartland Trail (53717-8923) P. O. Box 8923 (53708-8923) Madison, WI (608) 831-4444 FAX: (608) 831-3334 VOICE: (608) 831-1989

| PROJECT/PROPOSAL NAME | PREPARED | | CHECKED | | PROJECT/PROPOSAL NO. |
|---|---|---|---|---|---|
| | By: | Date: | By: | Date: | |
| Dairyland Power Cooperative | BJK | 5/97 | BLP | 6/97 | 3081.40 |

development conditions are slightly lower than the pre-development conditions. This is primarily due to the use of sedimentation basins to dissipate peak flows from the landfill to the surrounding areas. The reduced peak flows will result in reduced sediment transport from the site.

The results of these surface water runoff calculations have also been used in the attached diversion berm, perimeter ditch, spillway, and sedimentation basin calculations. These structures have been designed to handle the peak runoff from the 100-year, 24-hour storm event.

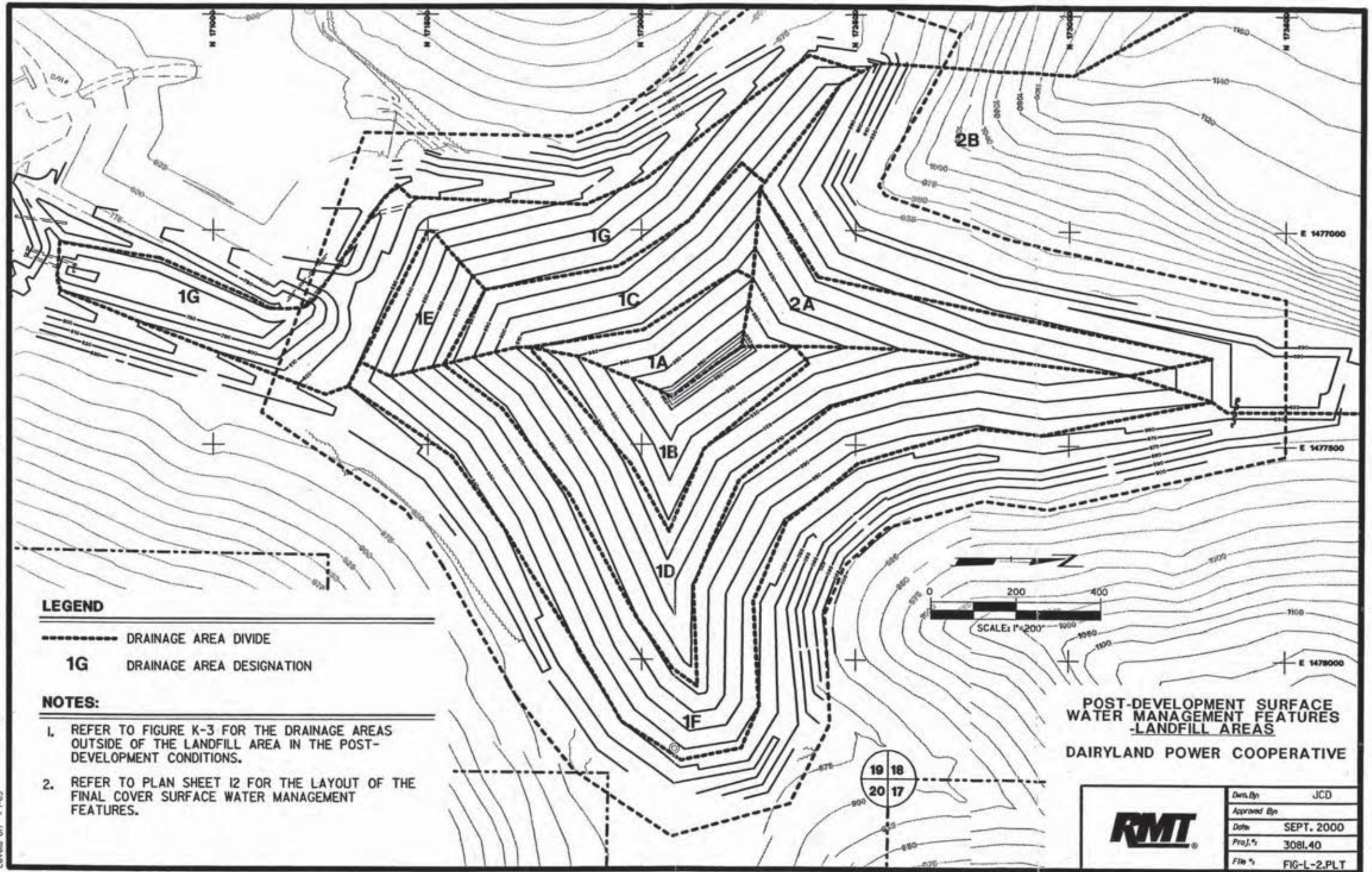
## References

US Department of Agriculture, Soil Conservation Service. Urban Hydrology for Small Watersheds. Technical Release No. 55. 2nd Edition. June 1986.

US Department of Agriculture, Soil Conservation Service. 1986. Engineering Field Manual for Conservation Practices. November 1986.

Haestad Methods. Pond Pack, QUICK TR-55. Hydrology for Small Watersheds. December 1989.

# Post-closure Run-off Calculations




RMT COMPUTER AIDED DESIGN & DRAFTING

FIGURE K-2

Quick TR-55 Ver.5.46 S/N:
Executed: 09:52:46 04-09-1997

Dairyland Power Coop.
Feasibility Report
Landfill Runoff
BJK 3/97

RUNOFF CURVE NUMBER SUMMARY

::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::

| Subarea Description | Area (acres) | CN (weighted) |
|---|---|---|
| 1A | 1.40 | 74 |
| 1B | 2.20 | 74 |
| 1C | 2.90 | 74 |
| 1D | 5.30 | 74 |
| 1E | 1.20 | 74 |
| 1F | 9.50 | 74 |
| 1G | 7.40 | 84 |

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Dairyland Power Coop.
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Landfill Runoff
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RUNOFF CURVE NUMBER DATA

::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::

Composite Area: 1A

| SURFACE DESCRIPTION | AREA (acres) | CN | |
|---|---|---|---|
| Landfill Cover | 1.40 | 74 | |
| COMPOSITE AREA ---> | 1.40 | 74.0 | ( 74 ) |

Composite Area: 1B

| SURFACE DESCRIPTION | AREA (acres) | CN | |
|---|---|---|---|
| Landfill Cover | 2.20 | 74 | |
| COMPOSITE AREA ---> | 2.20 | 74.0 | ( 74 ) |

Composite Area: 1C

| SURFACE DESCRIPTION | AREA (acres) | CN | |
|---|---|---|---|
| Landfill Cover | 2.90 | 74 | |
| COMPOSITE AREA ---> | 2.90 | 74.0 | ( 74 ) |

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Composite Area: 1D

| SURFACE DESCRIPTION | AREA (acres) | CN | |
|---|---|---|---|
| Landfill Cover | 5.30 | 74 | |
| COMPOSITE AREA ---> | 5.30 | 74.0 | ( 74 ) |

Composite Area: 1E

| SURFACE DESCRIPTION | AREA (acres) | CN | |
|---|---|---|---|
| Landfill Cover | 1.20 | 74 | |
| COMPOSITE AREA ---> | 1.20 | 74.0 | ( 74 ) |

Composite Area: 1F

| SURFACE DESCRIPTION | AREA (acres) | CN | |
|---|---|---|---|
| Landfill Cover | 9.50 | 74 | |
| COMPOSITE AREA ---> | 9.50 | 74.0 | ( 74 ) |

Composite Area: 1G

| SURFACE DESCRIPTION | AREA (acres) | CN | |
|---|---|---|---|
| Landfill Cover | 4.40 | 74 | |
| Sedimentation Basin | 3.00 | 98 | |
| COMPOSITE AREA ---> | 7.40 | 83.7 | ( 84 ) |

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Dairyland Power Coop.
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Landfill Runoff
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RUNOFF CURVE NUMBER SUMMARY

| Subarea Description | Area (acres) | CN (weighted) |
|---|---|---|
| 2A | 2.70 | 74 |
| 2B | 21.50 | 69 |

Quick TR-55 Ver.5.46 S/N:
Executed: 09:53:01 04-09-1997

✓ BJB 6/13/97

Dairyland Power Coop.
Feasibility Report
Landfill Runoff
BJK 3/97

RUNOFF CURVE NUMBER DATA

::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::

Composite Area: 2A

| SURFACE DESCRIPTION | AREA (acres) | CN | |
|---|---|---|---|
| Landfill Cover | 2.70 | 74 | |
| COMPOSITE AREA ---> | 2.70 | 74.0 | ( 74 ) |

::::::::::::::::::::::::::::::::::::::::::::::::::::::::

Composite Area: 2B

| SURFACE DESCRIPTION | AREA (acres) | CN | |
|---|---|---|---|
| Landfill Cover | 2.70 | 74 | |
| Graded/Grassed Area | 2.00 | 61 | |
| Woods/Brush | 15.80 | 67 | |
| Sedimentation Basin | 1.00 | 98 | |
| COMPOSITE AREA ---> | 21.50 | 68.8 | ( 69 ) |

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Quick TR-55 Ver.5.46 S/N:
Executed: 08:55:25 06-18-1997 a:COVER1.TCT

SUMMARY SHEET FOR Tc or Tt COMPUTATIONS
(Solved for Time using TR-55 Methods)

Dairyland Power Coop.
Feasibility Report
Landfill Final Cover
BJK 3/97

| Subarea descr. | Tc or Tt | Time (hrs) |
|---|---|---|
| 1A | Tc | 0.18 |
| 1B | Tc | 0.23 |
| 1C | Tc | 0.23 |
| 1D | Tc | 0.35 |
| 1E | Tc | 0.18 |
| 1F | Tc | 0.45 |
| 1G | Tc | 0.22 |

Quick TR-55 Ver.5.46 S/N:
Executed: 09:48:41 04-09-1997 a:COVER1.TCT

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Feasibility Report
Landfill Final Cover
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Tc COMPUTATIONS FOR: 1A

SHEET FLOW (Applicable to Tc only)

| | | | |
|---|---|---|---|
| Segment ID | | 1 | |
| Surface description | | Dense Grass | |
| Manning's roughness coeff., n | | 0.2400 ✓ | |
| Flow length, L (total < or = 300) | ft | 150.0 ✓ | |
| Two-yr 24-hr rainfall, P2 | in | 2.800 | |
| Land slope, s | ft/ft | 0.2500 ✓ | |

$$T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$$ hrs 0.13 = 0.13

SHALLOW CONCENTRATED FLOW

| | | | |
|---|---|---|---|
| Segment ID | | 2 | |
| Surface (paved or unpaved)? | | Unpaved | |
| Flow length, L | ft | 420.0 ✓ | |
| Watercourse slope, s | ft/ft | 0.0200 ✓ | |

$$Avg.V = Csf * (s)^{0.5}$$ ft/s 2.2818

where: Unpaved Csf = 16.1345
Paved Csf = 20.3282

T = L / (3600*V) hrs 0.05 = 0.05

CHANNEL FLOW

| | | | |
|---|---|---|---|
| Segment ID | | | |
| Cross Sectional Flow Area, a | sq.ft | 0.00 | |
| Wetted perimeter, Pw | ft | 0.00 | |
| Hydraulic radius, r = a/Pw | ft | 0.000 | |
| Channel slope, s | ft/ft | 0.0000 | |
| Manning's roughness coeff., n | | 0.0000 | |

$$V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$$ ft/s 0.0000

Flow length, L ft 0

T = L / (3600*V) hrs 0.00 = 0.00

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TOTAL TIME (hrs) 0.18

Quick TR-55 Ver.5.46 S/N:
Executed: 09:48:41 04-09-1997 a:COVER1.TCT

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Dairyland Power Coop.
Feasibility Report
Landfill Final Cover
BJK 3/97

Tc COMPUTATIONS FOR: 1B

SHEET FLOW (Applicable to Tc only)

| | | | |
|---|---|---|---|
| Segment ID | | 1 | |
| Surface description | | Dense Grass | |
| Manning's roughness coeff., n | | 0.2400 | |
| Flow length, L (total < or = 300) | ft | 125.0 | |
| Two-yr 24-hr rainfall, P2 | in | 2.800 | |
| Land slope, s | ft/ft | 0.2500 | |

$$T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$$ hrs 0.11 = 0.11

SHALLOW CONCENTRATED FLOW

| | | | |
|---|---|---|---|
| Segment ID | | 2 | |
| Surface (paved or unpaved)? | | Unpaved | |
| Flow length, L | ft | 960.0 | |
| Watercourse slope, s | ft/ft | 0.0200 | |

$$Avg.V = Csf * (s)^{0.5}$$ ft/s 2.2818

where: Unpaved Csf = 16.1345
Paved Csf = 20.3282

T = L / (3600*V) hrs 0.12 = 0.12

CHANNEL FLOW

| | | |
|---|---|---|
| Segment ID | | |
| Cross Sectional Flow Area, a | sq.ft | 0.00 |
| Wetted perimeter, Pw | ft | 0.00 |
| Hydraulic radius, r = a/Pw | ft | 0.000 |
| Channel slope, s | ft/ft | 0.0000 |
| Manning's roughness coeff., n | | 0.0000 |

$$V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$$ ft/s 0.0000

Flow length, L ft 0

T = L / (3600*V) hrs 0.00 = 0.00

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TOTAL TIME (hrs) 0.23

Quick TR-55 Ver.5.46 S/N:
Executed: 09:48:41 04-09-1997 a:COVER1.TCT

✓ GAG 6/13/97

Dairyland Power Coop.
Feasibility Report
Landfill Final Cover
BJK 3/97

Tc COMPUTATIONS FOR: 1C

SHEET FLOW (Applicable to Tc only)

| | | | |
|---|---|---|---|
| Segment ID | | 1 | |
| Surface description | | Dense Grass | |
| Manning's roughness coeff., n | | 0.2400 | |
| Flow length, L (total < or = 300) | ft | 165.0 | |
| Two-yr 24-hr rainfall, P2 | in | 2.800 | |
| Land slope, s | ft/ft | 0.2500 | |
| $T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$ | hrs | 0.14 | = 0.14 |

SHALLOW CONCENTRATED FLOW

| | | | |
|---|---|---|---|
| Segment ID | | 2 | |
| Surface (paved or unpaved)? | | Unpaved | |
| Flow length, L | ft | 720.0 | |
| Watercourse slope, s | ft/ft | 0.0200 | |
| $Avg.V = Csf * (s)^{0.5}$ | ft/s | 2.2818 | |
| where: Unpaved Csf = 16.1345 | | | |
| Paved Csf = 20.3282 | | | |
| T = L / (3600*V) | hrs | 0.09 | = 0.09 |

CHANNEL FLOW

| | | | |
|---|---|---|---|
| Segment ID | | | |
| Cross Sectional Flow Area, a | sq.ft | 0.00 | |
| Wetted perimeter, Pw | ft | 0.00 | |
| Hydraulic radius, r = a/Pw | ft | 0.000 | |
| Channel slope, s | ft/ft | 0.0000 | |
| Manning's roughness coeff., n | | 0.0000 | |
| $V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$ | ft/s | 0.0000 | |
| Flow length, L | ft | 0 | |
| T = L / (3600*V) | hrs | 0.00 | = 0.00 |

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TOTAL TIME (hrs) 0.23

Quick TR-55 Ver.5.46 S/N:
Executed: 08:55:25 06-18-1997 a:COVER1.TCT

✓ BJG 6/13/97

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Feasibility Report
Landfill Final Cover
BJK 3/97

Tc COMPUTATIONS FOR: 1D

SHEET FLOW (Applicable to Tc only)

| | | | |
|---|---|---|---|
| Segment ID | | 1 | |
| Surface description | | Dense Grass | |
| Manning's roughness coeff., n | | 0.2400 | |
| Flow length, L (total < or = 300) | ft | 160.0 ✓ | |
| Two-yr 24-hr rainfall, P2 | in | 2.800 | |
| Land slope, s | ft/ft | 0.2500 ✓ | |
| $T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$ | hrs | 0.13 | = 0.13 |

SHALLOW CONCENTRATED FLOW

| | | | |
|---|---|---|---|
| Segment ID | | 2 | |
| Surface (paved or unpaved)? | | Unpaved | |
| Flow length, L | ft | 1770.0 ✓ | |
| Watercourse slope, s | ft/ft | 0.0200 ✓ | |
| $Avg.V = Csf * (s)^{0.5}$ | ft/s | 2.2818 | |
| where: Unpaved Csf = 16.1345 | | | |
| Paved Csf = 20.3282 | | | |
| T = L / (3600*V) | hrs | 0.22 | = 0.22 |

CHANNEL FLOW

| | | | |
|---|---|---|---|
| Segment ID | | | |
| Cross Sectional Flow Area, a | sq.ft | 0.00 | |
| Wetted perimeter, Pw | ft | 0.00 | |
| Hydraulic radius, r = a/Pw | ft | 0.000 | |
| Channel slope, s | ft/ft | 0.0000 | |
| Manning's roughness coeff., n | | 0.0000 | |
| $V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$ | ft/s | 0.0000 | |
| Flow length, L | ft | 0 | |
| T = L / (3600*V) | hrs | 0.00 | = 0.00 |

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TOTAL TIME (hrs) 0.35

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Feasibility Report
Landfill Final Cover
BJK 3/97

Tc COMPUTATIONS FOR: 1E

SHEET FLOW (Applicable to Tc only)

| | | | |
|---|---|---|---|
| Segment ID | | 1 | |
| Surface description | | Dense Grass | |
| Manning's roughness coeff., n | | 0.2400 | |
| Flow length, L (total < or = 300) | ft | 175.0 ✓ | |
| Two-yr 24-hr rainfall, P2 | in | 2.800 | |
| Land slope, s | ft/ft | 0.2500 ✓ | |
| $T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$ | hrs | 0.14 | = 0.14 |

SHALLOW CONCENTRATED FLOW

| | | | |
|---|---|---|---|
| Segment ID | | 2 | |
| Surface (paved or unpaved)? | | Unpaved | |
| Flow length, L | ft | 250.0 ✓ | |
| Watercourse slope, s | ft/ft | 0.0200 ✓ | |
| $Avg.V = Csf * (s)^{0.5}$ | ft/s | 2.2818 | |
| where: Unpaved Csf = 16.1345 | | | |
| Paved Csf = 20.3282 | | | |
| T = L / (3600*V) | hrs | 0.03 | = 0.03 |

CHANNEL FLOW

| | | | |
|---|---|---|---|
| Segment ID | | | |
| Cross Sectional Flow Area, a | sq.ft | 0.00 | |
| Wetted perimeter, Pw | ft | 0.00 | |
| Hydraulic radius, r = a/Pw | ft | 0.000 | |
| Channel slope, s | ft/ft | 0.0000 | |
| Manning's roughness coeff., n | | 0.0000 | |
| $V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$ | ft/s | 0.0000 | |
| Flow length, L | ft | 0 | |
| T = L / (3600*V) | hrs | 0.00 | = 0.00 |

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TOTAL TIME (hrs) 0.18

Quick TR-55 Ver.5.46 S/N:
Executed: 09:48:41 04-09-1997 a:COVER1.TCT

Dairyland Power Coop.
Feasibility Report
Landfill Final Cover
BJK 3/97

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Tc COMPUTATIONS FOR: 1F

SHEET FLOW (Applicable to Tc only)

| | | | |
|---|---|---|---|
| Segment ID | | 1 | |
| Surface description | | Dense Grass | |
| Manning's roughness coeff., n | | 0.2400 | |
| Flow length, L (total < or = 300) | ft | 150.0 | |
| Two-yr 24-hr rainfall, P2 | in | 2.800 | |
| Land slope, s | ft/ft | 0.2500 | |
| $T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$ | hrs | 0.13 | = 0.13 |

SHALLOW CONCENTRATED FLOW

| | | | |
|---|---|---|---|
| Segment ID | | 2 | |
| Surface (paved or unpaved)? | | Unpaved | |
| Flow length, L | ft | 2650.0 | |
| Watercourse slope, s | ft/ft | 0.0200 | |
| $Avg.V = Csf * (s)^{0.5}$ | ft/s | 2.2818 | |
| where: Unpaved Csf = 16.1345 | | | |
| Paved Csf = 20.3282 | | | |
| T = L / (3600*V) | hrs | 0.32 | = 0.32 |

CHANNEL FLOW

| | | | |
|---|---|---|---|
| Segment ID | | | |
| Cross Sectional Flow Area, a | sq.ft | 0.00 | |
| Wetted perimeter, Pw | ft | 0.00 | |
| Hydraulic radius, r = a/Pw | ft | 0.000 | |
| Channel slope, s | ft/ft | 0.0000 | |
| Manning's roughness coeff., n | | 0.0000 | |
| $V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$ | ft/s | 0.0000 | |
| Flow length, L | ft | 0 | |
| T = L / (3600*V) | hrs | 0.00 | = 0.00 |

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TOTAL TIME (hrs) 0.45

Quick TR-55 Ver.5.46 S/N:
Executed: 09:48:41 04-09-1997 a:COVER1.TCT

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Dairyland Power Coop.
Feasibility Report
Landfill Final Cover
BJK 3/97

Tc COMPUTATIONS FOR: 1G

SHEET FLOW (Applicable to Tc only)

| | | | | |
|---|---|---|---|---|
| Segment ID | | 1 | | |
| Surface description | | Dense Grass | | |
| Manning's roughness coeff., n | | 0.2400 | | |
| Flow length, L (total < or = 300) | ft | 170.0 | | |
| Two-yr 24-hr rainfall, P2 | in | 2.800 | | |
| Land slope, s | ft/ft | 0.2500 | | |
| $T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$ | hrs | 0.14 | | = 0.14 |

SHALLOW CONCENTRATED FLOW

| | | | | |
|---|---|---|---|---|
| Segment ID | | 2 | 3 | |
| Surface (paved or unpaved)? | | Unpaved | Unpaved | |
| Flow length, L | ft | 780.0 | 370.0 | |
| Watercourse slope, s | ft/ft | 0.0600 | 0.0800 | |
| $Avg.V = Csf * (s)^{0.5}$ | ft/s | 3.9521 | 4.5635 | |
| where: Unpaved Csf = 16.1345 | | | | |
| Paved Csf = 20.3282 | | | | |
| T = L / (3600*V) | hrs | 0.05 | + 0.02 | = 0.08 |

CHANNEL FLOW

| | | | |
|---|---|---|---|
| Segment ID | | | |
| Cross Sectional Flow Area, a | sq.ft | 0.00 | |
| Wetted perimeter, Pw | ft | 0.00 | |
| Hydraulic radius, r = a/Pw | ft | 0.000 | |
| Channel slope, s | ft/ft | 0.0000 | |
| Manning's roughness coeff., n | | 0.0000 | |
| $V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$ | ft/s | 0.0000 | |
| Flow length, L | ft | 0 | |
| T = L / (3600*V) | hrs | 0.00 | = 0.00 |

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TOTAL TIME (hrs) 0.22

Quick TR-55 Ver.5.46 S/N:
Executed: 08:57:44 06-18-1997 a:COVER2.TCT

SUMMARY SHEET FOR Tc or Tt COMPUTATIONS
(Solved for Time using TR-55 Methods)

Dairyland Power Coop.
Feasibility Report
Landfill Final Cover
BJK 3/97

| Subarea descr. | Tc or Tt | Time (hrs) |
|---|---|---|
| 2A | Tc | 0.28 |
| 2B | Tc | 0.18 |

Quick TR-55 Ver.5.46 S/N:
Executed: 08:57:44 06-18-1997 a:COVER2.TCT

Dairyland Power Coop.
Feasibility Report
Landfill Final Cover
BJK 3/97

✓ BJG 6/13/97

Tc COMPUTATIONS FOR: 2A

SHEET FLOW (Applicable to Tc only)

| | | |
|---|---|---|
| Segment ID | | 1 |
| Surface description | | Dense Grass |
| Manning's roughness coeff., n | | 0.2400 |
| Flow length, L (total < or = 300) | ft | 200.0 ✓ |
| Two-yr 24-hr rainfall, P2 | in | 2.800 |
| Land slope, s | ft/ft | 0.2500 ✓ |

$$T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$$ hrs 0.16 = 0.16

SHALLOW CONCENTRATED FLOW

| | | |
|---|---|---|
| Segment ID | | 2 |
| Surface (paved or unpaved)? | | Unpaved |
| Flow length, L | ft | 940.0 ✓ |
| Watercourse slope, s | ft/ft | 0.0200 ✓ |

$$Avg.V = Csf * (s)^{0.5}$$ ft/s 2.2818

where: Unpaved Csf = 16.1345
Paved Csf = 20.3282

T = L / (3600*V) hrs 0.11 = 0.11

CHANNEL FLOW

| | | |
|---|---|---|
| Segment ID | | |
| Cross Sectional Flow Area, a | sq.ft | 0.00 |
| Wetted perimeter, Pw | ft | 0.00 |
| Hydraulic radius, r = a/Pw | ft | 0.000 |
| Channel slope, s | ft/ft | 0.0000 |
| Manning's roughness coeff., n | | 0.0000 |

$$V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$$ ft/s 0.0000

Flow length, L ft 0

T = L / (3600*V) hrs 0.00 = 0.00

::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::

TOTAL TIME (hrs) 0.28

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Quick TR-55 Ver.5.46   S/N:
Executed: 08:57:44   06-18-1997    a:COVER2.TCT

                          Dairyland Power Coop.
                           Feasibility Report
                          Landfill Final Cover
                               BJK 3/97

                    Tc COMPUTATIONS FOR: 2B

 SHEET FLOW (Applicable to Tc only)
    Segment ID                                 1
    Surface description                    Brush
    Manning's roughness coeff., n               0.1300
    Flow length, L (total < or = 300)    ft     300.0
    Two-yr 24-hr rainfall, P2             in     2.800
    Land slope, s                      ft/ft    0.2000
                       0.8
         .007 * (n*L)
    T =  --------------                  hrs      0.15              =  0.15
            0.5    0.4
          P2   *  s

 SHALLOW CONCENTRATED FLOW
    Segment ID                                 2        3
    Surface (paved or unpaved)?             Unpaved  Unpaved
    Flow length, L                       ft     560.0    300.0
    Watercourse slope, s               ft/ft   0.4400   0.0800

                        0.5
    Avg.V =  Csf *  (s)                ft/s  %10.7024  4.5635
    where:   Unpaved Csf = 16.1345
             Paved   Csf = 20.3282

    T = L / (3600*V)                    hrs     0.01  +   0.02  =  0.03


 CHANNEL FLOW
    Segment ID
    Cross Sectional Flow Area, a      sq.ft     0.00
    Wetted perimeter, Pw                 ft     0.00
    Hydraulic radius, r = a/Pw           ft     0.000
    Channel slope, s                  ft/ft    0.0000
    Manning's roughness coeff., n              0.0000

                    2/3    1/2
       1.49  *  r   *  s
    V =  --------------------          ft/s    0.0000
                  n

    Flow length, L                       ft         0

    T = L / (3600*V)                    hrs     0.00                =  0.00

  ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                                      TOTAL TIME (hrs)       0.18
```

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 09-18-2000 12:51:33
Watershed file: --> P:\DATA\PROJECTS\3081\40\SW\COVER1 .MOP
Hydrograph file: --> P:\DATA\PROJECTS\3081\40\SW\COVER125.HYD

Dairyland Power Coop.
Fesibility Study
Landfill Cover
BJK 3/97

>>>> Input Parameters Used to Compute Hydrograph <<<<

| Subarea Description | AREA (acres) | CN | Tc (hrs) | * Tt (hrs) | Precip. (in) | Runoff (in) | Ia/p input/used | |
|---|---|---|---|---|---|---|---|---|
| 1A | 1.40 | 74.0 | 0.20 | 0.00 | 4.90 | 2.28 | I.14 | .14 |
| 1B | 2.20 | 74.0 | 0.20 | 0.00 | 4.90 | 2.28 | I.14 | .14 |
| 1C | 2.90 | 74.0 | 0.20 | 0.00 | 4.90 | 2.28 | I.14 | .14 |
| 1D | 5.30 | 74.0 | 0.40 | 0.00 | 4.90 | 2.28 | I.14 | .14 |
| 1E | 1.20 | 74.0 | 0.20 | 0.00 | 4.90 | 2.28 | I.14 | .14 |
| 1F | 9.50 | 74.0 | 0.50 | 0.00 | 4.90 | 2.28 | I.14 | .14 |
| 1G | 7.40 | 84.0 | 0.20 | 0.00 | 4.90 | 3.18 | I.08 | .10 |

* Travel time from subarea outfall to composite watershed outfall point.
I -- Subarea where user specified interpolation between Ia/p tables.

Total area = 29.90 acres or 0.04672 sq.mi
Peak discharge = 67 cfs

WARNING: Drainage areas of two or more subareas differ by a factor of 5 or greater.

Total Runoff =

$$\frac{22.5\,ac\,(2.25'') + 7.4\,ac\,(3.18\,in)}{12}$$

$\Rightarrow 6.2\,ac\text{-}FT$

>>>> Computer Modifications of Input Parameters <<<<<

| Subarea Description | Input Values Tc (hr) | Input Values * Tt (hr) | Rounded Values Tc (hr) | Rounded Values * Tt (hr) | Ia/p Interpolated (Yes/No) | Ia/p Messages |
|---|---|---|---|---|---|---|
| 1A | 0.18 | 0.00 | 0.20 | 0.00 | Yes | -- |
| 1B | 0.23 | 0.00 | 0.20 | 0.00 | Yes | -- |
| 1C | 0.23 | 0.00 | 0.20 | 0.00 | Yes | -- |
| 1D | 0.35 | 0.00 | 0.40 | 0.00 | Yes | -- |
| 1E | 0.18 | 0.00 | 0.20 | 0.00 | Yes | -- |
| 1F | 0.45 | 0.00 | 0.50 | 0.00 | Yes | -- |
| 1G | 0.22 | 0.00 | 0.20 | 0.00 | No | Computed Ia/p < .1 |

* Travel time from subarea outfall to composite watershed outfall point.

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 09-18-2000 12:51:33
Watershed file: --> P:\DATA\PROJECTS\3081\40\SW\COVER1 .MOP
Hydrograph file: --> P:\DATA\PROJECTS\3081\40\SW\COVER125.HYD

Dairyland Power Coop.
Fesibility Study
Landfill Cover
BJK 3/97

>>>> Summary of Subarea Times to Peak <<<<

| Subarea | Peak Discharge at Composite Outfall (cfs) | Time to Peak at Composite Outfall (hrs) |
|---|---|---|
| 1A | 4 | 12.2 |
| 1B | 6 | 12.2 |
| 1C | 8 | 12.2 |
| 1D | 11 | 12.3 |
| 1E | 3 | 12.1 |
| 1F | 17 | 12.4 |
| 1G | 29 | 12.2 |
| Composite Watershed | 67 | 12.2 |

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 09-18-2000 12:51:33
Watershed file: --> P:\DATA\PROJECTS\3081\40\SW\COVER1 .MOP
Hydrograph file: --> P:\DATA\PROJECTS\3081\40\SW\COVER125.HYD

Dairyland Power Coop.
Fesibility Study
Landfill Cover
BJK 3/97

Composite Hydrograph Summary (cfs)

| Subarea Description | 11.0 hr | 11.3 hr | 11.6 hr | 11.9 hr | 12.0 hr | 12.1 hr | 12.2 hr | 12.3 hr | 12.4 hr |
|---|---|---|---|---|---|---|---|---|---|
| 1A | 0 | 0 | 0 | 1 | 2 | 3 | 4 | 2 | 1 |
| 1B | 0 | 0 | 0 | 1 | 3 | 5 | 6 | 4 | 2 |
| 1C | 0 | 0 | 0 | 2 | 4 | 7 | 8 | 5 | 3 |
| 1D | 0 | 0 | 1 | 1 | 2 | 5 | 8 | 11 | 11 |
| 1E | 0 | 0 | 0 | 1 | 2 | 3 | 3 | 2 | 1 |
| 1F | 0 | 1 | 1 | 2 | 3 | 5 | 9 | 15 | 17 |
| 1G | 1 | 1 | 2 | 8 | 15 | 27 | 29 | 18 | 9 |
| Total (cfs) | 1 | 2 | 4 | 16 | 31 | 55 | 67 | 57 | 44 |

| Subarea Description | 12.5 hr | 12.6 hr | 12.7 hr | 12.8 hr | 13.0 hr | 13.2 hr | 13.4 hr | 13.6 hr | 13.8 hr |
|---|---|---|---|---|---|---|---|---|---|
| 1A | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1B | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| 1C | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| 1D | 8 | 6 | 4 | 3 | 2 | 2 | 1 | 1 | 1 |
| 1E | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1F | 17 | 13 | 10 | 8 | 5 | 3 | 3 | 2 | 2 |
| 1G | 6 | 5 | 4 | 3 | 3 | 2 | 2 | 2 | 2 |
| Total (cfs) | 36 | 28 | 21 | 16 | 12 | 9 | 7 | 6 | 5 |

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 09-18-2000 12:51:33
Watershed file: --> P:\DATA\PROJECTS\3081\40\SW\COVER1 .MDP
Hydrograph file: --> P:\DATA\PROJECTS\3081\40\SW\COVER125.HYD

Dairyland Power Coop.
Fesibility Study
Landfill Cover
BJK 3/97

Composite Hydrograph Summary (cfs)

| Subarea Description | 14.0 hr | 14.3 hr | 14.6 hr | 15.0 hr | 15.5 hr | 16.0 hr | 16.5 hr | 17.0 hr | 17.5 hr |
|---|---|---|---|---|---|---|---|---|---|
| 1A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1D | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| 1E | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1F | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1G | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Total (cfs) | 4 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 |

| Subarea Description | 18.0 hr | 19.0 hr | 20.0 hr | 22.0 hr | 26.0 hr |
|---|---|---|---|---|---|
| 1A | 0 | 0 | 0 | 0 | 0 |
| 1B | 0 | 0 | 0 | 0 | 0 |
| 1C | 0 | 0 | 0 | 0 | 0 |
| 1D | 0 | 0 | 0 | 0 | 0 |
| 1E | 0 | 0 | 0 | 0 | 0 |
| 1F | 1 | 1 | 1 | 0 | 0 |
| 1G | 1 | 1 | 0 | 0 | 0 |
| Total (cfs) | 2 | 2 | 1 | 0 | 0 |

Return Frequency: 100 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 07-30-1998 11:54:55
Watershed file: --> A:COVER1 .MOP
Hydrograph file: --> A:COVER100.HYD

/BJB 8/20/98

Dairyland Power Coop.
Fesibility Study
Landfill Cover
BJK 3/97

>>>> Input Parameters Used to Compute Hydrograph <<<<

| Subarea Description | AREA (acres) | CN | Tc (hrs) | * Tt (hrs) | Precip. (in) | Runoff (in) | Ia/p input/used | |
|---|---|---|---|---|---|---|---|---|
| 1A | 1.40 | 74.0 | 0.20 | 0.00 | 6.10 | 3.27 | I.12 | .12 |
| 1B | 2.20 | 74.0 | 0.20 | 0.00 | 6.10 | 3.27 | I.12 | .12 |
| 1C | 2.90 | 74.0 | 0.20 | 0.00 | 6.10 | 3.27 | I.12 | .12 |
| 1D | 5.30 | 74.0 | 0.40 | 0.00 | 6.10 | 3.27 | I.12 | .12 |
| 1E | 1.20 | 74.0 | 0.20 | 0.00 | 6.10 | 3.27 | I.12 | .12 |
| 1F | 9.50 | 74.0 | 0.50 | 0.00 | 6.10 | 3.27 | I.12 | .12 |
| 1G | 7.40 | 84.0 | 0.20 | 0.00 | 6.10 | 4.29 | I.06 | .10 |

* Travel time from subarea outfall to composite watershed outfall point.
I -- Subarea where user specified interpolation between Ia/p tables.

Total area = 29.90 acres or 0.04672 sq.mi
Peak discharge = 98 cfs

WARNING: Drainage areas of two or more subareas differ by a factor of 5 or greater.

Total Runoff =

$$\frac{22.5\text{ ac }(3.27'') + 7.4\text{ ac }(4.29'')}{12}$$

= 3.8 ac-FT

>>>> Computer Modifications of Input Parameters <<<<<

| Subarea Description | Input Values Tc (hr) | Input Values * Tt (hr) | Rounded Values Tc (hr) | Rounded Values * Tt (hr) | Ia/p Interpolated (Yes/No) | Ia/p Messages |
|---|---|---|---|---|---|---|
| 1A | 0.18 | 0.00 | 0.20 | 0.00 | Yes | -- |
| 1B | 0.23 | 0.00 | 0.20 | 0.00 | Yes | -- |
| 1C | 0.23 | 0.00 | 0.20 | 0.00 | Yes | -- |
| 1D | 0.35 | 0.00 | 0.40 | 0.00 | Yes | -- |
| 1E | 0.18 | 0.00 | 0.20 | 0.00 | Yes | -- |
| 1F | 0.45 | 0.00 | 0.50 | 0.00 | Yes | -- |
| 1G | 0.22 | 0.00 | 0.20 | 0.00 | No | Computed Ia/p < .1 |

* Travel time from subarea outfall to composite watershed outfall point.

Return Frequency: 100 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 07-30-1998 11:54:55
Watershed file: --> A:COVER1 .WOP
Hydrograph file: --> A:COVER100.HYD

Dairyland Power Coop.
Fesibility Study
Landfill Cover
BJK 3/97

>>>> Summary of Subarea Times to Peak <<<<

| Subarea | Peak Discharge at Composite Outfall (cfs) | Time to Peak at Composite Outfall (hrs) |
|---|---|---|
| 1A | 6 | 12.2 |
| 1B | 9 | 12.2 |
| 1C | 12 | 12.2 |
| 1D | 16 | 12.3 |
| 1E | 5 | 12.2 |
| 1F | 25 | 12.4 |
| 1G | 40 | 12.2 |
| Composite Watershed | 98 | 12.2 |

Return Frequency: 100 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 07-30-1998 11:54:55
Watershed file: --> A:COVER1 .WOP
Hydrograph file: --> A:COVER100.HYD

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Composite Hydrograph Summary (cfs)

| Subarea Description | 11.0 hr | 11.3 hr | 11.6 hr | 11.9 hr | 12.0 hr | 12.1 hr | 12.2 hr | 12.3 hr | 12.4 hr |
|---|---|---|---|---|---|---|---|---|---|
| 1A | 0 | 0 | 0 | 1 | 3 | 5 | 6 | 3 | 2 |
| 1B | 0 | 0 | 0 | 2 | 4 | 8 | 9 | 5 | 3 |
| 1C | 0 | 0 | 1 | 3 | 6 | 11 | 12 | 7 | 4 |
| 1D | 0 | 1 | 1 | 2 | 4 | 7 | 12 | 16 | 15 |
| 1E | 0 | 0 | 0 | 1 | 2 | 4 | 5 | 3 | 2 |
| 1F | 1 | 1 | 1 | 2 | 4 | 8 | 14 | 22 | 25 |
| 1G | 1 | 2 | 2 | 10 | 20 | 37 | 40 | 24 | 12 |
| Total (cfs) | 2 | 4 | 5 | 21 | 43 | 80 | 98 | 80 | 63 |

| Subarea Description | 12.5 hr | 12.6 hr | 12.7 hr | 12.8 hr | 13.0 hr | 13.2 hr | 13.4 hr | 13.6 hr | 13.8 hr |
|---|---|---|---|---|---|---|---|---|---|
| 1A | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| 1B | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1C | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1D | 12 | 8 | 6 | 4 | 3 | 2 | 2 | 2 | 1 |
| 1E | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| 1F | 24 | 19 | 14 | 11 | 7 | 5 | 4 | 3 | 3 |
| 1G | 8 | 6 | 5 | 4 | 3 | 3 | 3 | 2 | 2 |
| Total (cfs) | 51 | 38 | 30 | 23 | 16 | 12 | 11 | 9 | 8 |

Return Frequency: 100 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 07-30-1998 11:54:55
Watershed file: --> A:COVER1 .WDP
Hydrograph file: --> A:COVER100.HYD

Dairyland Power Coop.
Fesibility Study
Landfill Cover
BJK 3/97

Composite Hydrograph Summary (cfs)

| Subarea Description | 14.0 hr | 14.3 hr | 14.6 hr | 15.0 hr | 15.5 hr | 16.0 hr | 16.5 hr | 17.0 hr | 17.5 hr |
|---|---|---|---|---|---|---|---|---|---|
| 1A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1C | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1D | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1E | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1F | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 |
| 1G | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 |
| Total (cfs) | 6 | 6 | 6 | 4 | 3 | 3 | 3 | 3 | 3 |

| Subarea Description | 18.0 hr | 19.0 hr | 20.0 hr | 22.0 hr | 26.0 hr |
|---|---|---|---|---|---|
| 1A | 0 | 0 | 0 | 0 | 0 |
| 1B | 0 | 0 | 0 | 0 | 0 |
| 1C | 0 | 0 | 0 | 0 | 0 |
| 1D | 1 | 0 | 0 | 0 | 0 |
| 1E | 0 | 0 | 0 | 0 | 0 |
| 1F | 1 | 1 | 1 | 1 | 0 |
| 1G | 1 | 1 | 1 | 1 | 0 |
| Total (cfs) | 3 | 2 | 2 | 2 | 0 |

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 09-18-2000 12:51:16
Watershed file: --> P:\DATA\PROJECTS\3081\40\SW\COVER2 .MOP
Hydrograph file: --> P:\DATA\PROJECTS\3081\40\SW\COVER225.HYD

Dairyland Power Coop.
Fesibility Study
Landfill Cover
BJK 3/97

>>>> Input Parameters Used to Compute Hydrograph <<<<

| Subarea Description | AREA (acres) | CN | Tc (hrs) | * Tt (hrs) | Precip. (in) | Runoff (in) | Ia/p input/used |
|---|---|---|---|---|---|---|---|
| 2A | 2.70 | 74.0 | 0.30 | 0.00 | 4.90 | 2.28 | I.14 .14 |
| 2B | 21.50 | 69.0 | 0.20 | 0.00 | 4.90 | 1.89 | I.18 .18 |

* Travel time from subarea outfall to composite watershed outfall point.
I -- Subarea where user specified interpolation between Ia/p tables.

Total area = 24.20 acres or 0.03781 sq.mi
Peak discharge = 54 cfs

WARNING: Drainage areas of two or more subareas
differ by a factor of 5 or greater.

>>>> Computer Modifications of Input Parameters <<<<<

| Subarea Description | Input Values Tc (hr) | * Tt (hr) | Rounded Values Tc (hr) | * Tt (hr) | Ia/p Interpolated (Yes/No) | Ia/p Messages |
|---|---|---|---|---|---|---|
| 2A | 0.28 | 0.00 | 0.30 | 0.00 | Yes | -- |
| 2B | 0.18 | 0.00 | 0.20 | 0.00 | Yes | -- |

* Travel time from subarea outfall to composite watershed outfall point.

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 09-18-2000 12:51:16
Watershed file: --> P:\DATA\PROJECTS\3081\40\SW\COVER2 .MOP
Hydrograph file: --> P:\DATA\PROJECTS\3081\40\SW\COVER225.HYD

Dairyland Power Coop.
Fesibility Study
Landfill Cover
BJK 3/97

>>>> Summary of Subarea Times to Peak <<<<

| Subarea | Peak Discharge at Composite Outfall (cfs) | Time to Peak at Composite Outfall (hrs) |
|---|---|---|
| 2A | 6 | 12.2 |
| 2B | 48 | 12.2 |
| Composite Watershed | 54 | 12.2 |

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 09-18-2000 12:51:16
Watershed file: --> P:\DATA\PROJECTS\3081\40\SW\COVER2 .WOP
Hydrograph file: --> P:\DATA\PROJECTS\3081\40\SW\COVER225.HYD

Dairyland Power Coop.
Fesibility Study
Landfill Cover
BJK 3/97

Composite Hydrograph Summary (cfs)

| Subarea Description | 11.0 hr | 11.3 hr | 11.6 hr | 11.9 hr | 12.0 hr | 12.1 hr | 12.2 hr | 12.3 hr | 12.4 hr |
|---|---|---|---|---|---|---|---|---|---|
| 2A | 0 | 0 | 0 | 1 | 2 | 4 | 6 | 6 | 4 |
| 2B | 1 | 1 | 2 | 9 | 20 | 42 | 48 | 31 | 17 |
| Total (cfs) | 1 | 1 | 2 | 10 | 22 | 46 | 54 | 37 | 21 |

| Subarea Description | 12.5 hr | 12.6 hr | 12.7 hr | 12.8 hr | 13.0 hr | 13.2 hr | 13.4 hr | 13.6 hr | 13.8 hr |
|---|---|---|---|---|---|---|---|---|---|
| 2A | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| 2B | 11 | 9 | 7 | 6 | 5 | 4 | 4 | 4 | 3 |
| Total (cfs) | 14 | 11 | 8 | 7 | 6 | 5 | 5 | 5 | 3 |

| Subarea Description | 14.0 hr | 14.3 hr | 14.6 hr | 15.0 hr | 15.5 hr | 16.0 hr | 16.5 hr | 17.0 hr | 17.5 hr |
|---|---|---|---|---|---|---|---|---|---|
| 2A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2B | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 1 |
| Total (cfs) | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 1 |

| Subarea Description | 18.0 hr | 19.0 hr | 20.0 hr | 22.0 hr | 26.0 hr |
|---|---|---|---|---|---|
| 2A | 0 | 0 | 0 | 0 | 0 |
| 2B | 1 | 1 | 1 | 1 | 0 |

Return Frequency: 100 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 10-01-1998 15:19:47
Watershed file: --> A:\COVER2 .WSP
Hydrograph file: --> A:\COVER200.HYD

Dairyland Power Coop.
Fesibility Study
Landfill Cover
BJK 3/97

>>>> Input Parameters Used to Compute Hydrograph <<<<

| Subarea Description | AREA (acres) | CN | Tc (hrs) | * Tt (hrs) | Precip. (in) | Runoff (in) | Ia/p input/used | |
|---|---|---|---|---|---|---|---|---|
| 2A | 2.70 | 74.0 | 0.30 | 0.00 | 6.10 | 3.27 | 1.12 | .12 |
| 2B | 21.50 | 69.0 | 0.20 | 0.00 | 6.10 | 2.79 | 1.15 | .15 |

* Travel time from subarea outfall to composite watershed outfall point.
I -- Subarea where user specified interpolation between Ia/p tables.

Total area = 24.20 acres or 0.03781 sq.mi
Peak discharge = 82 cfs

WARNING: Drainage areas of two or more subareas
differ by a factor of 5 or greater.

>>>> Computer Modifications of Input Parameters <<<<<

| Subarea Description | Input Values Tc (hr) | Input Values * Tt (hr) | Rounded Values Tc (hr) | Rounded Values * Tt (hr) | Ia/p Interpolated (Yes/No) | Ia/p Messages |
|---|---|---|---|---|---|---|
| 2A | 0.28 | 0.00 | 0.30 | 0.00 | Yes | -- |
| 2B | 0.18 | 0.00 | 0.20 | 0.00 | Yes | -- |

* Travel time from subarea outfall to composite watershed outfall point.

Return Frequency: 100 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 10-01-1998 15:19:47
Watershed file: --> A:\COVER2 .MOP
Hydrograph file: --> A:\COVER200.HYD

Dairyland Power Coop.
Fesibility Study
Landfill Cover
BJK 3/97

>>>> Summary of Subarea Times to Peak <<<<

| Subarea | Peak Discharge at Composite Outfall (cfs) | Time to Peak at Composite Outfall (hrs) |
|---|---|---|
| 2A | 9 | 12.2 |
| 2B | 73 | 12.2 |
| Composite Watershed | 82 | 12.2 |

Return Frequency: 100 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 10-01-1998 15:19:47
Watershed file: --> A:\COVER2 .MOP
Hydrograph file: --> A:\COVER200.HYD

Dairyland Power Coop.
Fesibility Study
Landfill Cover
BJK 3/97

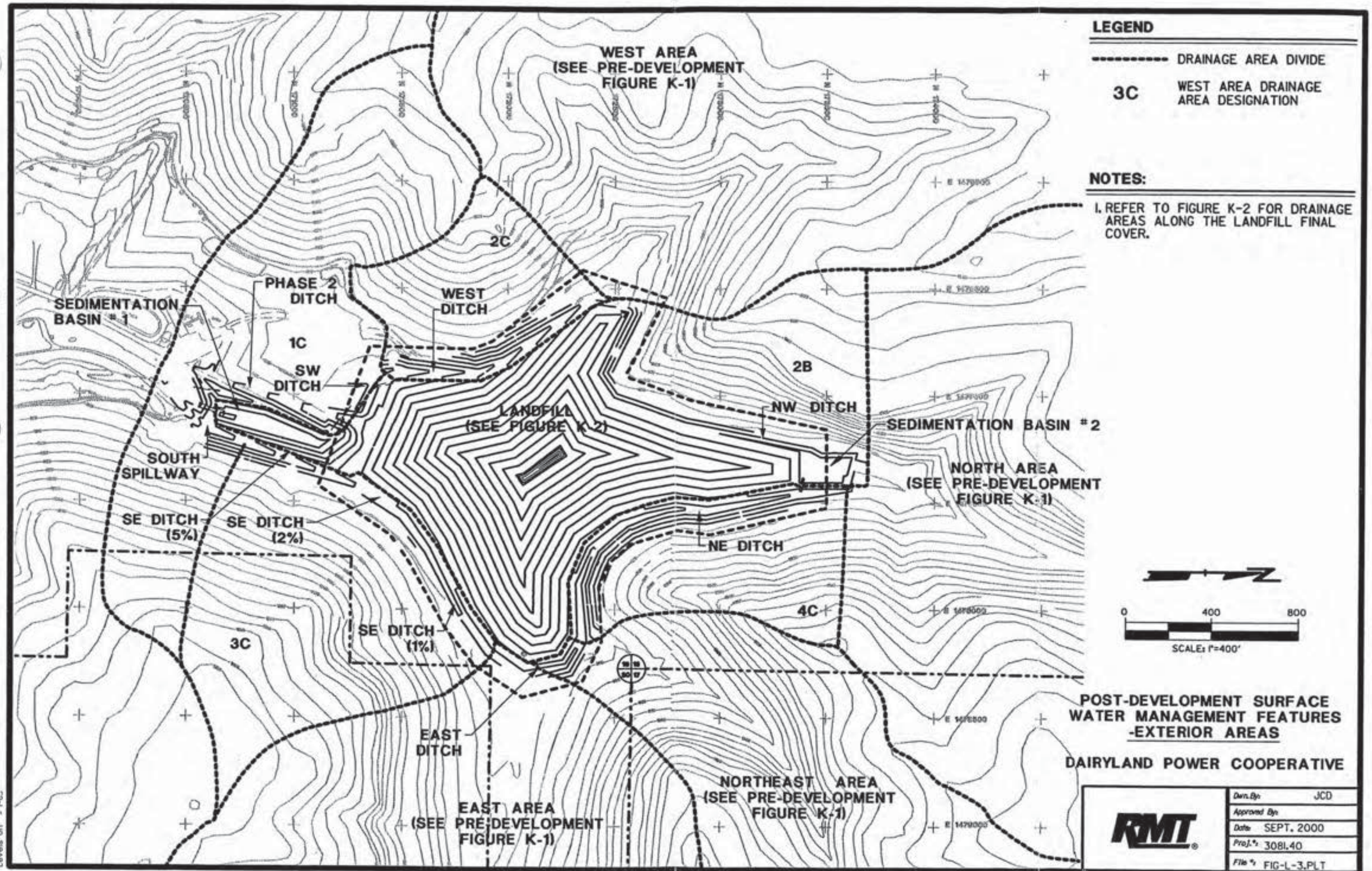
Composite Hydrograph Summary (cfs)

| Subarea Description | 11.0 hr | 11.3 hr | 11.6 hr | 11.9 hr | 12.0 hr | 12.1 hr | 12.2 hr | 12.3 hr | 12.4 hr |
|---|---|---|---|---|---|---|---|---|---|
| 2A | 0 | 0 | 1 | 1 | 3 | 6 | 9 | 9 | 6 |
| 2B | 2 | 2 | 3 | 16 | 33 | 65 | 73 | 45 | 24 |
| Total (cfs) | 2 | 2 | 4 | 17 | 36 | 71 | 82 | 54 | 30 |

| Subarea Description | 12.5 hr | 12.6 hr | 12.7 hr | 12.8 hr | 13.0 hr | 13.2 hr | 13.4 hr | 13.6 hr | 13.8 hr |
|---|---|---|---|---|---|---|---|---|---|
| 2A | 4 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 |
| 2B | 16 | 13 | 10 | 9 | 7 | 6 | 6 | 5 | 5 |
| Total (cfs) | 20 | 16 | 12 | 11 | 8 | 7 | 7 | 6 | 6 |

| Subarea Description | 14.0 hr | 14.3 hr | 14.6 hr | 15.0 hr | 15.5 hr | 16.0 hr | 16.5 hr | 17.0 hr | 17.5 hr |
|---|---|---|---|---|---|---|---|---|---|
| 2A | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2B | 4 | 4 | 3 | 3 | 3 | 3 | 2 | 2 | 2 |
| Total (cfs) | 5 | 5 | 3 | 3 | 3 | 3 | 2 | 2 | 2 |

| Subarea Description | 18.0 hr | 19.0 hr | 20.0 hr | 22.0 hr | 26.0 hr |
|---|---|---|---|---|---|
| 2A | 0 | 0 | 0 | 0 | 0 |
| 2B | 2 | 2 | 1 | 1 | 0 |




RMT COMPUTER AIDED DESIGN & DRAFTING

FIGURE K-3

Quick TR-55 Ver.5.46 S/N:
Executed: 11:43:33 07-30-1998

Dairyland Power Coop.
Feasibility Report
PostDevelopment Conditions
BJK 5/97 rev 7/98

RUNOFF CURVE NUMBER SUMMARY

| Subarea Description | Area (acres) | CN (weighted) |
|---|---|---|
| 1C | 42.00 | 67 |
| 2C | 15.00 | 56 |
| 3C | 33.00 | 58 |
| 4C | 16.00 | 57 |
| East | 520.00 | 67 |
| Northeast | 80.00 | 63 |
| North | 236.00 | 63 |
| West | 100.00 | 71 |

Quick TR-55 Ver.5.46 S/N:
Executed: 11:43:33 07-30-1998

JBB 8/20/98

Dairyland Power Coop.
Feasibility Report
PostDevelopment Conditions
BJK 5/97 rev 7/98

RUNOFF CURVE NUMBER DATA

::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::

Composite Area: 1C

| SURFACE DESCRIPTION | AREA (acres) | CN | |
|---|---|---|---|
| Woods (35%) | 15.00 | 55 | |
| Existing Landfill (50%) | 21.00 | 74 | |
| Graded Areas (10%) | 4.00 | 61 | |
| Fallow - Bare Soil (5%) | 2.00 | 86 | |
| COMPOSITE AREA ---> | 42.00 | 66.5 | ( 67 ) |

::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::

Composite Area: 2C

| SURFACE DESCRIPTION | AREA (acres) | CN | |
|---|---|---|---|
| Woods (85%) | 12.80 | 55 | |
| Graded Areas (15%) | 2.20 | 61 | |
| COMPOSITE AREA ---> | 15.00 | 55.9 | ( 56 ) |

::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::

Composite Area: 3C

| SURFACE DESCRIPTION | AREA (acres) | CN | |
|---|---|---|---|
| Woods (80%) | 27.00 | 55 | |
| Graded Areas (10%) | 3.00 | 61 | |
| Fallow - Bare Soil (10%) | 3.00 | 86 | |
| COMPOSITE AREA ---> | 33.00 | 58.4 | ( 58 ) |

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Quick TR-55 Ver.5.46 S/N:
Executed: 11:43:33 07-30-1998

✓BLB 8/20/98

Composite Area: 4C

| SURFACE DESCRIPTION | AREA (acres) | CN | |
|---|---|---|---|
| Woods (75%) | 12.00 | 55 | |
| Graded Areas (25%) | 4.00 | 61 | |
| COMPOSITE AREA ---> | 16.00 | 56.5 | ( 57 ) |

Composite Area: East

| SURFACE DESCRIPTION | AREA (acres) | CN | |
|---|---|---|---|
| Woods (60%) | 312.00 | 55 | |
| Fallow - Bare Soil (40%) | 208.00 | 86 | |
| COMPOSITE AREA ---> | 520.00 | 67.4 | ( 67 ) |

Composite Area: Northeast

| SURFACE DESCRIPTION | AREA (acres) | CN | |
|---|---|---|---|
| Woods (75%) | 60.00 | 55 | |
| Fallow - Bare Soil (25%) | 20.00 | 86 | |
| COMPOSITE AREA ---> | 80.00 | 62.8 | ( 63 ) |

Composite Area: North

| SURFACE DESCRIPTION | AREA (acres) | CN | |
|---|---|---|---|
| Woods (75%) | 177.00 | 55 | |
| Fallow - Bare Soil (25%) | 59.00 | 86 | |
| COMPOSITE AREA ---> | 236.00 | 62.8 | ( 63 ) |

Quick TR-55 Ver.5.46 S/N:
Executed: 11:43:33 07-30-1998

✓BLB
8/20/98

Composite Area: West

| SURFACE DESCRIPTION | AREA (acres) | CN | |
|---|---|---|---|
| Woods (50%) | 50.00 | 55 | |
| Fallow - Bare Soil (50%) | 50.00 | 86 | |
| COMPOSITE AREA ---> | 100.00 | 70.5 | ( 71 ) |

Quick TR-55 Ver.5.46 S/N:
Executed: 09:21:09 05-09-1997 a:POSTDVTC.TCT

SUMMARY SHEET FOR Tc or Tt COMPUTATIONS
(Solved for Time using TR-55 Methods)

Dairyland Power Coop.
Feasibility Report
PostDevelopment Conditions
BJK 5/97

| Subarea descr. | Tc or Tt | Time (hrs) |
|---|---|---|
| 1C | Tc | 0.35 |
| 2C | Tc | 0.32 |
| 3C | Tc | 0.41 |
| 4C | Tc | 0.38 |
| East | Tc | 0.68 |
| Northeast | Tc | 0.37 |
| North | Tc | 0.53 |
| West | Tc | 0.52 |

Quick TR-55 Ver.5.46 S/N:
Executed: 09:21:09 05-09-1997 a:POSTDVTC.TCT

Dairyland Power Coop.
Feasibility Report
PostDevelopment Conditions
BJK 5/97

√GBG
6/17/97

Tc COMPUTATIONS FOR: 1C

SHEET FLOW (Applicable to Tc only)

| | | | |
|---|---|---|---|
| Segment ID | | 1 | |
| Surface description | | Woods | |
| Manning's roughness coeff., n | | 0.4000 | |
| Flow length, L (total < or = 300) | ft | 300.0 ✓ | |
| Two-yr 24-hr rainfall, P2 | in | 2.800 | |
| Land slope, s | ft/ft | 0.2700 ✓ | |
| $T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$ | hrs | 0.33 | = 0.33 |

SHALLOW CONCENTRATED FLOW

| | | | |
|---|---|---|---|
| Segment ID | | 2 | |
| Surface (paved or unpaved)? | | Unpaved | |
| Flow length, L | ft | 650.0 ✓ | |
| Watercourse slope, s | ft/ft | 0.5000 ✓ | |
| $Avg.V = Csf * (s)^{0.5}$ | ft/s | %11.4088 | |
| where: Unpaved Csf = 16.1345 | | | |
| Paved Csf = 20.3282 | | | |
| T = L / (3600*V) | hrs | 0.02 | = 0.02 |

CHANNEL FLOW

| | | | |
|---|---|---|---|
| Segment ID | | 3 | |
| Cross Sectional Flow Area, a | sq.ft | 42.00 | |
| Wetted perimeter, Pw | ft | 28.00 | |
| Hydraulic radius, r = a/Pw | ft | 1.500 | |
| Channel slope, s | ft/ft | 0.1500 ✓ | |
| Manning's roughness coeff., n | | 0.0450 | |
| $V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$ | ft/s | %16.8040 | |
| Flow length, L | ft | 500 ✓ | |
| T = L / (3600*V) | hrs | 0.01 | = 0.01 |

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TOTAL TIME (hrs) 0.35

Quick TR-55 Ver.5.46 S/N:
Executed: 09:21:09 05-09-1997 a:POSTDVTC.TCT

✓ GBB 6/17/97

Dairyland Power Coop.
Feasibility Report
PostDevelopment Conditions
BJK 5/97

Tc COMPUTATIONS FOR: 2C

SHEET FLOW (Applicable to Tc only)

| | | | |
|---|---|---|---|
| Segment ID | | 1 | |
| Surface description | | Woods | |
| Manning's roughness coeff., n | | 0.4000 | |
| Flow length, L (total < or = 300) | ft | 300.0 | |
| Two-yr 24-hr rainfall, P2 | in | 2.800 | |
| Land slope, s | ft/ft | 0.4200 | |

$$T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$$ hrs 0.27 = 0.27

SHALLOW CONCENTRATED FLOW

| | | | |
|---|---|---|---|
| Segment ID | | 2 | |
| Surface (paved or unpaved)? | | Unpaved | |
| Flow length, L | ft | 370.0 | |
| Watercourse slope, s | ft/ft | 0.4200 | |

$$Avg.V = Csf * (s)^{0.5}$$ ft/s %10.4564

where: Unpaved Csf = 16.1345
Paved Csf = 20.3282

T = L / (3600*V) hrs 0.01 = 0.01

CHANNEL FLOW

| | | | |
|---|---|---|---|
| Segment ID | | 3 | |
| Cross Sectional Flow Area, a | sq.ft | 17.00 | |
| Wetted perimeter, Pw | ft | 17.00 | |
| Hydraulic radius, r = a/Pw | ft | 1.000 | |
| Channel slope, s | ft/ft | 0.0600 | |
| Manning's roughness coeff., n | | 0.0450 | |

$$V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$$ ft/s 8.1105

Flow length, L ft 1050

T = L / (3600*V) hrs 0.04 = 0.04

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TOTAL TIME (hrs) 0.32

Quick TR-55 Ver.5.46 S/N:
Executed: 09:21:09 05-09-1997 a:POSTDVTC.TCT

✓ 6/17/97

Dairyland Power Coop.
Feasibility Report
PostDevelopment Conditions
BJK 5/97

Tc COMPUTATIONS FOR: 3C

SHEET FLOW (Applicable to Tc only)

| | | | |
|---|---|---|---|
| Segment ID | | 1 | |
| Surface description | | Row Crops | |
| Manning's roughness coeff., n | | 0.1700 | |
| Flow length, L (total < or = 300) | ft | 300.0 | |
| Two-yr 24-hr rainfall, P2 | in | 2.800 | |
| Land slope, s | ft/ft | 0.0500 | |

$$T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$$ hrs 0.32 = 0.32

SHALLOW CONCENTRATED FLOW

| | | | |
|---|---|---|---|
| Segment ID | | 2 | |
| Surface (paved or unpaved)? | | Unpaved | |
| Flow length, L | ft | 1020.0 | |
| Watercourse slope, s | ft/ft | 0.3600 | |

$$Avg.V = Csf * (s)^{0.5}$$ ft/s 9.6807

where: Unpaved Csf = 16.1345
Paved Csf = 20.3282

T = L / (3600*V) hrs 0.03 = 0.03

CHANNEL FLOW

| | | | |
|---|---|---|---|
| Segment ID | | 3 | |
| Cross Sectional Flow Area, a | sq.ft | 150.00 | |
| Wetted perimeter, Pw | ft | 45.00 | |
| Hydraulic radius, r = a/Pw | ft | 3.333 | |
| Channel slope, s | ft/ft | 0.0150 | |
| Manning's roughness coeff., n | | 0.0600 | |

$$V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$$ ft/s 6.7868

Flow length, L ft 1450

T = L / (3600*V) hrs 0.06 = 0.06

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TOTAL TIME (hrs) 0.41

Quick TR-55 Ver.5.46 S/N:
Executed: 09:21:09 05-09-1997 a:POSTDVTC.TCT

Dairyland Power Coop.
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PostDevelopment Conditions
BJK 5/97

√BB 6/17/97

Tc COMPUTATIONS FOR: 4C

SHEET FLOW (Applicable to Tc only)

| | | | |
|---|---|---|---|
| Segment ID | | 1 | |
| Surface description | | Woods | |
| Manning's roughness coeff., n | | 0.4000 | |
| Flow length, L (total < or = 300) | ft | 300.0 ✓ | |
| Two-yr 24-hr rainfall, P2 | in | 2.800 | |
| Land slope, s | ft/ft | 0.3700 ✓ | |
| $T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$ | hrs | 0.29 | = 0.29 |

SHALLOW CONCENTRATED FLOW

| | | | |
|---|---|---|---|
| Segment ID | | 2 | |
| Surface (paved or unpaved)? | | Unpaved | |
| Flow length, L | ft | 390.0 ✓ | |
| Watercourse slope, s | ft/ft | 0.5000 ✓ | |
| Avg.V = Csf * $(s)^{0.5}$ | ft/s | X11.4088 | |
| where: Unpaved Csf = 16.1345 | | | |
| Paved Csf = 20.3282 | | | |
| T = L / (3600*V) | hrs | 0.01 | = 0.01 |

CHANNEL FLOW

| | | | |
|---|---|---|---|
| Segment ID | | 3 | |
| Cross Sectional Flow Area, a | sq.ft | 28.00 ✓ | |
| Wetted perimeter, Pw | ft | 20.00 ✓ | |
| Hydraulic radius, r = a/Pw | ft | 1.400 | |
| Channel slope, s | ft/ft | 0.0200 ✓ | |
| Manning's roughness coeff., n | | 0.0500 | |
| $V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$ | ft/s | 5.2741 | |
| Flow length, L | ft | 1670 ✓ | |
| T = L / (3600*V) | hrs | 0.09 | = 0.09 |

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TOTAL TIME (hrs) 0.38

Quick TR-55 Ver.5.46 S/N:
Executed: 09:21:09 05-09-1997 a:POSTDVTC.TCT

Dairyland Power Coop.
Feasibility Report
PostDevelopment Conditions
BJK 5/97

✓ BJB 6/17/97

Tc COMPUTATIONS FOR: East

SHEET FLOW (Applicable to Tc only)

| | | | | |
|---|---|---|---|---|
| Segment ID | | 1 | | |
| Surface description | | Row Crops | | |
| Manning's roughness coeff., n | | 0.1700 | | |
| Flow length, L (total < or = 300) | ft | 300.0 | | |
| Two-yr 24-hr rainfall, P2 | in | 2.800 | | |
| Land slope, s | ft/ft | 0.0500 | | |
| $T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$ | hrs | 0.32 | = | 0.32 |

SHALLOW CONCENTRATED FLOW

| | | | | |
|---|---|---|---|---|
| Segment ID | | 2 | | |
| Surface (paved or unpaved)? | | Unpaved | | |
| Flow length, L | ft | 2000.0 | | |
| Watercourse slope, s | ft/ft | 0.0700 | | |
| $Avg.V = Csf * (s)^{0.5}$ | ft/s | 4.2688 | | |
| where: Unpaved Csf = 16.1345 | | | | |
| Paved Csf = 20.3282 | | | | |
| T = L / (3600*V) | hrs | 0.13 | = | 0.13 |

CHANNEL FLOW

| | | | | | |
|---|---|---|---|---|---|
| Segment ID | | 3 | 4 | | |
| Cross Sectional Flow Area, a | sq.ft | 27.00 | 27.00 | | |
| Wetted perimeter, Pw | ft | 16.40 | 16.40 | | |
| Hydraulic radius, r = a/Pw | ft | 1.646 | 1.646 | | |
| Channel slope, s | ft/ft | 0.0700 | 0.0400 | | |
| Manning's roughness coeff., n | | 0.0700 | 0.0700 | | |
| $V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$ | ft/s | 7.8521 | 5.9356 | | |
| Flow length, L | ft | 2500 | 3000 | | |
| T = L / (3600*V) | hrs | 0.09 | 0.14 | = | 0.23 |

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TOTAL TIME (hrs) 0.68

Quick TR-55 Ver.5.46 S/N:
Executed: 09:21:09 05-09-1997 a:POSTDVTC.TCT

Dairyland Power Coop.
Feasibility Report
PostDevelopment Conditions
BJK 5/97

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Tc COMPUTATIONS FOR: Northeast

SHEET FLOW (Applicable to Tc only)

| | | | |
|---|---|---|---|
| Segment ID | | 1 | |
| Surface description | | Row Crops | |
| Manning's roughness coeff., n | | 0.1700 | |
| Flow length, L (total < or = 300) | ft | 300.0 ✓ | |
| Two-yr 24-hr rainfall, P2 | in | 2.800 | |
| Land slope, s | ft/ft | 0.0800 ✓ | |
| $T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$ | hrs | 0.27 | = 0.27 |

SHALLOW CONCENTRATED FLOW

| | | | |
|---|---|---|---|
| Segment ID | | 2 | |
| Surface (paved or unpaved)? | | Unpaved | |
| Flow length, L | ft | 600.0 ✓ | |
| Watercourse slope, s | ft/ft | 0.0700 ✓ | |
| Avg.V = Csf * $(s)^{0.5}$ | ft/s | 4.2688 | |
| where: Unpaved Csf = 16.1345 | | | |
| Paved Csf = 20.3282 | | | |
| T = L / (3600*V) | hrs | 0.04 | = 0.04 |

CHANNEL FLOW

| | | | |
|---|---|---|---|
| Segment ID | | 3 | |
| Cross Sectional Flow Area, a | sq.ft | 27.00 | |
| Wetted perimeter, Pw | ft | 16.40 | |
| Hydraulic radius, r = a/Pw | ft | 1.646 | |
| Channel slope, s | ft/ft | 0.1400 ✓ | |
| Manning's roughness coeff., n | | 0.0700 | |
| $V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$ | ft/s | %11.1045 | |
| Flow length, L | ft | 2400 ✓ | |
| T = L / (3600*V) | hrs | 0.06 | = 0.06 |

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TOTAL TIME (hrs) 0.37

Quick TR-55 Ver.5.46 S/N:
Executed: 09:21:09 05-09-1997 a:POSTDVTC.TCT

Dairyland Power Coop.
Feasibility Report
PostDevelopment Conditions
BJK 5/97

✓BJG
6/17/97

Tc COMPUTATIONS FOR: North

SHEET FLOW (Applicable to Tc only)

| | | | |
|---|---|---|---|
| Segment ID | | 1 | |
| Surface description | | Row Crops | |
| Manning's roughness coeff., n | | 0.1700 | |
| Flow length, L (total < or = 300) | ft | 300.0 ✓ | |
| Two-yr 24-hr rainfall, P2 | in | 2.800 | |
| Land slope, s | ft/ft | 0.0500 ✓ | |
| $T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$ | hrs | 0.32 | = 0.32 |

SHALLOW CONCENTRATED FLOW

| | | | |
|---|---|---|---|
| Segment ID | | 2 | |
| Surface (paved or unpaved)? | | Unpaved | |
| Flow length, L | ft | 1000.0 ✓ | |
| Watercourse slope, s | ft/ft | 0.0600 ✓ | |
| Avg.V = Csf * $(s)^{0.5}$ | ft/s | 3.9521 | |
| where: Unpaved Csf = 16.1345 | | | |
| Paved Csf = 20.3282 | | | |
| T = L / (3600*V) | hrs | 0.07 | = 0.07 |

CHANNEL FLOW

| | | | |
|---|---|---|---|
| Segment ID | | 3 | |
| Cross Sectional Flow Area, a | sq.ft | 27.00 | |
| Wetted perimeter, Pw | ft | 16.40 | |
| Hydraulic radius, r = a/Pw | ft | 1.646 | |
| Channel slope, s | ft/ft | 0.0830 ✓ | |
| Manning's roughness coeff., n | | 0.0700 | |
| $V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$ | ft/s | 8.5502 | |
| Flow length, L | ft | 4200 ✓ | |
| T = L / (3600*V) | hrs | 0.14 | = 0.14 |

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TOTAL TIME (hrs) 0.53

Quick TR-55 Ver.5.46 S/N:
Executed: 09:21:09 05-09-1997 a:POSTDVTC.TCT

✓ BJB 6/17/97

Dairyland Power Coop.
Feasibility Report
PostDevelopment Conditions
BJK 5/97

Tc COMPUTATIONS FOR: West

SHEET FLOW (Applicable to Tc only)

| | | | |
|---|---|---|---|
| Segment ID | | 1 | |
| Surface description | | Row Crops | |
| Manning's roughness coeff., n | | 0.1700 | |
| Flow length, L (total < or = 300) | ft | 300.0 ✓ | |
| Two-yr 24-hr rainfall, P2 | in | 2.800 | |
| Land slope, s | ft/ft | 0.0500 ✓ | |
| $T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$ | hrs | 0.32 | = 0.32 |

SHALLOW CONCENTRATED FLOW

| | | | |
|---|---|---|---|
| Segment ID | | 2 | |
| Surface (paved or unpaved)? | | Unpaved | |
| Flow length, L | ft | 1600.0 ✓ | |
| Watercourse slope, s | ft/ft | 0.0850 ✓ | |
| $Avg.V = Csf * (s)^{0.5}$ | ft/s | 4.7040 | |
| where: Unpaved Csf = 16.1345 | | | |
| Paved Csf = 20.3282 | | | |
| T = L / (3600*V) | hrs | 0.09 | = 0.09 |

CHANNEL FLOW

| | | | |
|---|---|---|---|
| Segment ID | | 3 | |
| Cross Sectional Flow Area, a | sq.ft | 17.00 | |
| Wetted perimeter, Pw | ft | 16.40 | |
| Hydraulic radius, r = a/Pw | ft | 1.037 | |
| Channel slope, s | ft/ft | 0.1000 ✓ | |
| Manning's roughness coeff., n | | 0.0700 | |
| $V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$ | ft/s | 6.8943 | |
| Flow length, L | ft | 2600 ✓ | |
| T = L / (3600*V) | hrs | 0.10 | = 0.10 |

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TOTAL TIME (hrs) 0.52

Quick TR-55 Ver.5.46 S/N:
Executed: 11:30:57 06-18-1997 a:POSTDVTT.TCT

SUMMARY SHEET FOR Tc or Tt COMPUTATIONS
(Solved for Time using TR-55 Methods)

Dairyland Power Coop.
Feasibility Report
PostDevelopment Conditions
BJK 5/97

| Subarea descr. | Tc or Tt | Time (hrs) |
|---|---|---|
| 1C | Tt | 0.00 |
| 2C | Tt | 0.05 |
| 3C | Tt | 0.01 |
| 4C | Tt | 0.09 |
| East | Tt | 0.07 |
| Northeast | Tt | 0.09 |
| North | Tt | 0.18 |
| West | Tt | 0.08 |

Quick TR-55 Ver.5.46 S/N:
Executed: 09:24:17 05-09-1997 a:POSTDVTT.TCT

Dairyland Power Coop.
Feasibility Report
PostDevelopment Conditions
BJK 5/97

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6/17/97

Tt COMPUTATIONS FOR: 2C

SHEET FLOW (Applicable to Tc only)

| | | | |
|---|---|---|---|
| Segment ID | | | |
| Surface description | | | |
| Manning's roughness coeff., n | | 0.0000 | |
| Flow length, L (total < or = 300) | ft | 0.0 | |
| Two-yr 24-hr rainfall, P2 | in | 0.000 | |
| Land slope, s | ft/ft | 0.0000 | |
| $T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$ | hrs | 0.00 | = 0.00 |

SHALLOW CONCENTRATED FLOW

| | | | |
|---|---|---|---|
| Segment ID | | | |
| Surface (paved or unpaved)? | | | |
| Flow length, L | ft | 0.0 | |
| Watercourse slope, s | ft/ft | 0.0000 | |
| $Avg.V = Csf * (s)^{0.5}$ | ft/s | 0.0000 | |
| where: Unpaved Csf = 16.1345 | | | |
| Paved Csf = 20.3282 | | | |
| T = L / (3600*V) | hrs | 0.00 | = 0.00 |

CHANNEL FLOW

| | | | |
|---|---|---|---|
| Segment ID | | 1 | |
| Cross Sectional Flow Area, a | sq.ft | 17.00 | |
| Wetted perimeter, Pw | ft | 17.00 | |
| Hydraulic radius, r = a/Pw | ft | 1.000 | |
| Channel slope, s | ft/ft | 0.0500 ✓ | |
| Manning's roughness coeff., n | | 0.0450 | |
| $V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$ | ft/s | 7.4039 | |
| Flow length, L | ft | 1200 ✓ | |
| T = L / (3600*V) | hrs | 0.05 | = 0.05 |

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TOTAL TIME (hrs) 0.05

Quick TR-55 Ver.5.46 S/N:
Executed: 09:24:17 05-09-1997 a:POSTDVTT.TCT

Dairyland Power Coop.
Feasibility Report
PostDevelopment Conditions
BJK 5/97

✓ BJB 6/17/97

Tt COMPUTATIONS FOR: 3C

SHEET FLOW (Applicable to Tc only)

| | | | |
|---|---|---|---|
| Segment ID | | | |
| Surface description | | | |
| Manning's roughness coeff., n | | 0.0000 | |
| Flow length, L (total < or = 300) | ft | 0.0 | |
| Two-yr 24-hr rainfall, P2 | in | 0.000 | |
| Land slope, s | ft/ft | 0.0000 | |
| $T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$ | hrs | 0.00 | = 0.00 |

SHALLOW CONCENTRATED FLOW

| | | | |
|---|---|---|---|
| Segment ID | | | |
| Surface (paved or unpaved)? | | | |
| Flow length, L | ft | 0.0 | |
| Watercourse slope, s | ft/ft | 0.0000 | |
| $Avg.V = Csf * (s)^{0.5}$ | ft/s | 0.0000 | |
| where: Unpaved Csf = 16.1345 | | | |
| Paved Csf = 20.3282 | | | |
| T = L / (3600*V) | hrs | 0.00 | = 0.00 |

CHANNEL FLOW

| | | | |
|---|---|---|---|
| Segment ID | | 1 | |
| Cross Sectional Flow Area, a | sq.ft | 42.00 ✓ | |
| Wetted perimeter, Pw | ft | 28.00 ✓ | |
| Hydraulic radius, r = a/Pw | ft | 1.500 | |
| Channel slope, s | ft/ft | 0.1500 ✓ | |
| Manning's roughness coeff., n | | 0.0450 | |
| $V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$ | ft/s | %16.8040 | |
| Flow length, L | ft | 550 ✓ | |
| T = L / (3600*V) | hrs | 0.01 | = 0.01 |

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TOTAL TIME (hrs) 0.01

Quick TR-55 Ver.5.46 S/N:
Executed: 09:24:17 05-09-1997 a:POSTDVTT.TCT

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Dairyland Power Coop.
Feasibility Report
PostDevelopment Conditions
BJK 5/97

Tt COMPUTATIONS FOR: 4C

SHEET FLOW (Applicable to Tc only)

| | | | |
|---|---|---|---|
| Segment ID | | | |
| Surface description | | | |
| Manning's roughness coeff., n | | 0.0000 | |
| Flow length, L (total < or = 300) | ft | 0.0 | |
| Two-yr 24-hr rainfall, P2 | in | 0.000 | |
| Land slope, s | ft/ft | 0.0000 | |
| $T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$ | hrs | 0.00 | = 0.00 |

SHALLOW CONCENTRATED FLOW

| | | | |
|---|---|---|---|
| Segment ID | | | |
| Surface (paved or unpaved)? | | | |
| Flow length, L | ft | 0.0 | |
| Watercourse slope, s | ft/ft | 0.0000 | |
| $Avg.V = Csf * (s)^{0.5}$ | ft/s | 0.0000 | |
| where: Unpaved Csf = 16.1345 | | | |
| Paved Csf = 20.3282 | | | |
| T = L / (3600*V) | hrs | 0.00 | = 0.00 |

CHANNEL FLOW

| | | | | |
|---|---|---|---|---|
| Segment ID | | 1 | 2 | |
| Cross Sectional Flow Area, a | sq.ft | 150.00 | 42.00 | |
| Wetted perimeter, Pw | ft | 45.00 | 28.00 | |
| Hydraulic radius, r = a/Pw | ft | 3.333 | 1.500 | |
| Channel slope, s | ft/ft | 0.0150✓ | 0.1500✓ | |
| Manning's roughness coeff., n | | 0.0600 | 0.0450 | |
| $V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$ | ft/s | 6.7868 | X16.8040 | |
| Flow length, L | ft | 1950✓ | 550✓ | |
| T = L / (3600*V) | hrs | 0.08 + | 0.01 | = 0.09 |

::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::

TOTAL TIME (hrs) 0.09

Quick TR-55 Ver.5.46 S/N:
Executed: 09:24:17 05-09-1997 a:POSTDVTT.TCT

Dairyland Power Coop.
Feasibility Report
PostDevelopment Conditions
BJK 5/97

✓ 6/12/97

Tt COMPUTATIONS FOR: East

SHEET FLOW (Applicable to Tc only)

| | | | |
|---|---|---|---|
| Segment ID | | | |
| Surface description | | | |
| Manning's roughness coeff., n | | 0.0000 | |
| Flow length, L (total < or = 300) | ft | 0.0 | |
| Two-yr 24-hr rainfall, P2 | in | 0.000 | |
| Land slope, s | ft/ft | 0.0000 | |
| $T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$ | hrs | 0.00 | = 0.00 |

SHALLOW CONCENTRATED FLOW

| | | | |
|---|---|---|---|
| Segment ID | | | |
| Surface (paved or unpaved)? | | | |
| Flow length, L | ft | 0.0 | |
| Watercourse slope, s | ft/ft | 0.0000 | |
| $Avg.V = Csf * (s)^{0.5}$ | ft/s | 0.0000 | |
| where: Unpaved Csf = 16.1345 | | | |
| Paved Csf = 20.3282 | | | |
| T = L / (3600*V) | hrs | 0.00 | = 0.00 |

CHANNEL FLOW

| | | 1 | 2 |
|---|---|---|---|
| Segment ID | | | |
| Cross Sectional Flow Area, a | sq.ft | 150.00 | 42.00 |
| Wetted perimeter, Pw | ft | 45.00 | 28.00 |
| Hydraulic radius, r = a/Pw | ft | 3.333 | 1.500 |
| Channel slope, s | ft/ft | 0.0150 ✓ | 0.1500 ✓ |
| Manning's roughness coeff., n | | 0.0600 | 0.0450 |
| $V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$ | ft/s | 6.7868 | %16.8040 |
| Flow length, L | ft | 1600 ✓ | 550 ✓ |
| T = L / (3600*V) | hrs | 0.07 + | 0.01 = 0.07 |

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TOTAL TIME (hrs) 0.07

Quick TR-55 Ver.5.46 S/N:
Executed: 11:30:57 06-18-1997 a:POSTDVTT.TCT

6/17/97

Dairyland Power Coop.
Feasibility Report
PostDevelopment Conditions
BJK 5/97

Tt COMPUTATIONS FOR: Northeast

SHEET FLOW (Applicable to Tc only)

| | | | |
|---|---|---|---|
| Segment ID | | | |
| Surface description | | | |
| Manning's roughness coeff., n | | 0.0000 | |
| Flow length, L (total < or = 300) | ft | 0.0 | |
| Two-yr 24-hr rainfall, P2 | in | 0.000 | |
| Land slope, s | ft/ft | 0.0000 | |

$$T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$$

| | | | |
|---|---|---|---|
| T = | hrs | 0.00 | = 0.00 |

SHALLOW CONCENTRATED FLOW

| | | | |
|---|---|---|---|
| Segment ID | | | |
| Surface (paved or unpaved)? | | | |
| Flow length, L | ft | 0.0 | |
| Watercourse slope, s | ft/ft | 0.0000 | |

$$Avg.V = Csf * (s)^{0.5}$$

| | | | |
|---|---|---|---|
| Avg.V = Csf * (s)^0.5 | ft/s | 0.0000 | |
| where: Unpaved Csf = 16.1345 | | | |
| Paved Csf = 20.3282 | | | |
| T = L / (3600*V) | hrs | 0.00 | = 0.00 |

CHANNEL FLOW

| | | | | |
|---|---|---|---|---|
| Segment ID | | 1 | 2 | |
| Cross Sectional Flow Area, a | sq.ft | 150.00 | 42.00 | |
| Wetted perimeter, Pw | ft | 45.00 | 28.00 | |
| Hydraulic radius, r = a/Pw | ft | 3.333 | 1.500 | |
| Channel slope, s | ft/ft | 0.0150 ✓ | 0.1500 ✓ | |
| Manning's roughness coeff., n | | 0.0600 | 0.0450 | |
| V = (1.49 * r^2/3 * s^1/2) / n | ft/s | 6.7868 | %16.8040 | |
| Flow length, L | ft | 1870 ✓ | 550 ✓ | |
| T = L / (3600*V) | hrs | 0.08 + | 0.01 | = 0.09 |

$$V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$$

::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::

TOTAL TIME (hrs) 0.09

Quick TR-55 Ver.5.46 S/N:
Executed: 11:30:57 06-18-1997 a:POSTDVTT.TCT

Dairyland Power Coop.
Feasibility Report
PostDevelopment Conditions
BJK 5/97

✓ BJB 6/17/97

Tt COMPUTATIONS FOR: North

SHEET FLOW (Applicable to Tc only)

| | | | |
|---|---|---|---|
| Segment ID | | | |
| Surface description | | | |
| Manning's roughness coeff., n | | 0.0000 | |
| Flow length, L (total < or = 300) | ft | 0.0 | |
| Two-yr 24-hr rainfall, P2 | in | 0.000 | |
| Land slope, s | ft/ft | 0.0000 | |
| $T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$ | hrs | 0.00 | = 0.00 |

SHALLOW CONCENTRATED FLOW

| | | | |
|---|---|---|---|
| Segment ID | | | |
| Surface (paved or unpaved)? | | | |
| Flow length, L | ft | 0.0 | |
| Watercourse slope, s | ft/ft | 0.0000 | |
| Avg.V = Csf * (s)$^{0.5}$ | ft/s | 0.0000 | |
| where: Unpaved Csf = 16.1345 | | | |
| Paved Csf = 20.3282 | | | |
| T = L / (3600*V) | hrs | 0.00 | = 0.00 |

CHANNEL FLOW

| | | 1 | 2 | |
|---|---|---|---|---|
| Segment ID | | 1 | 2 | |
| Cross Sectional Flow Area, a | sq.ft | 28.00 | 150.00 | |
| Wetted perimeter, Pw | ft | 20.00 | 45.00 | |
| Hydraulic radius, r = a/Pw | ft | 1.400 | 3.333 | |
| Channel slope, s | ft/ft | 0.0200 ✓ | 0.0150 ✓ | |
| Manning's roughness coeff., n | | 0.0500 | 0.0600 | |
| $V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$ | ft/s | 5.2741 | 6.7868 | |
| Flow length, L | ft | 1670 ✓ | 2250 ✓ | |
| T = L / (3600*V) | hrs | 0.09 + | 0.09 | = 0.18 |

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TOTAL TIME (hrs) 0.18

Quick TR-55 Ver.5.46 S/N:
Executed: 09:24:17 05-09-1997 a:POSTDVTT.TCT

1 BJK
6/17/97

Dairyland Power Coop.
Feasibility Report
PostDevelopment Conditions
BJK 5/97

Tt COMPUTATIONS FOR: West

SHEET FLOW (Applicable to Tc only)

| | | | |
|---|---|---|---|
| Segment ID | | | |
| Surface description | | | |
| Manning's roughness coeff., n | | 0.0000 | |
| Flow length, L (total < or = 300) | ft | 0.0 | |
| Two-yr 24-hr rainfall, P2 | in | 0.000 | |
| Land slope, s | ft/ft | 0.0000 | |
| T = .007 * (n*L)^0.8 / (P2^0.5 * s^0.4) | hrs | 0.00 | = 0.00 |

SHALLOW CONCENTRATED FLOW

| | | | |
|---|---|---|---|
| Segment ID | | | |
| Surface (paved or unpaved)? | | | |
| Flow length, L | ft | 0.0 | |
| Watercourse slope, s | ft/ft | 0.0000 | |
| Avg.V = Csf * (s)^0.5 | ft/s | 0.0000 | |
| where: Unpaved Csf = 16.1345; Paved Csf = 20.3282 | | | |
| T = L / (3600*V) | hrs | 0.00 | = 0.00 |

CHANNEL FLOW

| | | | | |
|---|---|---|---|---|
| Segment ID | | 1 | 2 | |
| Cross Sectional Flow Area, a | sq.ft | 17.00 | 17.00 | |
| Wetted perimeter, Pw | ft | 17.00 | 17.00 | |
| Hydraulic radius, r = a/Pw | ft | 1.000 | 1.000 | |
| Channel slope, s | ft/ft | 0.0600 ✓ | 0.0500 ✓ | |
| Manning's roughness coeff., n | | 0.0450 | 0.0450 | |
| V = 1.49 * r^2/3 * s^1/2 / n | ft/s | 8.1105 | 7.4039 | |
| Flow length, L | ft | 1050 ✓ | 1200 ✓ | |
| T = L / (3600*V) | hrs | 0.04 + | 0.05 | = 0.08 |

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TOTAL TIME (hrs) 0.08

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 09-18-2000 12:58:17
Watershed file: --> P:\DATA\PROJECTS\3081\40\SW\POSTDV2 .MOP
Hydrograph file: --> P:\DATA\PROJECTS\3081\40\SW\POSTDV25.HYD

Dairyland Power Coop.
Feasibility Report
PostDevelopment Conditions
BJK 5/97 REV 9/98

>>>> Input Parameters Used to Compute Hydrograph <<<<

| Subarea Description | AREA (acres) | CN | Tc (hrs) | * Tt (hrs) | Precip. (in) | Runoff (in) | Ia/p input/used | |
|---|---|---|---|---|---|---|---|---|
| 1C | 42.00 | 67.0 | 0.40 | 0.00 | 4.90 | 1.73 | I.2 | .20 |
| 2C | 15.00 | 56.0 | 0.30 | 0.10 | 4.90 | 0.99 | I.32 | .32 |
| 3C | 33.00 | 58.0 | 0.40 | 0.00 | 4.90 | 1.11 | I.3 | .30 |
| 4C | 16.00 | 57.0 | 0.40 | 0.10 | 4.90 | 1.05 | I.31 | .31 |
| East | 520.00 | 67.0 | 0.75 | 0.00 | 4.90 | 1.73 | I.2 | .20 |
| Northeast | 80.00 | 63.0 | 0.40 | 0.10 | 4.90 | 1.45 | I.24 | .24 |
| North | 236.00 | 63.0 | 0.50 | 0.20 | 4.90 | 1.45 | I.24 | .24 |
| West | 100.00 | 71.0 | 0.50 | 0.10 | 4.90 | 2.04 | I.17 | .17 |

* Travel time from subarea outfall to composite watershed outfall point.
I -- Subarea where user specified interpolation between Ia/p tables.

Total Runoff
= 141.9 ac-ft

Total area = 1042.00 acres or 1.6281 sq.mi
Peak discharge = 1027 cfs

WARNING: Drainage areas of two or more subareas
differ by a factor of 5 or greater.

>>>> Computer Modifications of Input Parameters <<<<<

| Subarea Description | Input Values Tc (hr) | Input Values * Tt (hr) | Rounded Values Tc (hr) | Rounded Values * Tt (hr) | Ia/p Interpolated (Yes/No) | Ia/p Messages |
|---|---|---|---|---|---|---|
| 1C | 0.35 | 0.00 | 0.40 | 0.00 | Yes | -- |
| 2C | 0.32 | 0.05 | 0.30 | 0.10 | Yes | -- |
| 3C | 0.41 | 0.01 | 0.40 | 0.00 | Yes | -- |
| 4C | 0.38 | 0.09 | 0.40 | 0.10 | Yes | -- |
| East | 0.68 | 0.07 | 0.75 | 0.00 | Yes | -- |
| Northeast | 0.37 | 0.09 | 0.40 | 0.10 | Yes | -- |
| North | 0.53 | 0.18 | 0.50 | 0.20 | Yes | -- |
| West | 0.52 | 0.08 | 0.50 | 0.10 | Yes | -- |

* Travel time from subarea outfall to composite watershed outfall point.

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 09-18-2000 12:58:17
Watershed file: --> P:\DATA\PROJECTS\3081\40\SW\POSTDV2 .MOP
Hydrograph file: --> P:\DATA\PROJECTS\3081\40\SW\POSTDV25.HYD

Dairyland Power Coop.
Feasibility Report
PostDevelopment Conditions
BJK 5/97 REV 9/98

>>>> Summary of Subarea Times to Peak <<<<

| Subarea | Peak Discharge at Composite Outfall (cfs) | Time to Peak at Composite Outfall (hrs) |
|---|---|---|
| 1C | 61 | 12.3 |
| 2C | 11 | 12.4 |
| 3C | 28 | 12.4 |
| 4C | 12 | 12.5 |
| East | 533 | 12.7 |
| Northeast | 84 | 12.5 |
| North | 219 | 12.6 |
| West | 145 | 12.5 |
| Composite Watershed | 1027 | 12.6 |

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 09-18-2000 12:58:17
Watershed file: --> P:\DATA\PROJECTS\3081\40\SW\POSTDV2 .MOP
Hydrograph file: --> P:\DATA\PROJECTS\3081\40\SW\POSTDV25.HYD

Dairyland Power Coop.
Feasibility Report
PostDevelopment Conditions
BJK 5/97 REV 9/98

Composite Hydrograph Summary (cfs)

| Subarea Description | 11.0 hr | 11.3 hr | 11.6 hr | 11.9 hr | 12.0 hr | 12.1 hr | 12.2 hr | 12.3 hr | 12.4 hr |
|---|---|---|---|---|---|---|---|---|---|
| 1C | 1 | 1 | 2 | 5 | 9 | 22 | 43 | 61 | 61 |
| 2C | 0 | 0 | 0 | 0 | 0 | 1 | 4 | 9 | 11 |
| 3C | 0 | 0 | 0 | 0 | 1 | 6 | 17 | 27 | 28 |
| 4C | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 6 | 10 |
| East | 9 | 13 | 17 | 25 | 33 | 52 | 102 | 197 | 329 |
| Northeast | 1 | 1 | 2 | 4 | 7 | 14 | 31 | 57 | 80 |
| North | 2 | 3 | 4 | 6 | 8 | 13 | 28 | 66 | 126 |
| West | 3 | 5 | 6 | 11 | 17 | 30 | 56 | 95 | 128 |
| Total (cfs) | 16 | 23 | 31 | 51 | 75 | 138 | 283 | 518 | 773 |

| Subarea Description | 12.5 hr | 12.6 hr | 12.7 hr | 12.8 hr | 13.0 hr | 13.2 hr | 13.4 hr | 13.6 hr | 13.8 hr |
|---|---|---|---|---|---|---|---|---|---|
| 1C | 48 | 34 | 26 | 20 | 13 | 10 | 8 | 7 | 7 |
| 2C | 10 | 8 | 6 | 5 | 3 | 2 | 2 | 2 | 2 |
| 3C | 24 | 18 | 13 | 11 | 7 | 6 | 5 | 4 | 4 |
| 4C | 12 | 11 | 9 | 7 | 4 | 3 | 3 | 2 | 2 |
| East | 454 | 527 | 533 | 490 | 350 | 248 | 183 | 143 | 117 |
| Northeast | 84 | 74 | 58 | 45 | 28 | 20 | 16 | 14 | 12 |
| North | 187 | 219 | 217 | 191 | 130 | 86 | 62 | 49 | 41 |
| West | 145 | 136 | 115 | 92 | 58 | 39 | 29 | 24 | 20 |
| Total (cfs) | 964 | 1027 | 977 | 861 | 593 | 414 | 308 | 245 | 205 |

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 09-18-2000 12:58:17
Watershed file: --> P:\DATA\PROJECTS\3081\40\SW\POSTDV2 .MOP
Hydrograph file: --> P:\DATA\PROJECTS\3081\40\SW\POSTDV25.HYD

Dairyland Power Coop.
Feasibility Report
PostDevelopment Conditions
BJK 5/97 REV 9/98

Composite Hydrograph Summary (cfs)

| Subarea Description | 14.0 hr | 14.3 hr | 14.6 hr | 15.0 hr | 15.5 hr | 16.0 hr | 16.5 hr | 17.0 hr | 17.5 hr |
|---|---|---|---|---|---|---|---|---|---|
| 1C | 6 | 5 | 5 | 4 | 4 | 4 | 3 | 3 | 3 |
| 2C | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 3C | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 |
| 4C | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| East | 98 | 81 | 69 | 59 | 53 | 47 | 42 | 38 | 36 |
| Northeast | 11 | 9 | 8 | 8 | 7 | 6 | 6 | 5 | 5 |
| North | 35 | 30 | 26 | 23 | 21 | 19 | 17 | 16 | 14 |
| West | 18 | 15 | 13 | 12 | 11 | 10 | 9 | 8 | 7 |
| Total (cfs) | 174 | 146 | 126 | 111 | 100 | 90 | 81 | 74 | 69 |

| Subarea Description | 18.0 hr | 19.0 hr | 20.0 hr | 22.0 hr | 26.0 hr |
|---|---|---|---|---|---|
| 1C | 3 | 2 | 2 | 2 | 0 |
| 2C | 1 | 1 | 1 | 0 | 0 |
| 3C | 2 | 1 | 1 | 1 | 0 |
| 4C | 1 | 1 | 1 | 1 | 0 |
| East | 34 | 30 | 27 | 22 | 0 |
| Northeast | 5 | 4 | 4 | 3 | 0 |
| North | 14 | 12 | 10 | 9 | 0 |
| West | 7 | 6 | 5 | 5 | 0 |
| Total (cfs) | 67 | 57 | 51 | 43 | 0 |

Return Frequency: 100 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 10-01-1998 11:25:28
Watershed file: --> A:\POSTDV2 .MOP
Hydrograph file: --> A:\POSTDV00.HYD

Dairyland Power Coop.
Feasibility Report
PostDevelopment Conditions
BJK 5/97 REV 9/98

>>>> Input Parameters Used to Compute Hydrograph <<<<

| Subarea Description | AREA (acres) | CN | Tc (hrs) | * Tt (hrs) | Precip. (in) | Runoff (in) | Ia/p input/used | |
|---|---|---|---|---|---|---|---|---|
| 1C | 42.00 | 67.0 | 0.40 | 0.00 | 6.10 | 2.61 | I.16 | .16 |
| 2C | 15.00 | 56.0 | 0.30 | 0.10 | 6.10 | 1.66 | I.26 | .26 |
| 3C | 33.00 | 58.0 | 0.40 | 0.00 | 6.10 | 1.82 | I.24 | .24 |
| 4C | 16.00 | 57.0 | 0.40 | 0.10 | 6.10 | 1.74 | I.25 | .25 |
| East | 520.00 | 67.0 | 0.75 | 0.00 | 6.10 | 2.61 | I.16 | .16 |
| Northeast | 80.00 | 63.0 | 0.40 | 0.10 | 6.10 | 2.25 | I.19 | .19 |
| North | 236.00 | 63.0 | 0.50 | 0.20 | 6.10 | 2.25 | I.19 | .19 |
| West | 100.00 | 71.0 | 0.50 | 0.10 | 6.10 | 2.98 | I.13 | .13 |

* Travel time from subarea outfall to composite watershed outfall point.
I -- Subarea where user specified interpolation between Ia/p tables.

Total Runoff

= 215.7 ac-ft

Total area = 1042.00 acres or 1.6281 sq.mi
Peak discharge = 1618 cfs

WARNING: Drainage areas of two or more subareas
differ by a factor of 5 or greater.

>>>> Computer Modifications of Input Parameters <<<<<

| Subarea Description | Input Values Tc (hr) | Input Values * Tt (hr) | Rounded Values Tc (hr) | Rounded Values * Tt (hr) | Ia/p Interpolated (Yes/No) | Ia/p Messages |
|---|---|---|---|---|---|---|
| 1C | 0.35 | 0.00 | 0.40 | 0.00 | Yes | -- |
| 2C | 0.32 | 0.05 | 0.30 | 0.10 | Yes | -- |
| 3C | 0.41 | 0.01 | 0.40 | 0.00 | Yes | -- |
| 4C | 0.38 | 0.09 | 0.40 | 0.10 | Yes | -- |
| East | 0.68 | 0.07 | 0.75 | 0.00 | Yes | -- |
| Northeast | 0.37 | 0.09 | 0.40 | 0.10 | Yes | -- |
| North | 0.53 | 0.18 | 0.50 | 0.20 | Yes | -- |
| West | 0.52 | 0.08 | 0.50 | 0.10 | Yes | -- |

* Travel time from subarea outfall to composite watershed outfall point.

Return Frequency: 100 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 10-01-1998 11:25:28
Watershed file: --> A:\POSTDV2 .MDP
Hydrograph file: --> A:\POSTDV00.HYD

Dairyland Power Coop.
Feasibility Report
PostDevelopment Conditions
BJK 5/97 REV 9/98

>>>> Summary of Subarea Times to Peak <<<<

| Subarea | Peak Discharge at Composite Outfall (cfs) | Time to Peak at Composite Outfall (hrs) |
|---|---|---|
| 1C | 96 | 12.3 |
| 2C | 20 | 12.4 |
| 3C | 49 | 12.4 |
| 4C | 20 | 12.5 |
| East | 837 | 12.6 |
| Northeast | 136 | 12.4 |
| North | 360 | 12.6 |
| West | 223 | 12.5 |
| Composite Watershed | 1618 | 12.6 |

Return Frequency: 100 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 10-01-1998 11:25:28
Watershed file: --> A:\POSTDV2 .MOP
Hydrograph file: --> A:\POSTDV00.HYD

Dairyland Power Coop.
Feasibility Report
PostDevelopment Conditions
BJK 5/97 REV 9/98

Composite Hydrograph Summary (cfs)

| Subarea Description | 11.0 hr | 11.3 hr | 11.6 hr | 11.9 hr | 12.0 hr | 12.1 hr | 12.2 hr | 12.3 hr | 12.4 hr |
|---|---|---|---|---|---|---|---|---|---|
| 1C | 2 | 3 | 4 | 9 | 18 | 38 | 71 | 96 | 94 |
| 2C | 0 | 0 | 0 | 1 | 2 | 4 | 10 | 18 | 20 |
| 3C | 1 | 1 | 1 | 2 | 6 | 15 | 33 | 48 | 49 |
| 4C | 0 | 0 | 0 | 1 | 1 | 3 | 7 | 13 | 19 |
| East | 19 | 27 | 36 | 53 | 69 | 105 | 190 | 343 | 547 |
| Northeast | 3 | 4 | 5 | 10 | 18 | 36 | 70 | 109 | 136 |
| North | 6 | 9 | 11 | 17 | 22 | 33 | 63 | 127 | 224 |
| West | 6 | 9 | 12 | 20 | 32 | 56 | 102 | 165 | 209 |
| Total (cfs) | 37 | 53 | 69 | 113 | 168 | 290 | 546 | 919 | 1298 |

| Subarea Description | 12.5 hr | 12.6 hr | 12.7 hr | 12.8 hr | 13.0 hr | 13.2 hr | 13.4 hr | 13.6 hr | 13.8 hr |
|---|---|---|---|---|---|---|---|---|---|
| 1C | 73 | 51 | 38 | 29 | 19 | 14 | 12 | 10 | 9 |
| 2C | 18 | 13 | 10 | 7 | 5 | 4 | 3 | 3 | 3 |
| 3C | 39 | 28 | 21 | 17 | 11 | 9 | 7 | 6 | 6 |
| 4C | 20 | 18 | 14 | 11 | 7 | 5 | 4 | 3 | 3 |
| East | 733 | 837 | 830 | 756 | 531 | 370 | 270 | 208 | 168 |
| Northeast | 132 | 110 | 85 | 65 | 40 | 28 | 23 | 19 | 17 |
| North | 315 | 360 | 350 | 303 | 200 | 130 | 92 | 71 | 59 |
| West | 223 | 201 | 163 | 128 | 79 | 53 | 40 | 32 | 27 |
| Total (cfs) | 1553 | 1618 | 1511 | 1316 | 892 | 613 | 451 | 352 | 292 |

Return Frequency: 100 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 10-01-1998 11:25:28
Watershed file: --> A:\POSTDV2 .WQP
Hydrograph file: --> A:\POSTDV00.HYD

Dairyland Power Coop.
Feasibility Report
PostDevelopment Conditions
BJK 5/97 REV 9/98

Composite Hydrograph Summary (cfs)

| Subarea Description | 14.0 hr | 14.3 hr | 14.6 hr | 15.0 hr | 15.5 hr | 16.0 hr | 16.5 hr | 17.0 hr | 17.5 hr |
|---|---|---|---|---|---|---|---|---|---|
| 1C | 8 | 7 | 7 | 6 | 5 | 5 | 4 | 4 | 4 |
| 2C | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 |
| 3C | 5 | 5 | 4 | 4 | 3 | 3 | 3 | 3 | 2 |
| 4C | 3 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| East | 141 | 115 | 97 | 83 | 74 | 66 | 59 | 53 | 49 |
| Northeast | 15 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 7 |
| North | 51 | 44 | 38 | 33 | 30 | 27 | 24 | 22 | 20 |
| West | 24 | 21 | 18 | 16 | 14 | 13 | 12 | 11 | 10 |
| Total (cfs) | 249 | 209 | 180 | 157 | 139 | 126 | 112 | 102 | 94 |

| Subarea Description | 18.0 hr | 19.0 hr | 20.0 hr | 22.0 hr | 26.0 hr |
|---|---|---|---|---|---|
| 1C | 4 | 3 | 3 | 2 | 0 |
| 2C | 1 | 1 | 1 | 1 | 0 |
| 3C | 2 | 2 | 2 | 2 | 0 |
| 4C | 1 | 1 | 1 | 1 | 0 |
| East | 47 | 42 | 37 | 30 | 0 |
| Northeast | 6 | 6 | 5 | 4 | 0 |
| North | 19 | 17 | 15 | 13 | 0 |
| West | 10 | 8 | 7 | 6 | 0 |
| Total (cfs) | 90 | 80 | 71 | 59 | 0 |

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Data directory: p:\data\projects\3081\40\sw*.HYD

File Summary for Composite Hydrograph

| Time (hrs) | POSTDV25 (cfs) | BSN1OUT1 (cfs) | BSN2OUT1 (cfs) | TPTPST25 (Total) |
|---|---|---|---|---|
| 11.00 | 16.0 | 0.0 | 0.0 | 16.0 |
| 11.10 | 18.0 | 0.2 | 0.2 | 18.4 |
| 11.20 | 21.0 | 0.2 | 0.2 | 21.4 |
| 11.30 | 23.0 | 0.3 | 0.2 | 23.5 |
| 11.40 | 26.0 | 0.3 | 0.2 | 26.5 |
| 11.50 | 28.0 | 0.3 | 0.2 | 28.5 |
| 11.60 | 31.0 | 0.4 | 0.2 | 31.6 |
| 11.70 | 38.0 | 0.4 | 0.3 | 38.7 |
| 11.80 | 44.0 | 0.4 | 0.3 | 44.7 |
| 11.90 | 51.0 | 0.5 | 0.3 | 51.8 |
| 12.00 | 75.0 | 0.5 | 0.4 | 75.9 |
| 12.10 | 138.0 | 0.6 | 0.4 | 139.0 |
| 12.20 | 283.0 | 0.6 | 0.5 | 284.1 |
| 12.30 | 518.0 | 0.7 | 0.5 | 519.2 |
| 12.40 | 773.0 | 0.7 | 0.5 | 774.2 |
| 12.50 | 964.0 | 0.7 | 0.6 | 965.3 |
| 12.60 | 1027.0 | 0.7 | 0.6 | 1028.3 ← Peak |
| 12.70 | 977.0 | 0.7 | 0.6 | 978.3 |
| 12.80 | 861.0 | 0.7 | 0.6 | 862.3 |
| 12.90 | 727.0 | 0.7 | 0.6 | 728.3 |
| 13.00 | 593.0 | 0.8 | 0.6 | 594.3 |
| 13.10 | 503.0 | 0.8 | 0.6 | 504.4 |
| 13.20 | 414.0 | 0.8 | 0.6 | 415.4 |
| 13.30 | 361.0 | 0.8 | 0.6 | 362.4 |
| 13.40 | 308.0 | 0.8 | 0.6 | 309.4 |
| 13.50 | 277.0 | 0.8 | 0.6 | 278.4 |
| 13.60 | 245.0 | 0.8 | 0.6 | 246.4 |
| 13.70 | 225.0 | 0.8 | 0.6 | 226.4 |
| 13.80 | 205.0 | 0.8 | 0.6 | 206.4 |
| 13.90 | 190.0 | 0.8 | 0.6 | 191.4 |
| 14.00 | 174.0 | 0.8 | 0.6 | 175.4 |
| 14.10 | 165.0 | 0.8 | 0.6 | 166.4 |
| 14.20 | 155.0 | 0.8 | 0.6 | 156.4 |
| 14.30 | 146.0 | 0.9 | 0.6 | 147.5 |
| 14.40 | 139.0 | 1.2 | 0.6 | 140.8 |
| 14.50 | 133.0 | 1.5 | 0.6 | 135.1 |
| 14.60 | 126.0 | 1.8 | 0.6 | 128.4 |
| 14.70 | 122.0 | 2.0 | 0.6 | 124.6 |
| 14.80 | 118.0 | 2.2 | 0.6 | 120.8 |
| 14.90 | 115.0 | 2.3 | 0.6 | 117.9 |

Combined Post-Development Hydrograph 25yr storm

Basin 1 +
Basin 2 +
Surrounding watershed.

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Data directory: p:\data\projects\3081\40\sw*.HYD

File Summary for Composite Hydrograph

| Time (hrs) | POSTDV25 (cfs) | BSN1OUT1 (cfs) | BSN2OUT1 (cfs) | TPTPST25 (Total) |
|---|---|---|---|---|
| 15.00 | 111.0 | 2.4 | 0.6 | 114.0 |
| 15.10 | 109.0 | 2.5 | 0.6 | 112.1 |
| 15.20 | 107.0 | 2.6 | 0.6 | 110.2 |
| 15.30 | 104.0 | 2.7 | 0.6 | 107.3 |
| 15.40 | 102.0 | 2.7 | 0.6 | 105.3 |
| 15.50 | 100.0 | 2.8 | 0.6 | 103.4 |
| 15.60 | 98.0 | 2.8 | 0.6 | 101.4 |
| 15.70 | 96.0 | 2.8 | 0.6 | 99.4 |
| 15.80 | 94.0 | 2.9 | 0.6 | 97.5 |
| 15.90 | 92.0 | 2.9 | 0.6 | 95.5 |
| 16.00 | 90.0 | 2.9 | 0.6 | 93.5 |
| 16.10 | 88.0 | 2.9 | 0.6 | 91.5 |
| 16.20 | 86.0 | 2.9 | 0.6 | 89.5 |
| 16.30 | 85.0 | 2.9 | 0.6 | 88.5 |
| 16.40 | 83.0 | 2.7 | 0.6 | 86.3 |
| 16.50 | 81.0 | 2.6 | 0.6 | 84.2 |
| 16.60 | 80.0 | 2.5 | 0.6 | 83.1 |
| 16.70 | 78.0 | 2.4 | 0.6 | 81.0 |
| 16.80 | 77.0 | 2.3 | 0.6 | 79.9 |
| 16.90 | 75.0 | 2.3 | 0.6 | 77.9 |
| 17.00 | 74.0 | 2.2 | 0.6 | 76.8 |
| 17.10 | 73.0 | 2.2 | 0.6 | 75.8 |
| 17.20 | 72.0 | 2.2 | 0.6 | 74.8 |
| 17.30 | 71.0 | 2.1 | 0.6 | 73.7 |
| 17.40 | 70.0 | 2.1 | 0.6 | 72.7 |
| 17.50 | 69.0 | 2.1 | 0.6 | 71.7 |
| 17.60 | 69.0 | 2.1 | 0.6 | 71.7 |
| 17.70 | 68.0 | 2.1 | 0.6 | 70.7 |
| 17.80 | 68.0 | 2.0 | 0.6 | 70.7 |
| 17.90 | 67.0 | 2.0 | 0.6 | 69.6 |
| 18.00 | 67.0 | 2.0 | 0.6 | 69.6 |
| 18.10 | 66.0 | 2.0 | 0.6 | 68.6 |
| 18.20 | 65.0 | 2.0 | 0.6 | 67.6 |
| 18.30 | 64.0 | 2.0 | 0.6 | 66.6 |
| 18.40 | 63.0 | 2.0 | 0.6 | 65.6 |
| 18.50 | 62.0 | 2.0 | 0.6 | 64.6 |
| 18.60 | 61.0 | 2.0 | 0.6 | 63.6 |
| 18.70 | 60.0 | 2.0 | 0.6 | 62.6 |
| 18.80 | 59.0 | 2.0 | 0.7 | 61.7 |
| 18.90 | 58.0 | 2.0 | 0.7 | 60.8 |
| 19.00 | 57.0 | 2.0 | 0.8 | 59.8 |

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Data directory: p:\data\projects\3081\40\sw*.HYD

File Summary for Composite Hydrograph

| Time (hrs) | POSTDV25 (cfs) | BSN1OUT1 (cfs) | BSN2OUT1 (cfs) | TPTPST25 (Total) |
|---|---|---|---|---|
| 19.10 | 56.0 | 2.0 | 0.8 | 58.8 |
| 19.20 | 56.0 | 2.0 | 0.9 | 58.9 |
| 19.30 | 55.0 | 2.0 | 0.9 | 57.9 |
| 19.40 | 55.0 | 2.0 | 0.9 | 57.9 |
| 19.50 | 54.0 | 2.0 | 0.9 | 56.9 |
| 19.60 | 53.0 | 1.9 | 0.9 | 55.9 |
| 19.70 | 53.0 | 1.8 | 0.9 | 55.7 |
| 19.80 | 52.0 | 1.6 | 1.0 | 54.6 |
| 19.90 | 52.0 | 1.5 | 1.0 | 54.5 |
| 20.00 | 51.0 | 1.4 | 1.0 | 53.4 |
| 20.10 | 51.0 | 1.4 | 1.0 | 53.3 |
| 20.20 | 50.0 | 1.3 | 1.0 | 52.3 |
| 20.30 | 50.0 | 1.2 | 1.0 | 52.2 |
| 20.40 | 49.0 | 1.2 | 1.0 | 51.2 |
| 20.50 | 49.0 | 1.2 | 1.0 | 51.2 |
| 20.60 | 49.0 | 1.1 | 1.0 | 51.1 |
| 20.70 | 48.0 | 1.1 | 1.0 | 50.1 |
| 20.80 | 48.0 | 1.1 | 1.0 | 50.1 |
| 20.90 | 47.0 | 1.1 | 1.0 | 49.1 |
| 21.00 | 47.0 | 1.0 | 1.0 | 49.0 |
| 21.10 | 47.0 | 0.8 | 1.0 | 48.8 |
| 21.20 | 46.0 | 0.8 | 1.0 | 47.8 |
| 21.30 | 46.0 | 0.8 | 1.0 | 47.8 |
| 21.40 | 45.0 | 0.8 | 1.0 | 46.8 |
| 21.50 | 45.0 | 0.8 | 1.0 | 46.8 |
| 21.60 | 45.0 | 0.8 | 1.0 | 46.8 |
| 21.70 | 44.0 | 0.8 | 1.0 | 45.8 |
| 21.80 | 44.0 | 0.8 | 1.0 | 45.8 |
| 21.90 | 43.0 | 0.8 | 1.0 | 44.8 |
| 22.00 | 43.0 | 0.8 | 1.0 | 44.8 |
| 22.10 | 42.0 | 0.8 | 1.0 | 43.8 |
| 22.20 | 41.0 | 0.8 | 1.0 | 42.8 |
| 22.30 | 40.0 | 0.8 | 1.0 | 41.8 |
| 22.40 | 39.0 | 0.8 | 1.0 | 40.8 |
| 22.50 | 38.0 | 0.8 | 1.0 | 39.8 |
| 22.60 | 37.0 | 0.8 | 1.0 | 38.8 |
| 22.70 | 35.0 | 0.8 | 1.0 | 36.8 |
| 22.80 | 34.0 | 0.8 | 1.0 | 35.8 |
| 22.90 | 33.0 | 0.8 | 1.0 | 34.8 |
| 23.00 | 32.0 | 0.8 | 1.0 | 33.8 |
| 23.10 | 31.0 | 0.8 | 1.0 | 32.8 |

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File Summary for Composite Hydrograph

| Time (hrs) | POSTDV25 (cfs) | BSN1OUT1 (cfs) | BSN2OUT1 (cfs) | TPTPST25 (Total) |
|---|---|---|---|---|
| 23.20 | 30.0 | 0.8 | 1.0 | 31.8 |
| 23.30 | 29.0 | 0.8 | 1.0 | 30.8 |
| 23.40 | 28.0 | 0.8 | 1.0 | 29.8 |
| 23.50 | 27.0 | 0.8 | 1.0 | 28.8 |
| 23.60 | 26.0 | 0.8 | 1.0 | 27.8 |
| 23.70 | 25.0 | 0.8 | 1.0 | 26.8 |
| 23.80 | 24.0 | 0.8 | 1.0 | 25.8 |
| 23.90 | 23.0 | 0.8 | 1.0 | 24.8 |
| 24.00 | 22.0 | 0.8 | 0.9 | 23.7 |
| 24.10 | 20.0 | 0.8 | 0.7 | 21.5 |
| 24.20 | 19.0 | 0.8 | 0.6 | 20.4 |
| 24.30 | 18.0 | 0.8 | 0.6 | 19.4 |
| 24.40 | 17.0 | 0.8 | 0.6 | 18.4 |
| 24.50 | 16.0 | 0.8 | 0.6 | 17.4 |
| 24.60 | 15.0 | 0.8 | 0.6 | 16.4 |
| 24.70 | 14.0 | 0.8 | 0.6 | 15.4 |
| 24.80 | 13.0 | 0.8 | 0.6 | 14.4 |
| 24.90 | 12.0 | 0.8 | 0.6 | 13.4 |
| 25.00 | 11.0 | 0.8 | 0.6 | 12.4 |
| 25.10 | 10.0 | 0.8 | 0.6 | 11.4 |
| 25.20 | 9.0 | 0.8 | 0.6 | 10.4 |
| 25.30 | 8.0 | 0.8 | 0.6 | 9.4 |
| 25.40 | 6.0 | 0.8 | 0.6 | 7.4 |
| 25.50 | 5.0 | 0.8 | 0.6 | 6.4 |

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File Summary for Composite Hydrograph

Combined Post-Development Hydrograph - 100 yr Storm

Basin 1 +
Basin 2 +
Surrounding Watershed.

| Time (hrs) | POSTDV00 (cfs) | BSN1OUT2 (cfs) | BSN2OUT2 (cfs) | TOTPST00 (Total) |
|---|---|---|---|---|
| 11.00 | 37.0 | 0.0 | 0.0 | 37.0 |
| 11.10 | 42.0 | 0.2 | 0.2 | 42.4 |
| 11.20 | 48.0 | 0.3 | 0.2 | 48.5 |
| 11.30 | 53.0 | 0.3 | 0.2 | 53.5 |
| 11.40 | 58.0 | 0.4 | 0.3 | 58.6 |
| 11.50 | 64.0 | 0.4 | 0.3 | 64.7 |
| 11.60 | 69.0 | 0.4 | 0.3 | 69.7 |
| 11.70 | 84.0 | 0.4 | 0.3 | 84.7 |
| 11.80 | 98.0 | 0.5 | 0.3 | 98.8 |
| 11.90 | 113.0 | 0.5 | 0.4 | 113.9 |
| 12.00 | 168.0 | 0.6 | 0.4 | 169.0 |
| 12.10 | 290.0 | 0.6 | 0.5 | 291.1 |
| 12.20 | 546.0 | 0.7 | 0.5 | 547.2 |
| 12.30 | 919.0 | 0.7 | 0.6 | 920.3 |
| 12.40 | 1298.0 | 0.7 | 0.6 | 1299.3 |
| 12.50 | 1553.0 | 0.8 | 0.6 | 1554.4 |
| 12.60 | 1618.0 | 2.8 | 1.2 | 1622.0 ← Peak |
| 12.70 | 1511.0 | 8.2 | 3.7 | 1522.9 |
| 12.80 | 1316.0 | 12.2 | 5.2 | 1333.4 |
| 12.90 | 1104.0 | 14.8 | 6.1 | 1124.9 |
| 13.00 | 892.0 | 15.7 | 6.6 | 914.3 |
| 13.10 | 752.0 | 15.5 | 6.9 | 774.4 |
| 13.20 | 613.0 | 14.8 | 7.0 | 634.8 |
| 13.30 | 532.0 | 14.0 | 7.0 | 553.0 |
| 13.40 | 451.0 | 13.3 | 7.0 | 471.3 |
| 13.50 | 402.0 | 12.5 | 7.0 | 421.5 |
| 13.60 | 352.0 | 11.7 | 6.9 | 370.6 |
| 13.70 | 322.0 | 10.8 | 6.7 | 339.5 |
| 13.80 | 292.0 | 10.0 | 6.6 | 308.6 |
| 13.90 | 270.0 | 9.6 | 6.5 | 286.0 |
| 14.00 | 249.0 | 9.1 | 6.3 | 264.3 |
| 14.10 | 236.0 | 8.5 | 6.0 | 250.6 |
| 14.20 | 222.0 | 8.1 | 5.8 | 235.9 |
| 14.30 | 209.0 | 7.7 | 5.7 | 222.4 |
| 14.40 | 199.0 | 7.4 | 5.4 | 211.9 |
| 14.50 | 190.0 | 7.2 | 5.2 | 202.3 |
| 14.60 | 180.0 | 7.0 | 4.8 | 191.8 |
| 14.70 | 174.0 | 6.8 | 4.5 | 185.3 |
| 14.80 | 168.0 | 6.6 | 4.2 | 178.8 |
| 14.90 | 163.0 | 6.2 | 4.0 | 173.2 |

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Data directory: p:\data\projects\3081\40\sw*.HYD

File Summary for Composite Hydrograph

| Time (hrs) | POSTDV00 (cfs) | BSN1OUT2 (cfs) | BSN2OUT2 (cfs) | TOTPST00 (Total) |
|---|---|---|---|---|
| 15.00 | 157.0 | 5.8 | 3.8 | 166.6 |
| 15.10 | 153.0 | 5.5 | 3.6 | 162.1 |
| 15.20 | 150.0 | 5.3 | 3.5 | 158.8 |
| 15.30 | 146.0 | 5.0 | 3.4 | 154.4 |
| 15.40 | 143.0 | 4.6 | 3.3 | 150.9 |
| 15.50 | 139.0 | 4.3 | 3.3 | 146.6 |
| 15.60 | 136.0 | 4.1 | 3.2 | 143.3 |
| 15.70 | 134.0 | 3.9 | 3.2 | 141.1 |
| 15.80 | 131.0 | 3.8 | 3.1 | 137.9 |
| 15.90 | 129.0 | 3.6 | 3.1 | 135.7 |
| 16.00 | 126.0 | 3.5 | 3.1 | 132.6 |
| 16.10 | 123.0 | 3.4 | 3.1 | 129.5 |
| 16.20 | 120.0 | 3.4 | 3.1 | 126.4 |
| 16.30 | 118.0 | 3.3 | 3.0 | 124.2 |
| 16.40 | 115.0 | 3.2 | 2.8 | 121.0 |
| 16.50 | 112.0 | 3.2 | 2.6 | 117.8 |
| 16.60 | 110.0 | 3.2 | 2.5 | 115.7 |
| 16.70 | 108.0 | 3.1 | 2.4 | 113.5 |
| 16.80 | 106.0 | 3.1 | 2.3 | 111.4 |
| 16.90 | 104.0 | 3.1 | 2.3 | 109.3 |
| 17.00 | 102.0 | 3.1 | 2.2 | 107.3 |
| 17.10 | 100.0 | 3.1 | 2.2 | 105.2 |
| 17.20 | 99.0 | 3.0 | 2.1 | 104.2 |
| 17.30 | 97.0 | 3.0 | 2.1 | 102.2 |
| 17.40 | 96.0 | 3.0 | 2.1 | 101.1 |
| 17.50 | 94.0 | 3.0 | 2.1 | 99.1 |
| 17.60 | 93.0 | 3.0 | 2.1 | 98.1 |
| 17.70 | 92.0 | 3.0 | 2.0 | 97.1 |
| 17.80 | 92.0 | 3.0 | 2.0 | 97.1 |
| 17.90 | 91.0 | 3.0 | 2.0 | 96.0 |
| 18.00 | 90.0 | 3.0 | 2.0 | 95.0 |
| 18.10 | 89.0 | 3.0 | 2.0 | 94.0 |
| 18.20 | 88.0 | 3.0 | 2.0 | 93.0 |
| 18.30 | 87.0 | 3.0 | 2.0 | 92.0 |
| 18.40 | 86.0 | 3.0 | 2.0 | 91.0 |
| 18.50 | 85.0 | 2.9 | 2.0 | 89.9 |
| 18.60 | 84.0 | 2.8 | 2.0 | 88.8 |
| 18.70 | 83.0 | 2.6 | 2.0 | 87.6 |
| 18.80 | 82.0 | 2.5 | 2.0 | 86.5 |
| 18.90 | 81.0 | 2.4 | 2.0 | 85.4 |
| 19.00 | 80.0 | 2.4 | 2.0 | 84.4 |

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Data directory: p:\data\projects\3081\40\sw*.HYD

File Summary for Composite Hydrograph

| Time (hrs) | POSTDV00 (cfs) | BSN1OUT2 (cfs) | BSN2OUT2 (cfs) | TOTPST00 (Total) |
|---|---|---|---|---|
| 19.10 | 79.0 | 2.3 | 2.0 | 83.3 |
| 19.20 | 78.0 | 2.2 | 2.0 | 82.2 |
| 19.30 | 77.0 | 2.2 | 2.0 | 81.2 |
| 19.40 | 76.0 | 2.2 | 2.0 | 80.2 |
| 19.50 | 76.0 | 2.1 | 2.0 | 80.1 |
| 19.60 | 75.0 | 2.1 | 1.9 | 79.0 |
| 19.70 | 74.0 | 2.1 | 1.7 | 77.8 |
| 19.80 | 73.0 | 2.1 | 1.6 | 76.7 |
| 19.90 | 72.0 | 2.1 | 1.5 | 75.5 |
| 20.00 | 71.0 | 2.0 | 1.4 | 74.4 |
| 20.10 | 70.0 | 2.0 | 1.3 | 73.3 |
| 20.20 | 70.0 | 2.0 | 1.3 | 73.3 |
| 20.30 | 69.0 | 2.0 | 1.2 | 72.2 |
| 20.40 | 69.0 | 2.0 | 1.2 | 72.2 |
| 20.50 | 68.0 | 2.0 | 1.1 | 71.1 |
| 20.60 | 67.0 | 2.0 | 1.1 | 70.1 |
| 20.70 | 67.0 | 2.0 | 1.1 | 70.1 |
| 20.80 | 66.0 | 2.0 | 1.1 | 69.1 |
| 20.90 | 66.0 | 2.0 | 1.0 | 69.1 |
| 21.00 | 65.0 | 2.0 | 1.0 | 68.1 |
| 21.10 | 64.0 | 2.0 | 1.0 | 67.0 |
| 21.20 | 64.0 | 2.0 | 1.0 | 67.0 |
| 21.30 | 63.0 | 2.0 | 1.0 | 66.0 |
| 21.40 | 63.0 | 2.0 | 1.0 | 66.0 |
| 21.50 | 62.0 | 2.0 | 1.0 | 65.0 |
| 21.60 | 61.0 | 2.0 | 1.0 | 64.0 |
| 21.70 | 61.0 | 2.0 | 1.0 | 64.0 |
| 21.80 | 60.0 | 2.0 | 1.0 | 63.0 |
| 21.90 | 60.0 | 2.0 | 1.0 | 63.0 |
| 22.00 | 59.0 | 2.0 | 1.0 | 62.0 |
| 22.10 | 58.0 | 2.0 | 1.0 | 61.0 |
| 22.20 | 56.0 | 2.0 | 1.0 | 59.0 |
| 22.30 | 55.0 | 2.0 | 1.0 | 58.0 |
| 22.40 | 53.0 | 2.0 | 1.0 | 56.0 |
| 22.50 | 52.0 | 2.0 | 1.0 | 55.0 |
| 22.60 | 50.0 | 2.0 | 1.0 | 53.0 |
| 22.70 | 49.0 | 2.0 | 1.0 | 52.0 |
| 22.80 | 47.0 | 2.0 | 1.0 | 50.0 |
| 22.90 | 46.0 | 2.0 | 1.0 | 49.0 |
| 23.00 | 44.0 | 2.0 | 1.0 | 47.0 |
| 23.10 | 43.0 | 1.9 | 1.0 | 45.9 |

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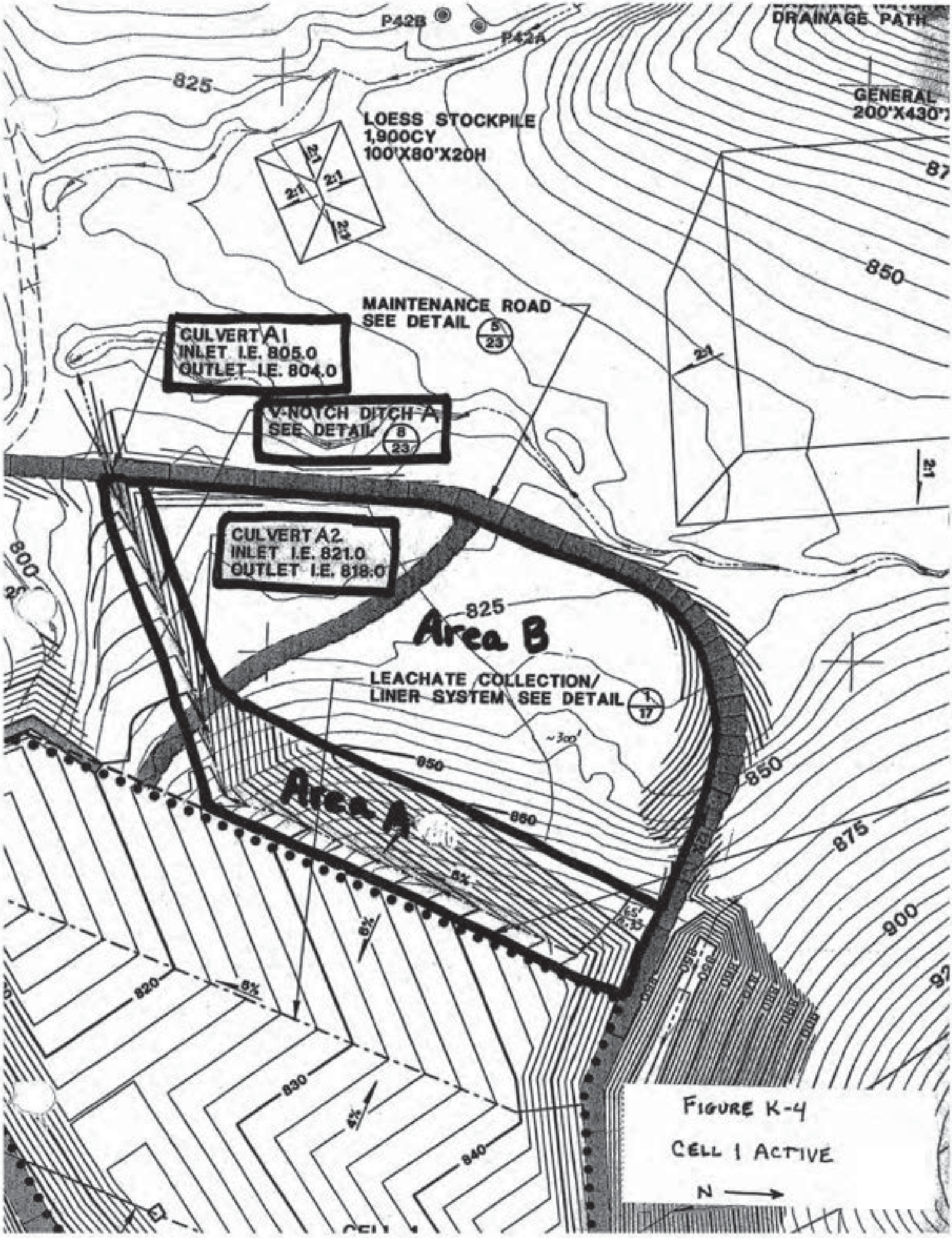
Data directory: p:\data\projects\3081\40\sw*.HYD

File Summary for Composite Hydrograph

| Time (hrs) | POSTDV00 (cfs) | BSN1OUT2 (cfs) | BSN2OUT2 (cfs) | TOTPST00 (Total) |
|---|---|---|---|---|
| 23.20 | 41.0 | 1.8 | 1.0 | 43.8 |
| 23.30 | 40.0 | 1.6 | 1.0 | 42.6 |
| 23.40 | 38.0 | 1.5 | 1.0 | 40.5 |
| 23.50 | 37.0 | 1.4 | 1.0 | 39.4 |
| 23.60 | 35.0 | 1.4 | 1.0 | 37.3 |
| 23.70 | 34.0 | 1.3 | 1.0 | 36.3 |
| 23.80 | 32.0 | 1.2 | 1.0 | 34.2 |
| 23.90 | 31.0 | 1.2 | 1.0 | 33.2 |
| 24.00 | 30.0 | 1.2 | 0.9 | 32.1 |
| 24.10 | 28.0 | 1.1 | 0.7 | 29.9 |
| 24.20 | 27.0 | 1.1 | 0.6 | 28.7 |
| 24.30 | 25.0 | 1.1 | 0.6 | 26.7 |
| 24.40 | 24.0 | 1.1 | 0.6 | 25.7 |
| 24.50 | 22.0 | 1.1 | 0.6 | 23.7 |
| 24.60 | 21.0 | 1.0 | 0.6 | 22.6 |
| 24.70 | 19.0 | 1.0 | 0.6 | 20.6 |
| 24.80 | 18.0 | 1.0 | 0.6 | 19.6 |
| 24.90 | 16.0 | 1.0 | 0.6 | 17.6 |
| 25.00 | 15.0 | 0.9 | 0.6 | 16.5 |
| 25.10 | 13.0 | 0.8 | 0.6 | 14.4 |
| 25.20 | 12.0 | 0.8 | 0.6 | 13.4 |
| 25.30 | 10.0 | 0.8 | 0.6 | 11.4 |
| 25.40 | 9.0 | 0.8 | 0.6 | 10.4 |
| 25.50 | 7.0 | 0.8 | 0.6 | 8.4 |

# Operational Run-off Calculations


P42B
P42A
DRAINAGE PATH
825
GENERAL
200'X430'
LOESS STOCKPILE
1,900CY
100'X80'X20H
2:1
850
MAINTENANCE ROAD
SEE DETAIL 5/23
CULVERT A1
INLET I.E. 805.0
OUTLET I.E. 804.0
V-NOTCH DITCH A
SEE DETAIL 8/23
CULVERT A2
INLET I.E. 821.0
OUTLET I.E. 818.0
800
825
Area B
LEACHATE COLLECTION/
LINER SYSTEM SEE DETAIL 1/17
~300'
850
860
Area A
8%
875
900
820
830
840
FIGURE K-4
CELL 1 ACTIVE
N

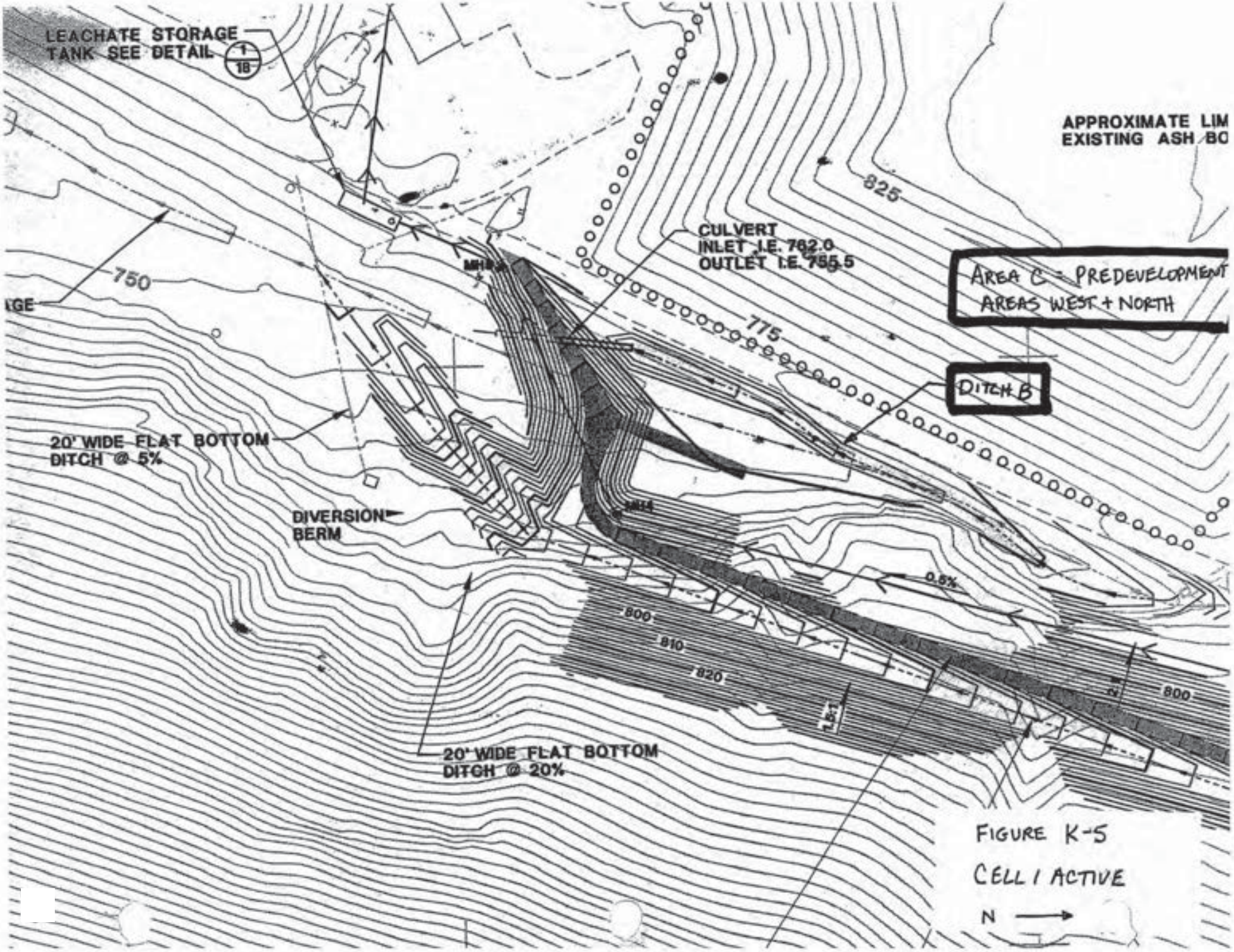



FIGURE K-5

CELL 1 ACTIVE

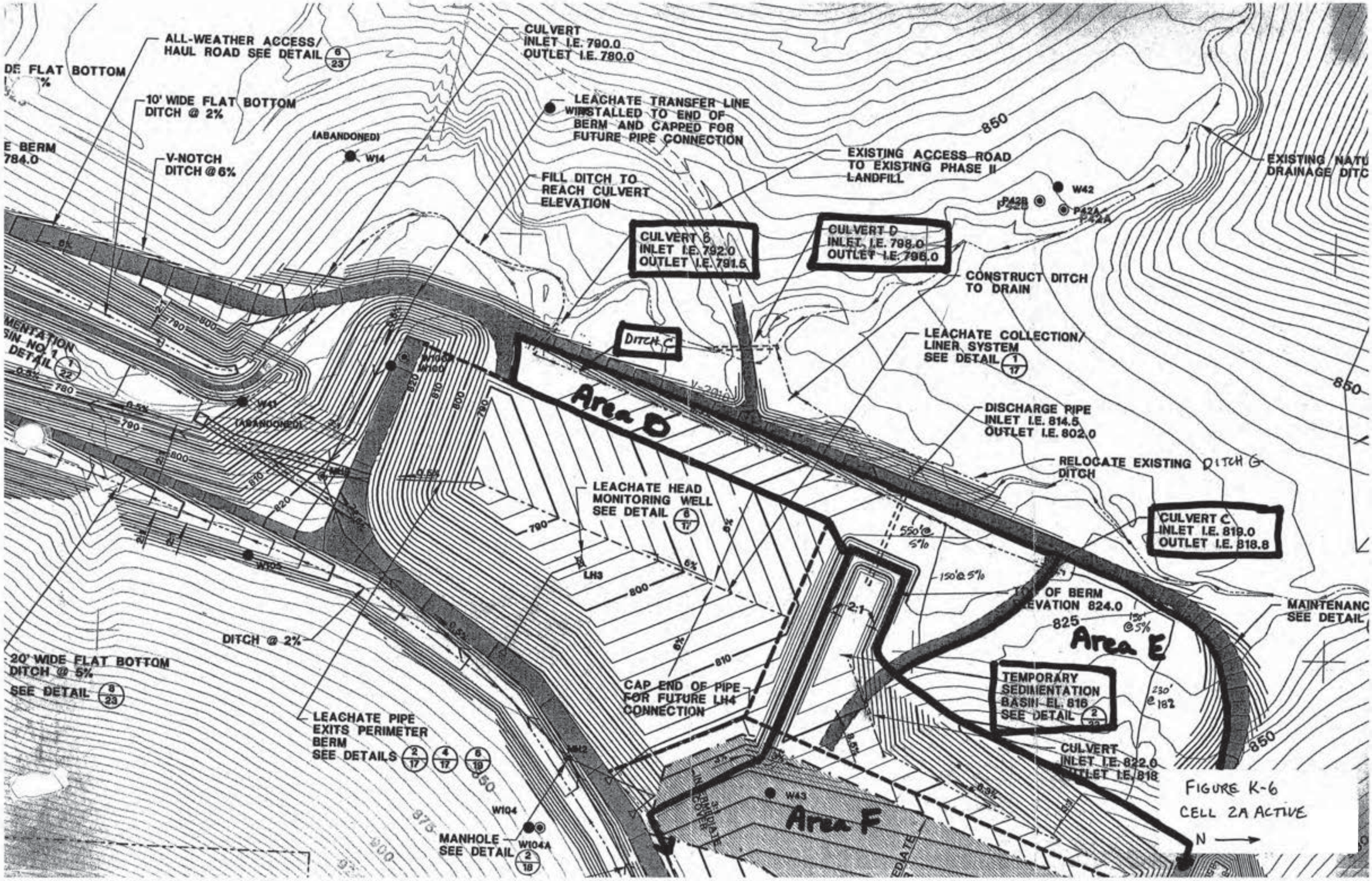
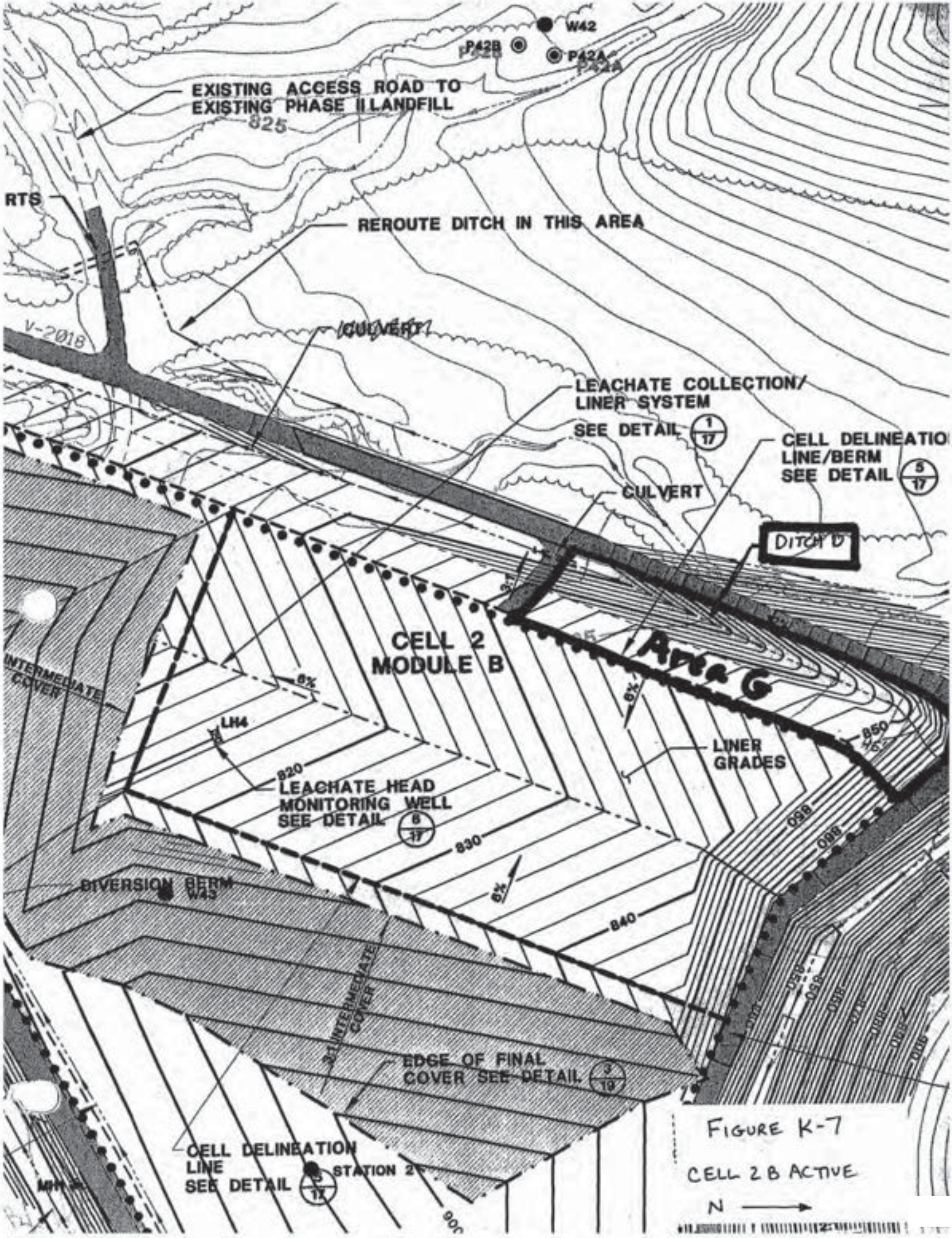



FIGURE K-6
CELL 2A ACTIVE


W42
P42B
P42A
EXISTING ACCESS ROAD TO
EXISTING PHASE II LANDFILL
825
RTS
REROUTE DITCH IN THIS AREA
V-2018
CULVERT
LEACHATE COLLECTION/
LINER SYSTEM
SEE DETAIL 1/17
CELL DELINEATIO
LINE/BERM
SEE DETAIL 5/17
CULVERT
DITCH D
CELL 2
MODULE B
AREA G
INTERMEDIATE
COVER
8%
LH4
820
LEACHATE HEAD
MONITORING WELL
SEE DETAIL 6/17
830
LINER
GRADES
850
860
DIVERSION BERM
W43
840
INTERMEDIATE
COVER
EDGE OF FINAL
COVER SEE DETAIL 3/19
CELL DELINEATION
LINE
SEE DETAIL 5/17
STATION 2
MH
FIGURE K-7
CELL 2B ACTIVE
N

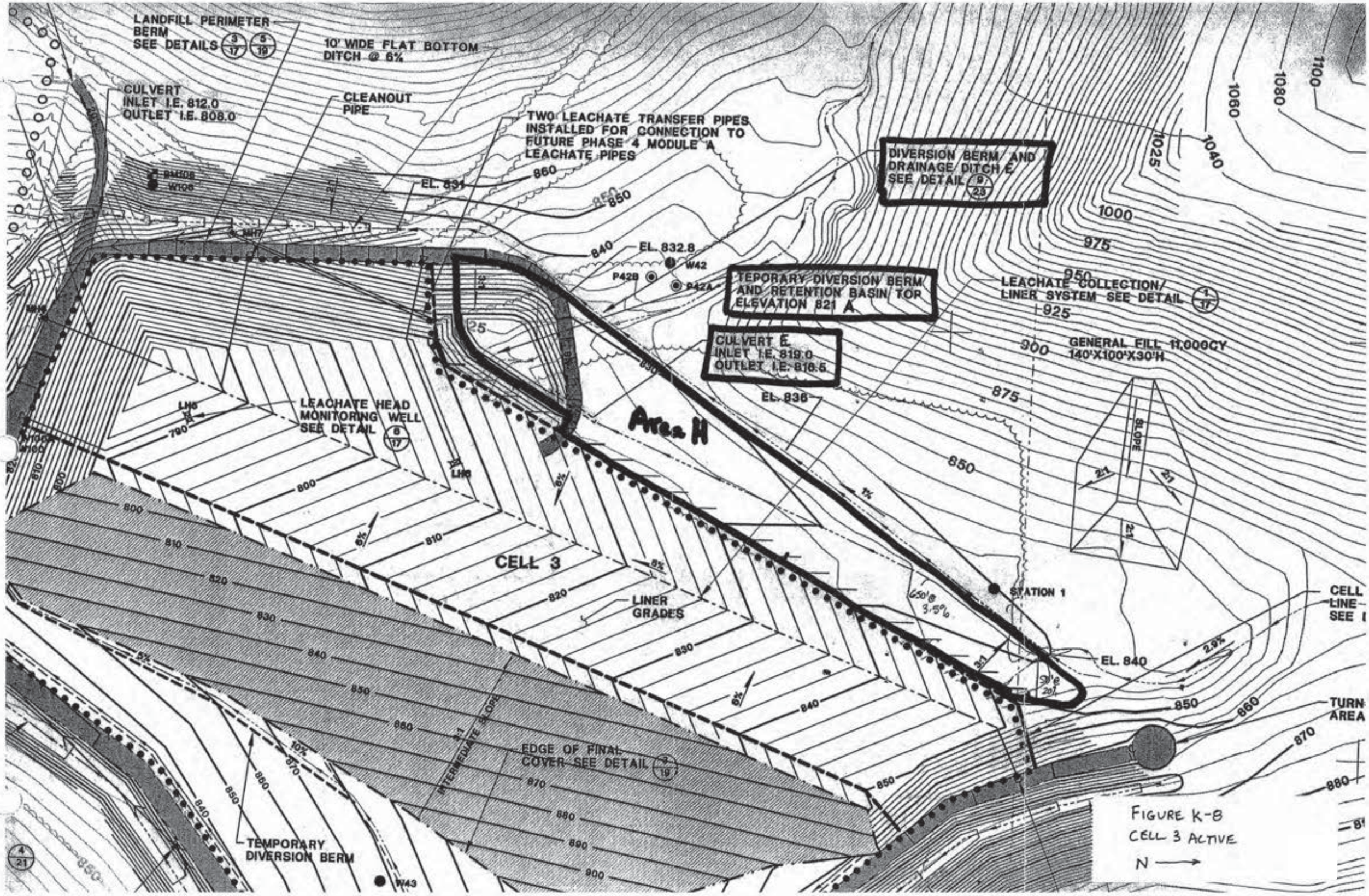



FIGURE K-8
CELL 3 ACTIVE

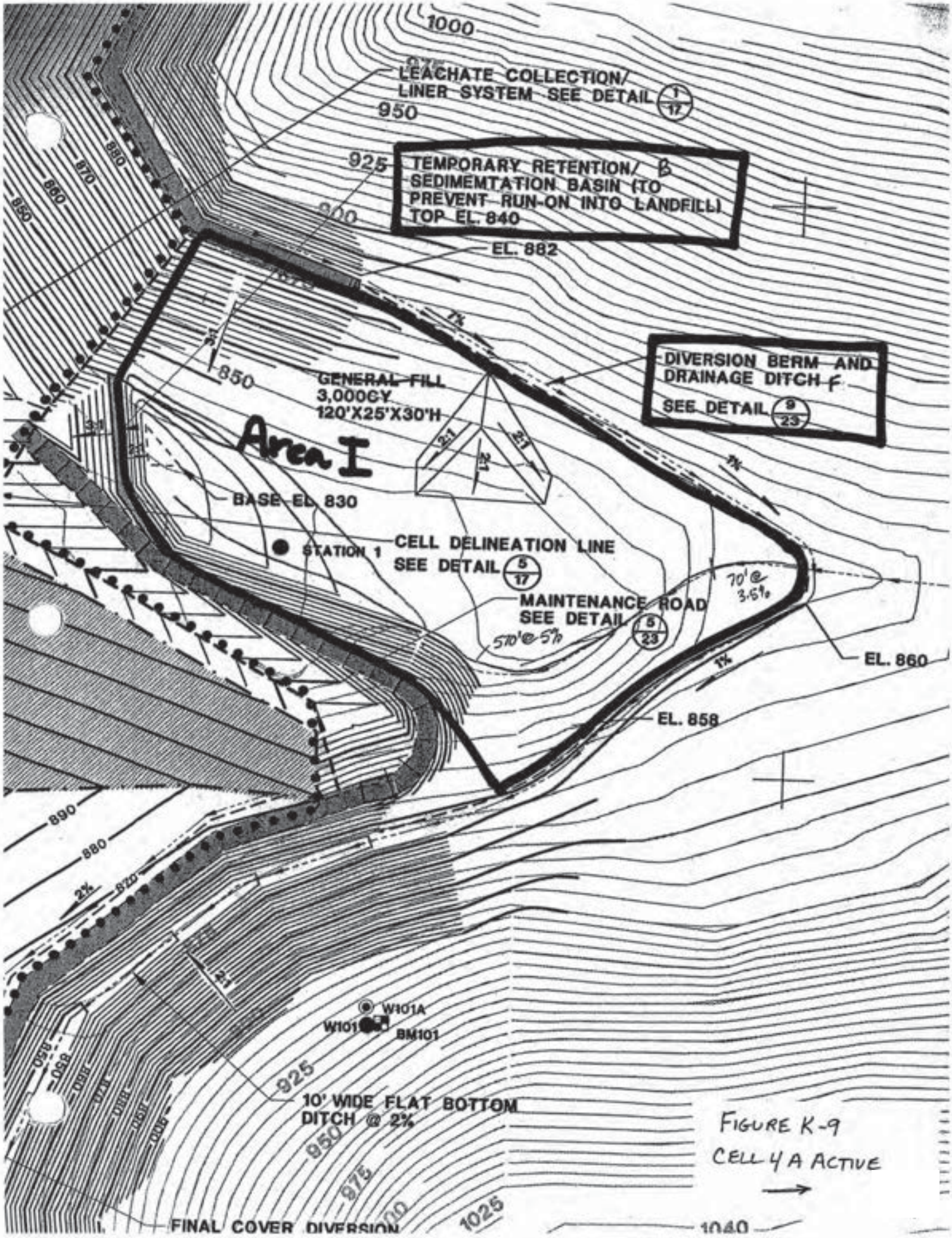



FIGURE K-9
CELL 4 A ACTIVE

Quick TR-55 Ver.5.46 S/N:
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SUMMARY SHEET FOR Tc or Tt COMPUTATIONS
(Solved for Time using TR-55 Methods)

Dairyland Power Coop.
Plan of Operation
Operational Conditions

| Subarea descr. | Tc or Tt | Time (hrs) |
|---|---|---|
| Area A | Tc | 0.08 |
| Area B | Tc | 0.21 |
| Area D | Tc | 0.06 – Round to 0.10 |
| Area E | Tc | 0.15 |
| Area F | Tc | 0.24 |
| Area G | Tc | 0.05 – Round to 0.10 |
| Area H | Tc | 0.10 |
| Area I | Tc | 0.15 |

Quick TR-55 Ver.5.46 S/N:
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Dairyland Power Coop.
Plan of Operation
Operational Conditions

Tc COMPUTATIONS FOR: Area A

SHEET FLOW (Applicable to Tc only)

| | | | |
|---|---|---|---|
| Segment ID | | 1 | |
| Surface description | | grass | |
| Manning's roughness coeff., n | | 0.1500 | |
| Flow length, L (total < or = 300) | ft | 65.0 | |
| Two-yr 24-hr rainfall, P2 | in | 2.800 | |
| Land slope, s | ft/ft | 0.3330 | |
| $T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$ | hrs | 0.04 | = 0.04 |

SHALLOW CONCENTRATED FLOW

| | | | |
|---|---|---|---|
| Segment ID | | 2 | |
| Surface (paved or unpaved)? | | Unpaved | |
| Flow length, L | ft | 625.0 | |
| Watercourse slope, s | ft/ft | 0.0600 | |
| $Avg.V = Csf * (s)^{0.5}$ | ft/s | 3.9521 | |
| where: Unpaved Csf = 16.1345 | | | |
| Paved Csf = 20.3282 | | | |
| T = L / (3600*V) | hrs | 0.04 | = 0.04 |

CHANNEL FLOW

| | | | |
|---|---|---|---|
| Segment ID | | | |
| Cross Sectional Flow Area, a | sq.ft | 0.00 | |
| Wetted perimeter, Pw | ft | 0.00 | |
| Hydraulic radius, r = a/Pw | ft | 0.000 | |
| Channel slope, s | ft/ft | 0.0000 | |
| Manning's roughness coeff., n | | 0.0000 | |
| $V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$ | ft/s | 0.0000 | |
| Flow length, L | ft | 0 | |
| T = L / (3600*V) | hrs | 0.00 | = 0.00 |

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TOTAL TIME (hrs) 0.08

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Dairyland Power Coop.
Plan of Operation
Operational Conditions

Tc COMPUTATIONS FOR: Area B

SHEET FLOW (Applicable to Tc only)

| | | | |
|---|---|---|---|
| Segment ID | | 1 | |
| Surface description | | grass | |
| Manning's roughness coeff., n | | 0.1500 | |
| Flow length, L (total < or = 300) | ft | 300.0 | |
| Two-yr 24-hr rainfall, P2 | in | 2.800 | |
| Land slope, s | ft/ft | 0.1700 | |
| $T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$ | hrs | 0.18 | = 0.18 |

SHALLOW CONCENTRATED FLOW

| | | | |
|---|---|---|---|
| Segment ID | | 2 | |
| Surface (paved or unpaved)? | | Unpaved | |
| Flow length, L | ft | 220.0 | |
| Watercourse slope, s | ft/ft | 0.0200 | |
| $Avg.V = Csf * (s)^{0.5}$ | ft/s | 2.2818 | |
| where: Unpaved Csf = 16.1345 | | | |
| Paved Csf = 20.3282 | | | |
| T = L / (3600*V) | hrs | 0.03 | = 0.03 |

CHANNEL FLOW

| | | | |
|---|---|---|---|
| Segment ID | | | |
| Cross Sectional Flow Area, a | sq.ft | 0.00 | |
| Wetted perimeter, Pw | ft | 0.00 | |
| Hydraulic radius, r = a/Pw | ft | 0.000 | |
| Channel slope, s | ft/ft | 0.0000 | |
| Manning's roughness coeff., n | | 0.0000 | |
| $V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$ | ft/s | 0.0000 | |
| Flow length, L | ft | 0 | |
| T = L / (3600*V) | hrs | 0.00 | = 0.00 |

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TOTAL TIME (hrs) 0.21

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Dairyland Power Coop.
Plan of Operation
Operational Conditions

Tc COMPUTATIONS FOR: Area D

SHEET FLOW (Applicable to Tc only)

| | | | |
|---|---|---|---|
| Segment ID | | 1 | |
| Surface description | | soil | |
| Manning's roughness coeff., n | | 0.0110 | |
| Flow length, L (total < or = 300) | ft | 150.0 | |
| Two-yr 24-hr rainfall, P2 | in | 2.800 | |
| Land slope, s | ft/ft | 0.0500 | |
| $T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$ | hrs | 0.02 | = 0.02 |

SHALLOW CONCENTRATED FLOW

| | | | |
|---|---|---|---|
| Segment ID | | 2 | |
| Surface (paved or unpaved)? | | Unpaved | |
| Flow length, L | ft | 550.0 | |
| Watercourse slope, s | ft/ft | 0.0500 | |
| $Avg.V = Csf * (s)^{0.5}$ | ft/s | 3.6078 | |
| where: Unpaved Csf = 16.1345 | | | |
| Paved Csf = 20.3282 | | | |
| T = L / (3600*V) | hrs | 0.04 | = 0.04 |

CHANNEL FLOW

| | | | |
|---|---|---|---|
| Segment ID | | | |
| Cross Sectional Flow Area, a | sq.ft | 0.00 | |
| Wetted perimeter, Pw | ft | 0.00 | |
| Hydraulic radius, r = a/Pw | ft | 0.000 | |
| Channel slope, s | ft/ft | 0.0000 | |
| Manning's roughness coeff., n | | 0.0000 | |
| $V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$ | ft/s | 0.0000 | |
| Flow length, L | ft | 0 | |
| T = L / (3600*V) | hrs | 0.00 | = 0.00 |

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TOTAL TIME (hrs) 0.06

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                    Dairyland Power Coop.
                     Plan of Operation
                   Operational Conditions


              Tc COMPUTATIONS FOR: Area E

SHEET FLOW (Applicable to Tc only)
    Segment ID                                1
    Surface description                  grass
    Manning's roughness coeff., n             0.1500
    Flow length, L (total < or = 300)    ft   230.0
    Two-yr 24-hr rainfall, P2            in   2.800
    Land slope, s                       ft/ft 0.1800
                   0.8
       .007 * (n*L)
    T = --------------                  hrs    0.14              = 0.14
          0.5   0.4
        P2   *  s

SHALLOW CONCENTRATED FLOW
    Segment ID                                2
    Surface (paved or unpaved)?               Unpaved
    Flow length, L                       ft   150.0
    Watercourse slope, s                ft/ft 0.0500

                    0.5
    Avg.V =  Csf *  (s)                 ft/s  3.6078
    where:   Unpaved Csf = 16.1345
             Paved   Csf = 20.3282

    T = L / (3600*V)                    hrs    0.01              = 0.01


CHANNEL FLOW
    Segment ID
    Cross Sectional Flow Area, a       sq.ft   0.00
    Wetted perimeter, Pw                 ft    0.00
    Hydraulic radius, r = a/Pw           ft   0.000
    Channel slope, s                    ft/ft 0.0000
    Manning's roughness coeff., n             0.0000

                 2/3   1/2
       1.49  *  r   *  s
    V = --------------------            ft/s  0.0000
                  n

    Flow length, L                       ft       0

    T = L / (3600*V)                    hrs    0.00              = 0.00

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                                        TOTAL TIME (hrs)        0.15
```

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Dairyland Power Coop.
Plan of Operation
Operational Conditions

Tc COMPUTATIONS FOR: Area F

SHEET FLOW (Applicable to Tc only)

| | | | |
|---|---|---|---|
| Segment ID | | 1 | |
| Surface description | | grass | |
| Manning's roughness coeff., n | | 0.1500 | |
| Flow length, L (total < or = 300) | ft | 185.0 | |
| Two-yr 24-hr rainfall, P2 | in | 2.800 | |
| Land slope, s | ft/ft | 0.2500 | |
| $T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$ | hrs | 0.10 | = 0.10 |

SHALLOW CONCENTRATED FLOW

| | | | |
|---|---|---|---|
| Segment ID | | 2 | |
| Surface (paved or unpaved)? | | Unpaved | |
| Flow length, L | ft | 1370.0 | |
| Watercourse slope, s | ft/ft | 0.0300 | |
| $Avg.V = Csf * (s)^{0.5}$ | ft/s | 2.7946 | |
| where: Unpaved Csf = 16.1345 | | | |
| Paved Csf = 20.3282 | | | |
| T = L / (3600*V) | hrs | 0.14 | = 0.14 |

CHANNEL FLOW

| | | | |
|---|---|---|---|
| Segment ID | | | |
| Cross Sectional Flow Area, a | sq.ft | 0.00 | |
| Wetted perimeter, Pw | ft | 0.00 | |
| Hydraulic radius, r = a/Pw | ft | 0.000 | |
| Channel slope, s | ft/ft | 0.0000 | |
| Manning's roughness coeff., n | | 0.0000 | |
| $V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$ | ft/s | 0.0000 | |
| Flow length, L | ft | 0 | |
| T = L / (3600*V) | hrs | 0.00 | = 0.00 |

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TOTAL TIME (hrs) 0.24

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Dairyland Power Coop.
Plan of Operation
Operational Conditions

Tc COMPUTATIONS FOR: Area G

SHEET FLOW (Applicable to Tc only)

| | | | |
|---|---|---|---|
| Segment ID | | 1 | |
| Surface description | | grass | |
| Manning's roughness coeff., n | | 0.1500 | |
| Flow length, L (total < or = 300) | ft | 45.0 | |
| Two-yr 24-hr rainfall, P2 | in | 2.800 | |
| Land slope, s | ft/ft | 0.3300 | |
| $T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$ | hrs | 0.03 | = 0.03 |

SHALLOW CONCENTRATED FLOW

| | | | |
|---|---|---|---|
| Segment ID | | 2 | |
| Surface (paved or unpaved)? | | Unpaved | |
| Flow length, L | ft | 320.0 | |
| Watercourse slope, s | ft/ft | 0.1200 | |
| $Avg.V = Csf * (s)^{0.5}$ | ft/s | 5.5892 | |
| where: Unpaved Csf = 16.1345 | | | |
| Paved Csf = 20.3282 | | | |
| T = L / (3600*V) | hrs | 0.02 | = 0.02 |

CHANNEL FLOW

| | | | |
|---|---|---|---|
| Segment ID | | | |
| Cross Sectional Flow Area, a | sq.ft | 0.00 | |
| Wetted perimeter, Pw | ft | 0.00 | |
| Hydraulic radius, r = a/Pw | ft | 0.000 | |
| Channel slope, s | ft/ft | 0.0000 | |
| Manning's roughness coeff., n | | 0.0000 | |
| $V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$ | ft/s | 0.0000 | |
| Flow length, L | ft | 0 | |
| T = L / (3600*V) | hrs | 0.00 | = 0.00 |

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TOTAL TIME (hrs) 0.05

Quick TR-55 Ver.5.46 S/N:
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Dairyland Power Coop.
Plan of Operation
Operational Conditions

Tc COMPUTATIONS FOR: Area H

SHEET FLOW (Applicable to Tc only)

| | | | |
|---|---|---|---|
| Segment ID | | 1 | |
| Surface description | | grass | |
| Manning's roughness coeff., n | | 0.1500 | |
| Flow length, L (total < or = 300) | ft | 50.0 | |
| Two-yr 24-hr rainfall, P2 | in | 2.800 | |
| Land slope, s | ft/ft | 0.2000 | |
| $T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$ | hrs | 0.04 | = 0.04 |

SHALLOW CONCENTRATED FLOW

| | | | |
|---|---|---|---|
| Segment ID | | 2 | |
| Surface (paved or unpaved)? | | Unpaved | |
| Flow length, L | ft | 650.0 | |
| Watercourse slope, s | ft/ft | 0.0350 | |
| $Avg.V = Csf * (s)^{0.5}$ | ft/s | 3.0185 | |
| where: Unpaved Csf = 16.1345 | | | |
| Paved Csf = 20.3282 | | | |
| T = L / (3600*V) | hrs | 0.06 | = 0.06 |

CHANNEL FLOW

| | | | |
|---|---|---|---|
| Segment ID | | | |
| Cross Sectional Flow Area, a | sq.ft | 0.00 | |
| Wetted perimeter, Pw | ft | 0.00 | |
| Hydraulic radius, r = a/Pw | ft | 0.000 | |
| Channel slope, s | ft/ft | 0.0000 | |
| Manning's roughness coeff., n | | 0.0000 | |
| $V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$ | ft/s | 0.0000 | |
| Flow length, L | ft | 0 | |
| T = L / (3600*V) | hrs | 0.00 | = 0.00 |

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TOTAL TIME (hrs) 0.10

Quick TR-55 Ver.5.46 S/N:
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Dairyland Power Coop.
Plan of Operation
Operational Conditions

Tc COMPUTATIONS FOR: Area I

SHEET FLOW (Applicable to Tc only)

| | | | |
|---|---|---|---|
| Segment ID | | 1 | |
| Surface description | | grass | |
| Manning's roughness coeff., n | | 0.1500 | |
| Flow length, L (total < or = 300) | ft | 70.0 | |
| Two-yr 24-hr rainfall, P2 | in | 2.800 | |
| Land slope, s | ft/ft | 0.0350 | |
| $T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$ | hrs | 0.10 | = 0.10 |

SHALLOW CONCENTRATED FLOW

| | | | |
|---|---|---|---|
| Segment ID | | 2 | |
| Surface (paved or unpaved)? | | Unpaved | |
| Flow length, L | ft | 570.0 | |
| Watercourse slope, s | ft/ft | 0.0500 | |
| $Avg.V = Csf * (s)^{0.5}$ | ft/s | 3.6078 | |
| where: Unpaved Csf = 16.1345 | | | |
| Paved Csf = 20.3282 | | | |
| T = L / (3600*V) | hrs | 0.04 | = 0.04 |

CHANNEL FLOW

| | | | |
|---|---|---|---|
| Segment ID | | | |
| Cross Sectional Flow Area, a | sq.ft | 0.00 | |
| Wetted perimeter, Pw | ft | 0.00 | |
| Hydraulic radius, r = a/Pw | ft | 0.000 | |
| Channel slope, s | ft/ft | 0.0000 | |
| Manning's roughness coeff., n | | 0.0000 | |
| $V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$ | ft/s | 0.0000 | |
| Flow length, L | ft | 0 | |
| T = L / (3600*V) | hrs | 0.00 | = 0.00 |

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TOTAL TIME (hrs) 0.15

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 10-12-2000 20:11:42
Watershed file: --> p:\data\projects\3081\40\sw\op\CELL1 .WSD
Hydrograph file: --> p:\data\projects\3081\40\sw\op\CELL1 .HYD

Dairyland Power Coop.
Plan of Operation
Operational Conditions
Cell 1

>>>> Input Parameters Used to Compute Hydrograph <<<<

| Subarea Description | AREA (acres) | CN | Tc (hrs) | * Tt (hrs) | Precip. (in) | Runoff (in) | Ia/p input/used | |
|---|---|---|---|---|---|---|---|---|
| Area A | 1.10 | 69.0 | 0.10 | 0.00 | 6.10 | 2.79 | .15 | .10 |
| Area B | 2.70 | 69.0 | 0.20 | 0.00 | 6.10 | 2.79 | .15 | .10 |

* Travel time from subarea outfall to composite watershed outfall point.
Total area = 3.80 acres or 0.00594 sq.mi
Peak discharge = 14 cfs

>>>> Computer Modifications of Input Parameters <<<<<

| Subarea Description | Input Values Tc (hr) | Input Values * Tt (hr) | Rounded Values Tc (hr) | Rounded Values * Tt (hr) | Ia/p Interpolated (Yes/No) | Ia/p Messages |
|---|---|---|---|---|---|---|
| Area A | 0.10 | 0.00 | ** | ** | No | -- |
| Area B | 0.21 | 0.00 | 0.20 | 0.00 | No | -- |

* Travel time from subarea outfall to composite watershed outfall point.
** Tc & Tt are available in the hydrograph tables.

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 10-12-2000 20:11:42
Watershed file: --> p:\data\projects\3081\40\sw\op\CELL1 .WSD
Hydrograph file: --> p:\data\projects\3081\40\sw\op\CELL1 .HYD

Dairyland Power Coop.
Plan of Operation
Operational Conditions
Cell 1

>>>> Summary of Subarea Times to Peak <<<<

| Subarea | Peak Discharge at Composite Outfall (cfs) | Time to Peak at Composite Outfall (hrs) |
|---|---|---|
| Area A | 5 | 12.1 |
| Area B | 9 | 12.1 |
| Composite Watershed | 14 | 12.1 |

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 10-12-2000 20:11:49
Watershed file: --> p:\data\projects\3081\40\sw\op\CELL2A .WSD
Hydrograph file: --> p:\data\projects\3081\40\sw\op\CELL2A .HYD

Dairyland Power Coop.
Plan of Opertaion
Operational Conditions
Cell 2A

>>>> Input Parameters Used to Compute Hydrograph <<<<

| Subarea Description | AREA (acres) | CN | Tc (hrs) | * Tt (hrs) | Precip. (in) | Runoff (in) | Ia/p input | Ia/p used |
|---|---|---|---|---|---|---|---|---|
| Area D | 1.30 | 69.0 | 0.10 | 0.00 | 6.10 | 2.79 | .15 | .10 |
| Area E | 1.60 | 69.0 | 0.20 | 0.00 | 6.10 | 2.79 | .15 | .10 |

* Travel time from subarea outfall to composite watershed outfall point.
Total area = 2.90 acres or 0.00453 sq.mi
Peak discharge = 11 cfs

>>>> Computer Modifications of Input Parameters <<<<<

| Subarea Description | Input Values Tc (hr) | Input Values * Tt (hr) | Rounded Values Tc (hr) | Rounded Values * Tt (hr) | Ia/p Interpolated (Yes/No) | Ia/p Messages |
|---|---|---|---|---|---|---|
| Area D | 0.10 | 0.00 | ** | ** | No | -- |
| Area E | 0.15 | 0.00 | 0.20 | 0.00 | No | -- |

* Travel time from subarea outfall to composite watershed outfall point.
** Tc & Tt are available in the hydrograph tables.

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 10-12-2000 20:11:49
Watershed file: --> p:\data\projects\3081\40\sw\op\CELL2A .WSD
Hydrograph file: --> p:\data\projects\3081\40\sw\op\CELL2A .HYD

Dairyland Power Coop.
Plan of Opertaion
Operational Conditions
Cell 2A

>>>> Summary of Subarea Times to Peak <<<<

| Subarea | Peak Discharge at Composite Outfall (cfs) | Time to Peak at Composite Outfall (hrs) |
|---|---|---|
| Area D | 6 | 12.1 |
| Area E | 6 | 12.2 |
| Composite Watershed | 11 | 12.1 |

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 10-12-2000 20:11:57
Watershed file: --> p:\data\projects\3081\40\sw\op\TEMPBAS .WSD
Hydrograph file: --> p:\data\projects\3081\40\sw\op\TEMPBAS .HYD

Dairyland Power Coop.
Plan of Opertaion
Operational Conditions
Cell 2A Temporary Basin

>>>> Input Parameters Used to Compute Hydrograph <<<<

| Subarea Description | AREA (acres) | CN | Tc (hrs) | * Tt (hrs) | Precip. (in) | Runoff (in) | Ia/p input/used |
|---|---|---|---|---|---|---|---|
| Area F | 7.60 | 69.0 | 0.20 | 0.00 | 6.10 | 2.79 | .15 .10 |

* Travel time from subarea outfall to composite watershed outfall point.
Total area = 7.60 acres or 0.01187 sq.mi
Peak discharge = 27 cfs

>>>> Computer Modifications of Input Parameters <<<<<

| Subarea Description | Input Values Tc (hr) | * Tt (hr) | Rounded Values Tc (hr) | * Tt (hr) | Ia/p Interpolated (Yes/No) | Ia/p Messages |
|---|---|---|---|---|---|---|
| Area F | 0.24 | 0.00 | 0.20 | 0.00 | No | -- |

* Travel time from subarea outfall to composite watershed outfall point.

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 10-12-2000 20:11:57
Watershed file: --> p:\data\projects\3081\40\sw\op\TEMPBAS .WSD
Hydrograph file: --> p:\data\projects\3081\40\sw\op\TEMPBAS .HYD

Dairyland Power Coop.
Plan of Opertaion
Operational Conditions
Cell 2A Temporary Basin

>>>> Summary of Subarea Times to Peak <<<<

| Subarea | Peak Discharge at Composite Outfall (cfs) | Time to Peak at Composite Outfall (hrs) |
|---|---|---|
| Area F | 27 | 12.2 |
| Composite Watershed | 27 | 12.2 |

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 10-12-2000 20:12:03
Watershed file: --> p:\data\projects\3081\40\sw\op\CELL2B .WSD
Hydrograph file: --> p:\data\projects\3081\40\sw\op\CELL2B .HYD

Dairyland Power Coop.
Plan of Opertaion
Operational Conditions
Cell 2B

>>>> Input Parameters Used to Compute Hydrograph <<<<

| Subarea Description | AREA (acres) | CN | Tc (hrs) | * Tt (hrs) | Precip. (in) | Runoff (in) | Ia/p input/used | |
|---|---|---|---|---|---|---|---|---|
| Area G | 0.60 | 69.0 | 0.10 | 0.00 | 6.10 | 2.79 | .15 | .10 |

* Travel time from subarea outfall to composite watershed outfall point.
Total area = 0.60 acres or 0.00094 sq.mi
Peak discharge = 3 cfs

>>>> Computer Modifications of Input Parameters <<<<<

| Subarea Description | Input Values Tc (hr) | Input Values * Tt (hr) | Rounded Values Tc (hr) | Rounded Values * Tt (hr) | Ia/p Interpolated (Yes/No) | Ia/p Messages |
|---|---|---|---|---|---|---|
| Area G | 0.10 | 0.00 | ** | ** | No | -- |

* Travel time from subarea outfall to composite watershed outfall point.
** Tc & Tt are available in the hydrograph tables.

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 10-12-2000 20:12:03
Watershed file: --> p:\data\projects\3081\40\sw\op\CELL2B .WSD
Hydrograph file: --> p:\data\projects\3081\40\sw\op\CELL2B .HYD

Dairyland Power Coop.
Plan of Opertaion
Operational Conditions
Cell 2B

>>>> Summary of Subarea Times to Peak <<<<

| Subarea | Peak Discharge at Composite Outfall (cfs) | Time to Peak at Composite Outfall (hrs) |
|---|---|---|
| Area G | 3 | 12.1 |
| Composite Watershed | 3 | 12.1 |

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 10-12-2000 20:12:08
Watershed file: --> p:\data\projects\3081\40\sw\op\CELL3 .WSD
Hydrograph file: --> p:\data\projects\3081\40\sw\op\CELL3 .HYD

Dairyland Power Coop.
Plan of Operation
Operational Conditions
Cell 3

>>>> Input Parameters Used to Compute Hydrograph <<<<

| Subarea Description | AREA (acres) | CN | Tc (hrs) | * Tt (hrs) | Precip. (in) | Runoff (in) | Ia/p input/used | |
|---|---|---|---|---|---|---|---|---|
| Area H | 1.70 | 69.0 | 0.10 | 0.00 | 6.10 | 2.79 | .15 | .10 |

* Travel time from subarea outfall to composite watershed outfall point.
Total area = 1.70 acres or 0.00266 sq.mi
Peak discharge = 7 cfs

>>>> Computer Modifications of Input Parameters <<<<<

| Subarea Description | Input Values Tc (hr) | Input Values * Tt (hr) | Rounded Values Tc (hr) | Rounded Values * Tt (hr) | Ia/p Interpolated (Yes/No) | Ia/p Messages |
|---|---|---|---|---|---|---|
| Area H | 0.10 | 0.00 | ** | ** | No | -- |

* Travel time from subarea outfall to composite watershed outfall point.
** Tc & Tt are available in the hydrograph tables.

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 10-12-2000 20:12:08
Watershed file: --> p:\data\projects\3081\40\sw\op\CELL3 .WSD
Hydrograph file: --> p:\data\projects\3081\40\sw\op\CELL3 .HYD

Dairyland Power Coop.
Plan of Operation
Operational Conditions
Cell 3

>>>> Summary of Subarea Times to Peak <<<<

| Subarea | Peak Discharge at Composite Outfall (cfs) | Time to Peak at Composite Outfall (hrs) |
|---|---|---|
| Area H | 7 | 12.1 |
| Composite Watershed | 7 | 12.1 |

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 10-12-2000 20:21:09
Watershed file: --> p:\data\projects\3081\40\sw\op\CELL4A .WSD
Hydrograph file: --> p:\data\projects\3081\40\sw\op\CELL4A .HYD

Dairyland Power Coop.
Plan of Operation
Operational Conditions
Cell 4A

>>>> Input Parameters Used to Compute Hydrograph <<<<

| Subarea Description | AREA (acres) | CN | Tc (hrs) | * Tt (hrs) | Precip. (in) | Runoff (in) | Ia/p input/used |
|---|---|---|---|---|---|---|---|
| Area I | 3.60 | 69.0 | 0.20 | 0.00 | 6.10 | 2.79 | .15 .10 |

* Travel time from subarea outfall to composite watershed outfall point.
Total area = 3.60 acres or 0.00562 sq.mi
Peak discharge = 13 cfs

>>>> Computer Modifications of Input Parameters <<<<<

| Subarea Description | Input Values Tc (hr) | Input Values * Tt (hr) | Rounded Values Tc (hr) | Rounded Values * Tt (hr) | Ia/p Interpolated (Yes/No) | Ia/p Messages |
|---|---|---|---|---|---|---|
| Area I | 0.15 | 0.00 | 0.20 | 0.00 | No | -- |

* Travel time from subarea outfall to composite watershed outfall point.

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 10-12-2000 20:21:09
Watershed file: --> p:\data\projects\3081\40\sw\op\CELL4A .WSD
Hydrograph file: --> p:\data\projects\3081\40\sw\op\CELL4A .HYD

Dairyland Power Coop.
Plan of Operation
Operational Conditions
Cell 4A

>>>> Summary of Subarea Times to Peak <<<<

| Subarea | Peak Discharge at Composite Outfall (cfs) | Time to Peak at Composite Outfall (hrs) |
|---|---|---|
| Area I | 13 | 12.2 |
| Composite Watershed | 13 | 12.2 |

# Reference Information

**Table 2-2a.—Runoff curve numbers for urban areas[1]**

| Cover description | | Curve numbers for hydrologic soil group— | | | |
|---|---|---|---|---|---|
| Cover type and hydrologic condition | Average percent impervious area[2] | A | B | C | D |
| *Fully developed urban areas (vegetation established)* | | | | | |
| Open space (lawns, parks, golf courses, cemeteries, etc.)[3]: | | | | | |
| Poor condition (grass cover < 50%) | | 68 | 79 | 86 | 89 |
| Fair condition (grass cover 50% to 75%) | | 49 | 69 | 79 | 84 |
| Good condition (grass cover > 75%) | | 39 | 61 | 74 | 80 |
| Impervious areas: | | | | | |
| Paved parking lots, roofs, driveways, etc. (excluding right-of-way) | | 98 | 98 | 98 | 98 |
| Streets and roads: | | | | | |
| Paved: curbs and storm sewers (excluding right-of-way) | | 98 | 98 | 98 | 98 |
| Paved: open ditches (including right-of-way) | | 83 | 89 | 92 | 93 |
| Gravel (including right-of-way) | | 76 | 85 | 89 | 91 |
| Dirt (including right-of-way) | | 72 | 82 | 87 | 89 |
| Western desert urban areas: | | | | | |
| Natural desert landscaping (pervious areas only)[4] | | 63 | 77 | 85 | 88 |
| Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders) | | 96 | 96 | 96 | 96 |
| Urban districts: | | | | | |
| Commercial and business | 85 | 89 | 92 | 94 | 95 |
| Industrial | 72 | 81 | 88 | 91 | 93 |
| Residential districts by average lot size: | | | | | |
| 1/8 acre or less (town houses) | 65 | 77 | 85 | 90 | 92 |
| 1/4 acre | 38 | 61 | 75 | 83 | 87 |
| 1/3 acre | 30 | 57 | 72 | 81 | 86 |
| 1/2 acre | 25 | 54 | 70 | 80 | 85 |
| 1 acre | 20 | 51 | 68 | 79 | 84 |
| 2 acres | 12 | 46 | 65 | 77 | 82 |
| *Developing urban areas* | | | | | |
| Newly graded areas (pervious areas only, no vegetation)[5] | | 77 | 86 | 91 | 94 |
| Idle lands (CN's are determined using cover types similar to those in table 2-2c). | | | | | |

[1]Average runoff condition, and $I_a = 0.2S$.
[2]The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.
[3]CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.
[4]Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.
[5]Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4, based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

Table 2-2b.—Runoff curve numbers for cultivated agricultural lands[1]

| Cover description | | | Curve numbers for hydrologic soil group— | | | |
|---|---|---|---|---|---|---|
| Cover type | Treatment[2] | Hydrologic condition[3] | A | B | C | D |
| Fallow | Bare soil | — | 77 | 86 | 91 | 94 |
| | Crop residue cover (CR) | Poor | 76 | 85 | 90 | 93 |
| | | Good | 74 | 83 | 88 | 90 |
| Row crops | Straight row (SR) ⊥ to slope | Poor | 72 | 81 | 88 | 91 |
| | | Good | 67 | 78 | 85 | 89 |
| | SR + CR | Poor | 71 | 80 | 87 | 90 |
| | | Good | 64 | 75 | 82 | 85 |
| | Contoured (C) | Poor | 70 | 79 | 84 | 88 |
| | | Good | 65 | 75 ≈77 | 82 | 86 |
| | C + CR | Poor | 69 | 78 | 83 | 87 |
| | | Good | 64 | 74 | 81 | 85 |
| | Contoured & terraced (C&T) | Poor | 66 | 74 | 80 | 82 |
| | | Good | 62 | 71 | 78 | 81 |
| | C&T + CR | Poor | 65 | 73 | 79 | 81 |
| | | Good | 61 | 70 | 77 | 80 |
| Small grain | SR | Poor | 65 | 76 | 84 | 88 |
| | | Good | 63 | 75 | 83 | 87 |
| | SR + CR | Poor | 64 | 75 | 83 | 86 |
| | | Good | 60 | 72 | 80 | 84 |
| | C | Poor | 63 | 74 | 82 | 85 |
| | | Good | 61 | 73 | 81 | 84 |
| | C + CR | Poor | 62 | 73 | 81 | 84 |
| | | Good | 60 | 72 | 80 | 83 |
| | C&T | Poor | 61 | 72 | 79 | 82 |
| | | Good | 59 | 70 | 78 | 81 |
| | C&T + CR | Poor | 60 | 71 | 78 | 81 |
| | | Good | 58 | 69 | 77 | 80 |
| Close-seeded or broadcast legumes or rotation meadow | SR | Poor | 66 | 77 | 85 | 89 |
| | | Good | 58 | 72 | 81 | 85 |
| | C | Poor | 64 | 75 | 83 | 85 |
| | | Good | 55 | 69 | 78 | 83 |
| | C&T | Poor | 63 | 73 | 80 | 83 |
| | | Good | 51 | 67 | 76 | 80 |

[1]Average runoff condition, and $I_a = 0.2S$.
[2]*Crop residue cover* applies only if residue is on at least 5% of the surface throughout the year.
[3]Hydrologic condition is based on combination of factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes in rotations, (d) percent of residue cover on the land surface (good ≥ 20%), and (e) degree of surface roughness.
*Poor:* Factors impair infiltration and tend to increase runoff.
*Good:* Factors encourage average and better than average infiltration and tend to decrease runoff.

**Table 2-2c.—Runoff curve numbers for other agricultural lands[1]**

| Cover description | | Curve numbers for hydrologic soil group— | | | |
|---|---|---|---|---|---|
| Cover type | Hydrologic condition | A | B | C | D |
| Pasture, grassland, or range—continuous forage for grazing.[2] | Poor | 68 | 79 | 86 | 89 |
| | Fair | 49 | 69 | 79 | 84 |
| | Good | 39 | 61 | 74 | 80 |
| Meadow—continuous grass, protected from grazing and generally mowed for hay. | — | 30 | 58 | 71 | 78 |
| Brush—brush-weed-grass mixture with brush the major element.[3] | Poor | 48 | 67 | 77 | 83 |
| | Fair | 35 | 56 | 70 | 77 |
| | Good | [4]30 | 48 | 65 | 73 |
| Woods—grass combination (orchard or tree farm).[5] | Poor | 57 | 73 | 82 | 86 |
| | Fair | 43 | 65 | 76 | 82 |
| | Good | 32 | 58 | 72 | 79 |
| Woods.[6] | Poor | 45 | 66 | 77 | 83 |
| | Fair | 36 | 60 | 73 | 79 |
| | Good | [4]30 | 55 | 70 | 77 |
| Farmsteads—buildings, lanes, driveways, and surrounding lots. | — | 59 | 74 | 82 | 86 |

[1]Average runoff condition, and $I_a = 0.2S$.

[2]*Poor:* <50% ground cover or heavily grazed with no mulch.
*Fair:* 50 to 75% ground cover and not heavily grazed.
*Good:* >75% ground cover and lightly or only occasionally grazed.

[3]*Poor:* <50% ground cover.
*Fair:* 50 to 75% ground cover.
*Good:* >75% ground cover.

[4]Actual curve number is less than 30; use CN = 30 for runoff computations.

[5]CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

[6]*Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
*Fair:* Woods are grazed but not burned, and some forest litter covers the soil.
*Good:* Woods are protected from grazing, and litter and brush adequately cover the soil.

### Sheet flow

Sheet flow is flow over plane surfaces. It usually occurs in the headwater of streams. With sheet flow, the friction value (Manning's n) is an effective roughness coefficient that includes the effect of raindrop impact; drag over the plane surface; obstacles such as litter, crop ridges, and rocks; and erosion and transportation of sediment. These n values are for very shallow flow depths of about 0.1 foot or so. Table 3-1 gives Manning's n values for sheet flow for various surface conditions.

For sheet flow of less than 300 feet, use Manning's kinematic solution (Overton and Meadows 1976) to compute $T_t$:

$$T_t = \frac{0.007\,(nL)^{0.8}}{(P_2)^{0.5}\,s^{0.4}} \qquad \text{[Eq. 3-3]}$$

**Table 3-1.—Roughness coefficients (Manning's n) for sheet flow**

| Surface description | n[1] |
|---|---|
| Smooth surfaces (concrete, asphalt, gravel, or bare soil) | 0.011 |
| Fallow (no residue) | 0.05 |
| Cultivated soils: | |
| Residue cover ≤20% | 0.06 |
| Residue cover >20% | 0.17 |
| Grass: | |
| Short grass prairie | 0.15 |
| Dense grasses[2] | 0.24 |
| Bermudagrass | 0.41 |
| Range (natural) | 0.13 |
| Woods:[3] | |
| Light underbrush | 0.40 |
| Dense underbrush | 0.80 |

[1]The n values are a composite of information compiled by Engman (1986).
[2]Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.
[3]When selecting n, consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.

where

$T_t$ = travel time (hr),
n = Manning's roughness coefficient (table 3-1),
L = flow length (ft),
$P_2$ = 2-year, 24-hour rainfall (in), and
s = slope of hydraulic grade line (land slope, ft/ft).

This simplified form of the Manning's kinematic solution is based on the following: (1) shallow steady uniform flow, (2) constant intensity of rainfall excess (that part of a rain available for runoff), (3) rainfall duration of 24 hours, and (4) minor effect of infiltration on travel time. Rainfall depth can be obtained from appendix B.

### Shallow concentrated flow

After a maximum of 300 feet, sheet flow usually becomes shallow concentrated flow. The average velocity for this flow can be determined from figure 3-1, in which average velocity is a function of watercourse slope and type of channel. For slopes less than 0.005 ft/ft, use equations given in appendix F for figure 3-1. Tillage can affect the direction of shallow concentrated flow. Flow may not always be directly down the watershed slope if tillage runs across the slope.

After determining average velocity in figure 3-1, use equation 3-1 to estimate travel time for the shallow concentrated flow segment.

### Open channels

Open channels are assumed to begin where surveyed cross section information has been obtained, where channels are visible on aerial photographs, or where blue lines (indicating streams) appear on United States Geological Survey (USGS) quadrangle sheets. Manning's equation or water surface profile information can be used to estimate average flow velocity. Average flow velocity is usually determined for bank-full elevation.

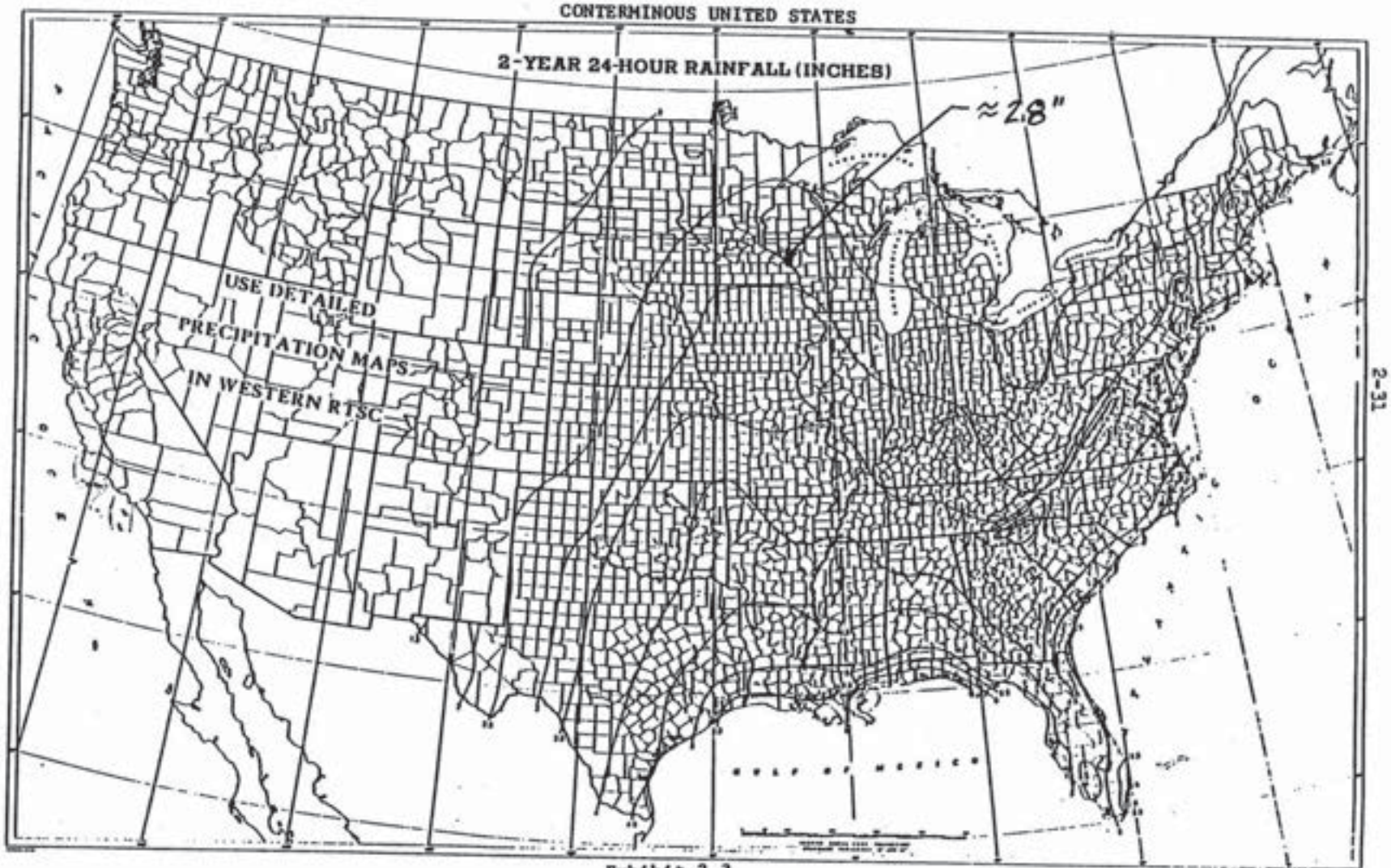
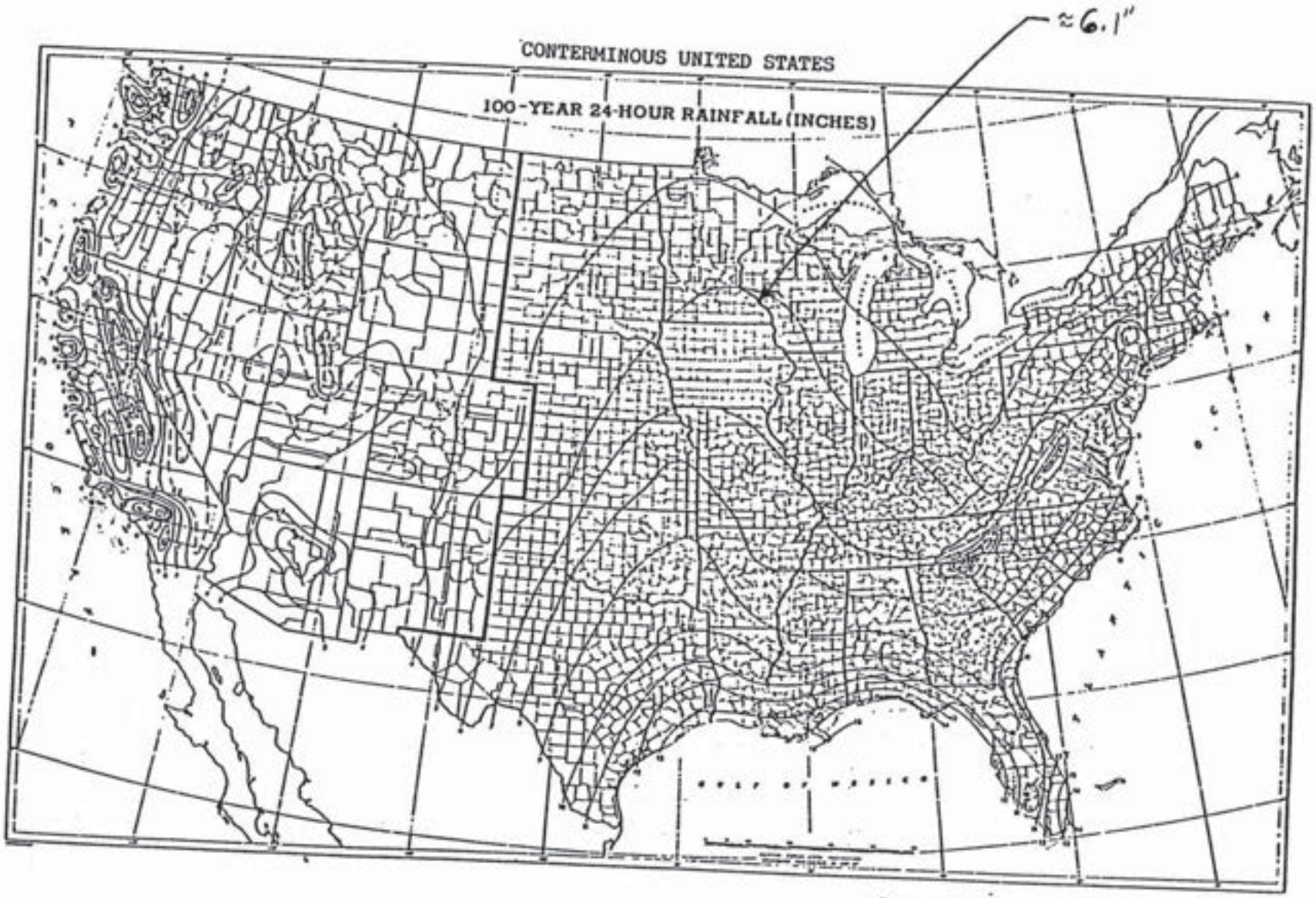


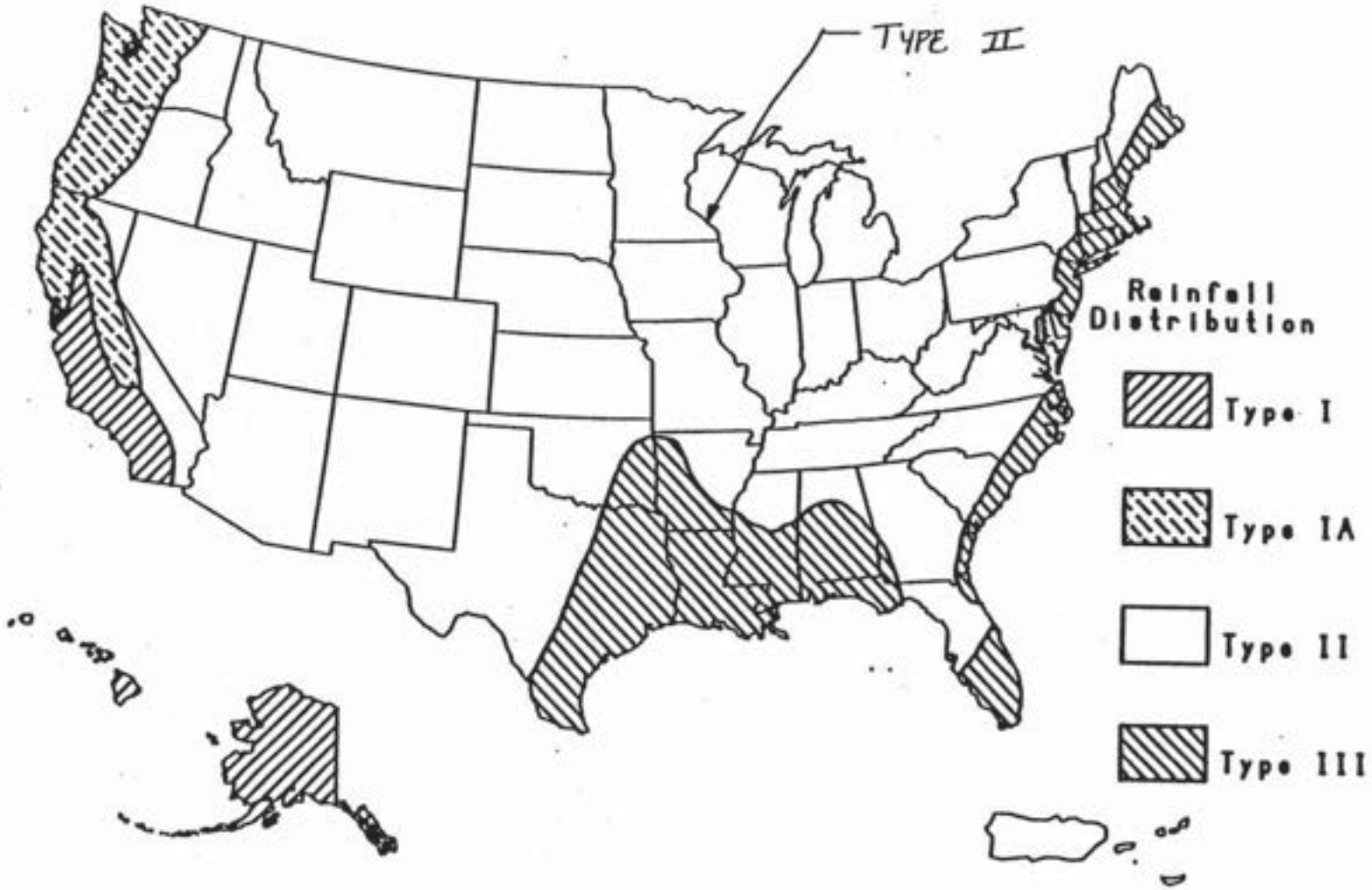

Exhibit 2-3
Sheet 1 of 5

Prepared by U. S. Weather Bureau




Prepared by U. S. Weather Bureau

FROM: Urban Hydrology for Small Watersheds. [ n.p. ]: U.S. Department of Agriculture. Soil Conservation Service Engineering Division, ( Technical Release No. 55 ). 1975, as revised 1981.




—Approximate geographic boundaries for SCS rainfall distributions.

# Diversion Berm, Perimeter Ditch, and Spillway Design Calculations

# Purpose/Methodology/Assumptions/Results/References

744 Heartland Trail (53717-8923) P. O. Box 8923 (53708-8923) Madison, WI (608) 831-4444 FAX: (608) 831-3334 VOICE: (608) 831-1989

| PROJECT/PROPOSAL NAME | PREPARED | | CHECKED | | PROJECT/PROPOSAL NO. |
|---|---|---|---|---|---|
| | By: | Date: | By: | Date: | |
| Dairyland Power Cooperative | BJK | 9/00 | | | 3081.40 |

# DIVERSION BERM, PERIMETER DITCH, AND SPILLWAY DESIGN CALCULATIONS

## Purpose

To size the diversion berms, perimeter ditches and spillway at the proposed Dairyland Power Cooperative Landfill to adequately handle the surface water runoff from a 100-year, 24-hour storm.

## Methodologies

Ditches, diversion berms and spillways were designed to channel the surface water runoff from the landfill drainage areas to the sedimentation basins, receiving ditches, or spillways. The direction of surface water runoff from the drainage areas surrounding the proposed landfill is towards the proposed landfill. Perimeter drainage ditches were therefore incorporated into the design to route the surface water runoff from outside the proposed landfill limits along the perimeter of the landfill area to the existing main channel at the south end of the landfill. These ditches are labeled as the NW, NE, West, SE, and SW ditches. The perimeter ditches sized in this subsection of the appendix, then, include ditches to collect runoff from the landfill drainage areas as well as ditches to collect surface water run-on from the drainage areas surrounding the landfill.

The adequacy of the diversion berms and ditches in handling the surface water runoff and run-on and in limiting the amount of erosion is based on the depth of flow and velocity, respectively, in the ditch. An in-house RMT spreadsheet incorporating Manning's equation was used to assist in the design of the diversion berms and ditches. This program allows the user to input the ditch geometry, the peak flow (as determined by the surface water runoff calculation), and the vegetative retardance factor (Chow, 1959). The program then begins an iterative process which adjusts the flow depth and Manning's coefficient until the trial velocity and the resultant velocity are within 0.002 feet per second (fps) of each other. The end result is the peak flow depth and peak velocity for the geometry and peak flow entered. Design software provided by Synthetic Industries was also used to select erosion control matting for ditches and grouted riprap for spillways.

Permanent ditches, diversion berms, and spillways will be constructed as early in the site development as practicable. Where temporary ditching is required, these temporary ditches have been designed to the same standards as the permanent ditches. Calculations for the sizing of the temporary ditches are also attached.

744 Heartland Trail (53717-8923) P. O. Box 8923 (53708-8923) Madison, WI (608) 831-4444 FAX: (608) 831-3334 VOICE: (608) 831-1989

| PROJECT/PROPOSAL NAME | PREPARED By: | PREPARED Date: | CHECKED By: | CHECKED Date: | PROJECT/PROPOSAL NO. |
|---|---|---|---|---|---|
| Dairyland Power Cooperative | BJK | 9/00 | | | 3081.40 |

It is noted that the storm water control structures have been designed using a 100-year, 24-hour storm event and a TR-55 Type II storm distribution. As noted in the surface water runoff calculations, the peak flows calculated using this method meet or exceed the peak flows calculated using a 25-year, time of concentration storm event (required by NR 504.09).

## Assumptions

The following assumptions were used to design the diversion berms and perimeter ditches:

- Diversion berms, perimeter ditches and the spillway were designed to handle the runoff from the 100-year, 24-hour storm event.
- Diversion berm ditches were designed as V-notch ditches with a minimum 0.5 foot of freeboard for the 25-year, 24-hour storm. Diversion berm ditches were designed to convey the 100-year, 24-hour storm without overtopping.
- Perimeter ditches were designed as both V-notch and flat bottom (10-foot and 20-foot-wide) ditches with a minimum 0.5 foot of freeboard for the 25-year, 24-hour storm. Perimeter ditches were designed to convey the 100-year, 24-hour storm without overtopping.
- Grass-lined diversion berm and perimeter ditches were designed for a maximum velocity of 4 fps. Ditches with velocities exceeding 4 fps were designed to be lined with erosion mat or riprap, as appropriate.
- The spillway was designed as 20-foot-wide, flat-bottom spillway with a minimum 0.5 foot of freeboard.
- The peak flows in the diversion berms, perimeter ditches and the spillway were obtained from the hydrographs generated in the "Surface Water Runoff Calculations" subsection of this appendix.
- Manning's numbers were selected for both "low" retardance (Type "D") and "moderate" retardance (Type "C") as given by the U.S. Soil and Conservation Service. Type "D" is typical of spring conditions while Type "C" is typical of summer conditions. For ditches lined with erosion matting, default Manning numbers from the Synthetic Industries design software were utilized.

## Results

The diversion berms and perimeter ditches were adequately sized to handle the surface water runoff from a 100-year, 24-hour storm event. The diversion berms at a 2 percent slope will be grass-lined. To limit erosion, permanent erosion matting will be placed in the diversion berms at a 6 percent slope, as well as in most of the perimeter ditching. Grouted riprap will be constructed in the spillways. The attached figure highlights the ditch sizing results.

744 Heartland Trail (53717-8923) P. O. Box 8923 (53708-8923) Madison, WI (608) 831-4444 FAX: (608) 831-3334 VOICE: (608) 831-1989

| PROJECT/PROPOSAL NAME | PREPARED | | CHECKED | | PROJECT/PROPOSAL NO. |
|---|---|---|---|---|---|
| | By: | Date: | By: | Date: | |
| Dairyland Power Cooperative | BJK | 9/00 | | | 3081.40 |

## References

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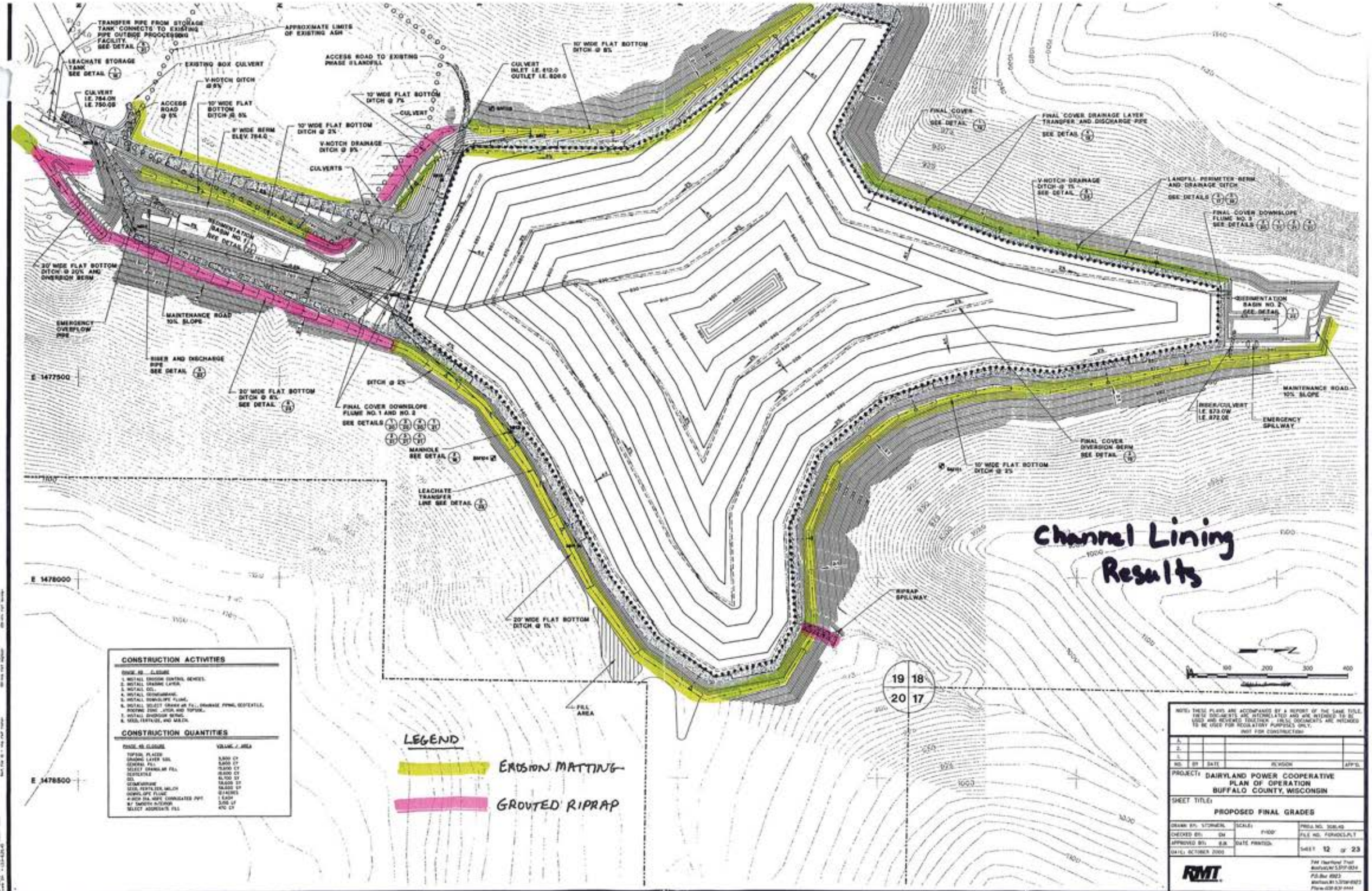

Channel Lining Results
TRANSFER PIPE FROM STORAGE TANK CONNECTS TO EXISTING PIPE OUTSIDE PROCESSING FACILITY. SEE DETAIL
APPROXIMATE LIMITS OF EXISTING ASH
LEACHATE STORAGE TANK SEE DETAIL
EXISTING BOX CULVERT
V-NOTCH DITCH @ 5%
CULVERT I.E. 764.0N I.E. 750.0S
ACCESS ROAD @ 5%
10' WIDE FLAT BOTTOM DITCH @ 5%
8' WIDE BERM ELEV. 764.0
10' WIDE FLAT BOTTOM DITCH @ 2%
V-NOTCH DRAINAGE DITCH @ 5%
CULVERTS
ACCESS ROAD TO EXISTING PHASE II LANDFILL
10' WIDE FLAT BOTTOM DITCH @ 7%
CULVERT
CULVERT INLET I.E. 812.0 OUTLET I.E. 808.0
10' WIDE FLAT BOTTOM DITCH @ 8%
FINAL COVER SEE DETAIL
FINAL COVER DRAINAGE LAYER TRANSFER AND DISCHARGE PIPE SEE DETAIL
V-NOTCH DRAINAGE DITCH @ 1% SEE DETAIL
LANDFILL PERIMETER BERM AND DRAINAGE DITCH SEE DETAILS
FINAL COVER DOWNSLOPE FLUME NO. 3 SEE DETAILS
SEDIMENTATION BASIN NO. 1 SEE DETAIL
20' WIDE FLAT BOTTOM DITCH @ 20% AND DIVERSION BERM
EMERGENCY OVERFLOW PIPE
MAINTENANCE ROAD 10% SLOPE
RISER AND DISCHARGE PIPE SEE DETAIL
20' WIDE FLAT BOTTOM DITCH @ 6% SEE DETAIL
DITCH @ 2%
FINAL COVER DOWNSLOPE FLUME NO. 1 AND NO. 2 SEE DETAILS
MANHOLE SEE DETAIL
LEACHATE TRANSFER LINE SEE DETAIL
20' WIDE FLAT BOTTOM DITCH @ 1%
FILL AREA
RIPRAP SPILLWAY
SEDIMENTATION BASIN NO. 2 SEE DETAIL
MAINTENANCE ROAD 10% SLOPE
RISER/CULVERT I.E. 873.0W I.E. 872.0E
EMERGENCY SPILLWAY
FINAL COVER DIVERSION BERM SEE DETAIL
10' WIDE FLAT BOTTOM DITCH @ 2%
E 1477500
E 1478000
E 1478500
19 18
20 17
CONSTRUCTION ACTIVITIES
CONSTRUCTION QUANTITIES
LEGEND
EROSION MATTING
GROUTED RIPRAP
NOTE: THESE PLANS ARE ACCOMPANIED BY A REPORT OF THE SAME TITLE. THESE DOCUMENTS ARE INTERRELATED AND ARE INTENDED TO BE USED AND REVIEWED TOGETHER. THESE DOCUMENTS ARE INTENDED TO BE USED FOR REGULATORY PURPOSES ONLY. (NOT FOR CONSTRUCTION)
NO. BY DATE REVISION APP'D.
PROJECT: DAIRYLAND POWER COOPERATIVE PLAN OF OPERATION BUFFALO COUNTY, WISCONSIN
SHEET TITLE: PROPOSED FINAL GRADES
DRAWN BY: STORMERL
CHECKED BY: DM
APPROVED BY: BJK
DATE: OCTOBER 2000
SCALE: 1"=100'
DATE PRINTED:
PROJ. NO. 3080.40
FILE NO. FORMDCS.PLT
SHEET 12 OF 23
RMT


FIGURE K-10

# Calculations – Post-closure Landfill Conditions

RMT, Inc.
Grass Channel Sizing Calculations

| | | | |
|---|---|---|---|
| Site: | Dairyland Power Cooperative | Date: | 10/1/98 |
| Project #: | 3081.33 | User: | BLP |
| Channel: | Diversion Berm (2%) - worst case flow | | |
| | Area 1F | | |

I. Input Parameters.

| | | |
|---|---|---|
| A. Side slope, Z1 (hor/vert) = | 4.000 | ft/ft |
| B. Side slope, Z2 (hor/vert) = | 2.000 | ft/ft |
| C. Bottom width, B = | 0.000 | ft |
| D. Design channel slope, S = | 0.020 | ft/ft |
| E. Channel Peak Flow, Q = | 25.000 | cfs |
| F. Enter - 1 - for Type "C" Veg. Retardence<br>- 2 - for Type "D" Veg. Retardence | 1 | ← Summer Conditions |

II. Peak Flow Calculations.

| | | |
|---|---|---|
| **A. Trial flow depth, D =**<br>(Bisection method until Va=Vb) | 1.570 | ft 0.4' freeboard |
| B. Channel flow area, Ac =<br>(.5*Z1*D^2) + (B*D) + (.5*Z2*D^2) | 7.390 | sq ft |
| C. Wetted Perimeter, Pw =<br>(D*(Z1^2+1)^.5) + B + (D*(Z2^2+1)^.5) | 9.981 | ft |
| D. Hydraulic radius, Rh =<br>(Ac/Pw) | 0.740 | ft |
| E. Velocity and hydraulic radius, VR =<br>(Va * Rh) | 2.505 | sfps |
| F. Channel flow Manning's coeff, nc =<br>0 | 0.051 | |
| G. Trial velocity, Va =<br>(Q/Ac) | 3.383 | fps |
| **H. Resultant velocity, Vb =**<br>(1.49/nc) * (Rh^.667) * (S^.5) | 3.383 | fps < 4 fps |

Invoke Solution Macro by typing - 'ctrl' D

h:\data\common\template\sc-51\grasscha.xls

RMT, Inc.
Grass Channel Sizing Calculations

| | | | |
|---|---|---|---|
| Site: | Dairyland Power Cooperative | Date: | 10/1/98 |
| Project #: | 3081.33 | User: | BLP |
| Channel: | Diversion Berm (2%) - worst case flow<br>Area 1F | | ✓ [illegible] 10/98 |

I. Input Parameters.

| | | |
|---|---|---|
| A. Side slope, Z1 (hor/vert) = | 4.000 | ft/ft ✓ |
| B. Side slope, Z2 (hor/vert) = | 2.000 | ft/ft ✓ |
| C. Bottom width, B = | 0.000 | ft ✓ |
| D. Design channel slope, S = | 0.020 | ft/ft ✓ |
| E. Channel Peak Flow, Q = | 25.000 | cfs ✓ |
| F. Enter - 1 - for Type "C" Veg. Retardence<br>- 2 - for Type "D" Veg. Retardence | 2 | ← Spring Conditions ✓ |

II. Peak Flow Calculations.

| | | |
|---|---|---|
| **A. Trial flow depth, D =**<br>(Bisection method until Va=Vb) | 1.456 | ft 0.5' freeboard |
| B. Channel flow area, Ac =<br>(.5*Z1*D^2) + (B*D) + (.5*Z2*D^2) | 6.357 | sq ft |
| C. Wetted Perimeter, Pw =<br>(D*(Z1^2+1)^.5) + B + (D*(Z2^2+1)^.5) | 9.257 | ft |
| D. Hydraulic radius, Rh =<br>(Ac/Pw) | 0.687 | ft |
| E. Velocity and hydraulic radius, VR =<br>(Va * Rh) | 2.701 | sfps |
| F. Channel flow Manning's coeff, nc =<br>0 | 0.042 | |
| G. Trial velocity, Va =<br>(Q/Ac) | 3.933 | fps |
| **H. Resultant velocity, Vb =**<br>(1.49/nc) * (Rh^.667) * (S^.5) | 3.933 | fps <4 fps ✓ |

Invoke Solution Macro by typing - 'ctrl' D

h:\data\common\template\sc-51\grasscha.xls

RMT, Inc.
Grass Channel Sizing Calculations

| | | | |
|---|---|---|---|
| Site: | Dairyland Power Corp. | Date: | 31-July-98 |
| Project #: | 3081.33 | User: | SRC |
| Channel: | Ditch (8%) | | |
| | Area 1G - Flow From Landfill Portion - 15 cfs | | |

I. Input Parameters.

| | |
|---|---|
| A. Side slope, Z1 (hor/vert) = | 3.000 ft/ft |
| B. Side slope, Z2 (hor/vert) = | 2.000 ft/ft |
| C. Bottom width, B = | 0.000 ft |
| D. Design channel slope, S = | 0.080 ft/ft |
| E. Channel Peak Flow, Q = | 15.000 cfs |
| F. Enter - 1 - for Type "C" Veg. Retardence<br>- 2 - for Type "D" Veg. Retardence | 1 ← summer conditions |

II. Peak Flow Calculations.

| | |
|---|---|
| **A. Trial flow depth, D =**<br>(Bisection method until Va=Vb) | 1.071 ft 0.9' freeboard |
| B. Channel flow area, Ac =<br>(.5*Z1*D^2) + (B*D) + (.5*Z2*D^2) | 2.870 sq ft |
| C. Wetted Perimeter, Pw =<br>(D*(Z1^2+1)^.5) + B + (D*(Z2^2+1)^.5) | 5.784 ft |
| D. Hydraulic radius, Rh =<br>(Ac/Pw) | 0.496 ft |
| E. Velocity and hydraulic radius, VR =<br>(Va * Rh) | 2.593 sfps |
| F. Channel flow Manning's coeff, nc =<br>0 | 0.051 |
| G. Trial velocity, Va =<br>(Q/Ac) | 5.226 fps |
| **H. Resultant velocity, Vb =**<br>(1.49/nc) * (Rh^.667) * (S^.5) | 5.226 fps > 4fps |

use permanent erosion

H:\data\common\src\Grassch5.xls

RMT, Inc.

Grass Channel Sizing Calculations

| | | | |
|---|---|---|---|
| Site: | Dairyland Power Corp. | Date: | 31-July-98 |
| Project #: | 3081.33 | User: | SRC |
| Channel: | Ditch (8%) | | |
| | Area 1G - Flow From Landfill Portion - 15 cfs | | |

I. Input Parameters.

| | |
|---|---|
| A. Side slope, Z1 (hor/vert) = | 3.000 ft/ft |
| B. Side slope, Z2 (hor/vert) = | 2.000 ft/ft |
| C. Bottom width, B = | 0.000 ft |
| D. Design channel slope, S = | 0.080 ft/ft |
| E. Channel Peak Flow, Q = | 15.000 cfs |
| F. Enter - 1 - for Type "C" Veg. Retardence<br>- 2 - for Type "D" Veg. Retardence | 2 ← Spring conditions |

II. Peak Flow Calculations.

| | |
|---|---|
| **A. Trial flow depth, D =**<br>(Bisection method until Va=Vb) | 0.992 ft 1' freeboard |
| B. Channel flow area, Ac =<br>(.5*Z1*D^2) + (B*D) + (.5*Z2*D^2) | 2.459 sq ft |
| C. Wetted Perimeter, Pw =<br>(D*(Z1^2+1)^.5) + B + (D*(Z2^2+1)^.5) | 5.353 ft |
| D. Hydraulic radius, Rh =<br>(Ac/Pw) | 0.459 ft |
| E. Velocity and hydraulic radius, VR =<br>(Va * Rh) | 2.802 sfps |
| F. Channel flow Manning's coeff, nc =<br>0 | 0.041 |
| G. Trial velocity, Va =<br>(Q/Ac) | 6.101 fps |
| **H. Resultant velocity, Vb =**<br>(1.49/nc) * (Rh^.667) * (S^.5) | 6.101 fps > 4 fps<br>use permanent erosion matting |

H:\data\common\src\Grassch6.xls

✓ BJB 10/6/98

**********

NORTH AMERICAN GREEN - ECMDS VER.IV - CHANNEL PROTECTION - ENGLISH

USER SPECIFIED CHANNEL LINING ANALYSIS

**********

PROJECT NAME: Dairyland Power
PROJECT NO.: 3081.33
COMPUTED BY: BJK
DATE: 10-06-1998
FROM STATION/REACH: Area 1G - Fl
TO STATION/REACH:
DRAINAGE AREA:
DESIGN FREQUENCY: 100

| Channel Bottom Width (ft) | Side Slope Lt. (Horz. to 1) | Side Slope Rt. (Horz. to 1) | Channel Slope (ft/ft) |
|---|---|---|---|
| 0.00 | 3.0 | 2.0 | 0.080 |

✓

| Discharge (cfs) | Peak Flow Period (hrs) | Velocity (ft/sec) | Area (ft^2) | Hydraulic Radius (ft) | Normal Depth (ft) |
|---|---|---|---|---|---|
| 15.0 | 2.0 | 5.34 | 2.81 | 0.49 | 1.06 |

ok

| Lining Type | Growth Habit | Veg. Den | Manning Coefficient | Permissible Shear (lb/sf) | Calculated Shear (lb/sf) | Safety Factor | Remark |
|---|---|---|---|---|---|---|---|
| P300 | | | 0.049 | 8.00 | 5.29 | 1.51 | STABLE |

✓

Staple E

Phase 3 (Mature Vegetation)

RMT, Inc.
Grass Channel Sizing Calculations

| | | | |
|---|---|---|---|
| Site: | Dairyland Power Corp. | Date: | 31-July-98 |
| Project #: | 3081.33 | User: | SRC |
| Channel: | Ditch (1%) | | |
| | Area 2B | | VWL 10/98 |

I. Input Parameters.

| | | |
|---|---|---|
| A. Side slope, Z1 (hor/vert) = | 3.000 | ft/ft |
| B. Side slope, Z2 (hor/vert) = | 2.000 | ft/ft |
| C. Bottom width, B = | 0.000 | ft |
| D. Design channel slope, S = | 0.010 | ft/ft |
| E. Channel Peak Flow, Q = | 73.000 | cfs |
| F. Enter - 1 - for Type "C" Veg. Retardence<br>- 2 - for Type "D" Veg. Retardence | 1 | ← Summer conditions |

II. Peak Flow Calculations.

| | | |
|---|---|---|
| **A. Trial flow depth, D =**<br>(Bisection method until Va=Vb) | 2.593 | ft 0.4' freeboard |
| B. Channel flow area, Ac =<br>(.5*Z1*D^2) + (B*D) + (.5*Z2*D^2) | 16.814 | sq ft |
| C. Wetted Perimeter, Pw =<br>(D*(Z1^2+1)^.5) + B + (D*(Z2^2+1)^.5) | 14.000 | ft |
| D. Hydraulic radius, Rh =<br>(Ac/Pw) | 1.201 | ft |
| E. Velocity and hydraulic radius, VR =<br>(Va * Rh) | 5.214 | sfps |
| F. Channel flow Manning's coeff, nc =<br>0 | 0.039 | |
| G. Trial velocity, Va =<br>(Q/Ac) | 4.342 | fps |
| **H. Resultant velocity, Vb =**<br>(1.49/nc) * (Rh^.667) * (S^.5) | 4.341 | fps > 4 fps |

use permanent erosion matting

RMT, Inc.
Grass Channel Sizing Calculations

| | | | |
|---|---|---|---|
| Site: | Dairyland Power Corp. | Date: | 31-July-98 |
| Project #: | 3081.33 | User: | SRC |
| Channel: | Ditch (1%) | | |
| | Area 2B | | |

I. Input Parameters.

| | |
|---|---|
| A. Side slope, Z1 (hor/vert) = | 3.000 ft/ft |
| B. Side slope, Z2 (hor/vert) = | 2.000 ft/ft |
| C. Bottom width, B = | 0.000 ft |
| D. Design channel slope, S = | 0.010 ft/ft |
| E. Channel Peak Flow, Q = | 73.000 cfs |
| F. Enter - 1 - for Type "C" Veg. Retardence<br>- 2 - for Type "D" Veg. Retardence | 2 ← Spring conditions |

II. Peak Flow Calculations.

| | | |
|---|---|---|
| **A. Trial flow depth, D =**<br>(Bisection method until Va=Vb) | 2.512 ft | 0.5' freeboard |
| B. Channel flow area, Ac =<br>(.5*Z1*D^2) + (B*D) + (.5*Z2*D^2) | 15.774 sq ft | |
| C. Wetted Perimeter, Pw =<br>(D*(Z1^2+1)^.5) + B + (D*(Z2^2+1)^.5) | 13.560 ft | |
| D. Hydraulic radius, Rh =<br>(Ac/Pw) | 1.163 ft | |
| E. Velocity and hydraulic radius, VR =<br>(Va * Rh) | 5.383 sfps | |
| F. Channel flow Manning's coeff, nc =<br>0 | 0.036 | |
| G. Trial velocity, Va =<br>(Q/Ac) | 4.628 fps | |
| **H. Resultant velocity, Vb =**<br>(1.49/nc) * (Rh^.667) * (S^.5) | 4.627 fps | > 4 fps<br>use permanent erosion matting |

✓BRB 10/6/98

**********

NORTH AMERICAN GREEN - ECMDS VER.IV - CHANNEL PROTECTION - ENGLISH

USER SPECIFIED CHANNEL LINING ANALYSIS

**********

PROJECT NAME: Dairyland Paower Coop.
PROJECT NO.: 3081.33
COMPUTED BY: BJK
DATE: 10-06-1998
FROM STATION/REACH: Area 2B
TO STATION/REACH:
DRAINAGE AREA:
DESIGN FREQUENCY: 100

| Channel Bottom Width (ft) | Side Slope Lt. (Horz. to 1) | Side Slope Rt. (Horz. to 1) | Channel Slope (ft/ft) |
|---|---|---|---|
| 0.00 | 3.0 | 2.0 | 0.010 |

| Discharge (cfs) | Peak Flow Period (hrs) | Velocity (ft/sec) | Area (ft^2) | Hydraulic Radius (ft) | Normal Depth (ft) |
|---|---|---|---|---|---|
| 73.0 | 2.0 | 3.64 | 20.08 | 1.31 | 2.83 |

| Lining Type | Growth Habit | Veg. Den | Manning Coefficient | Permissible Shear (lb/sf) | Calculated Shear (lb/sf) | Safety Factor | Remark |
|---|---|---|---|---|---|---|---|
| P300 | | | 0.049 | 8.00 | 1.77 | 4.52 | STABLE |
| Staple E | | | | | | | |
| Phase 3 (Mature Vegetation) | | | | | | | |

# COMPUTATION SHEET

RMT INC.



744 Heartland Trail P.O. Box 8923 Madison, WI 53708-8923 (608) 831-4444 FAX: (608) 831-3334 VOICE: (608) 831-1969

| PROJECT / PROPOSAL NAME | PREPARED | | CHECKED | | PROJECT / PROPOSAL NO. |
|---|---|---|---|---|---|
| DAIRYLAND POWER COOP. | BY BJK | DATE 3/19/97 | BY [illegible] | DATE 4/17/97 | 3081.24 |

Rev BLP/BJK 10/96
~~Rev BSK 9/00~~

DITCH DESIGN CALCULATIONS - DESIGN INFORMATION (25 YR-24 HR STORM)

SOUTH SPILLWAY

WIDTH = 20'
SLOPE = 20%
MIN DEPTH = 4'

PEAK FLOW - CONTRIBUTING DRAINAGE AREAS
3C + 4C + EAST + NORTHEAST + NORTH + BASIN 2 OUTFLOW ✓

18 + 11 + 445 + 68 + 194 + 10 = 746 cfs (25-YEAR)
↳ Round to 750 for calc's

28 + 18 + 837 + 110 + 360 + 21 = 1,374 cfs (100-year) ✓

Note: ALL FLOWS @ 12.6 HRS (25 year) and @ 12.6 HRS (100-YR Fallow)

SE DITCH (2%) & (5%)

WIDTH = 20'
SLOPE = 2%
MIN DEPTH = 5'

PEAK FLOW - CONTRIBUTING DRAINAGE AREAS
3C + 4C + EAST + NORTHEAST + NORTH + BASIN 2 OUTFLOW ✓

See above = 750 cfs (25-YEAR)
= 1,374 (100-yr Fallow)

SE DITCH (1%)

SAME FLOWS AS ABOVE

WIDTH - 20'
SLOPE - 1%
MIN DEPTH - 6'

NE DITCH

WIDTH = 10'
SLOPE = 2%
MIN DEPTH = 10+'

PEAK FLOW - CONTRIBUTING DRAINAGE AREAS
4C + NORTH + BASIN 2 OUT ✓

11 + 194 + 10 = 215 cfs (25-YEAR) ✓

18 + 360 + 21 = 399 cfs (100-YEAR FALLOW)
- ALL FLOWS AT 12.6 HRS (25 yr) and AT 12.6 HRS (100-YR FALLOW)

E Ditch

width = 10'
Slope = 2%
Min Depth = 10'+

Peak Flow - Contributing Drainage Areas
4C + Northeast + North + Basin 2 out
= 18 + 110 + 360 + 21 = 509 cfs (100 yr)

# COMPUTATION SHEET



RMT INC.
744 Heartland Trail P.O. Box 8923 Madison, WI 53708-8923 (608) 831-4444 FAX: (608) 831-3334 VOICE: (608) 831-1989

| PROJECT / PROPOSAL NAME | PREPARED By: | Date: | CHECKED By: | Date: | PROJECT / PROPOSAL NO. |
|---|---|---|---|---|---|
| DAIRYLAND POWER COOP | BJK | | [illegible] | 6/17/97 | 3081.24 |

NW DITCH

WIDTH - 0' (V-NOTCH)
SLOPE - 1%
MIN DEPTH - 4 FT

PEAK FLOW - CONTRIBUTING DRAINAGE AREAS

2B - 48 CFS (25 YR) ✓

73 CFS (100 YR FALLOW)

WEST DITCH

WIDTH = 10'
SLOPE = 6%
MIN DEPTH = 6'

PEAK FLOW - CONTRIBUTING DRAINAGE AREAS

2C + WEST AREA ✓

10 + 111 = 121 CFS (25-YEAR) ✓

18 + 223 = 241 CFS (100 YEAR - FALLOW) ✓
- FLOWS @ 12.5 HRS (25-YEAR) AND AT
12.5 HRS (100-YEAR FALLOW)

SW DITCH

WIDTH = 10'
SLOPE = 2%, 5%, 7%
MIN DEPTH = 4' +

PEAK FLOW - CONTRIBUTING DRAINAGE AREAS

1C + 2C + WEST AREA ✓

46 + 10 + 111 = 167 CFS (25-YEAR) ✓

94 + 20 + 209 = 323 cfs (100-YEAR FALLOW) ✓
FLOWS @ 12.5 HRS (25-YEAR) AND
@ 12.4 HRS (100-YEAR FALLOW)

MAIN CHANNEL

WIDTH ~20' MIN
SLOPE ~0.3%
MIN DEPTH ~ 6'

PEAK FLOW - CONTRIBUTING DRAINAGE AREAS

1C + 2C + 3C + 4C + EAST + NE + NORTH + WEST + BASIN 1 + BASIN 2 ✓

887 CFS + 8 + 10 = 905 CFS (25 YR)
1618 CFS + 21 + 21 = 1660 CFS (100-YR FALLOW) ✓

FLOWS @ 12.6 HRS (25-YEAR) AND @ 12.6 HRS
(100-YEAR FALLOW)

RMT
744 Heartland Trail
Madison, WI 53717-1934
Tel. (608) 831-4444 • Fax (608) 831-3334



| PROJECT / PROPOSAL NAME / LOCATION: | | PROJECT / PROPOSAL NO. |
|---|---|---|
| SUBJECT: Dairyland Power Coop | | 3081.40 |
| PREPARED BY: RJK | DATE: 9/00 | FINAL ☒ |
| CHECKED BY: | DATE: | REVISION ☐ |

AREA 1G DITCH

Width - V-NOTCH
SLOPE - 8%
MIN DEPTH = 4'

PEAK FLOW - CONTRIBUTING DRAINAGE AREA

= 15 CFS FLOW FROM LF.

PHASE 2 DITCH

WIDTH: V-NOTCH
SLOPE : 6%
MIN DEPTH: 2'

PEAK FLOW - CONTRIBUTING DRAINAGE AREA

~ 1.5 ACRES OF PHASE 2 COVER
DRAINAGE AREA - 1C = 42 ACRES

$\frac{1.5}{42}$ (96 CFS) = 3.4 CFS

USE 4 CFS

# EC-Design 2000 Channel Analysis Report



## Analysis By:

| User Information: | Generated by EC-Design: |
|---|---|
| **Bernie Krantz**<br>**RMT, Inc.**<br>**744 Heartland Trail**<br><br>**Madison, WI 53717** | SYNTHETIC INDUSTRIES<br>*Geosynthetic Products Division*<br>4019 Industry Drive • Chattanooga, TN 37416 • USA<br>(423) 899-0444 • (800) FIX-SOIL<br>www.fixsoil.com |

## General Information:

| Project Details: | | Project Notes: |
|---|---|---|
| Project Name: | **DPC Plan of Operation** | |
| Description: | **Channel Lining** | |
| State\Country: | **WI** | |
| City: | **La Crosse** | |
| Units: | **English** | |
| Created: | **01/19/99 @ 10:43** | |

## Disclaimer:

*The information presented herein is for general information only. While every effort has been made to ensure its accuracy, this information should not be used for a specific application without independent professional examination and verification of its suitability, applicability and accuracy.*

# EC-Design 2000 Channel Analysis Report



## Channel Analysis Information:

**Name:**

Channel Analysis Name: **South Spillway**

## Channel Geometry & Hydraulics:

**Design By:**

Designed By: **FLOW**

**Channel Side Slopes:**

Left Slope (xH:1V): **2.00**
Right Slope (xH:1V): **2.00**

**Flow\Velocity:**

Discharge (cfs): **1374.00**
Flow Duration (hrs): **1.00**
Average Velocity (ft/s): **0.00**

**Channel Geometry:**

Bed Slope (ft/ft): **0.20000**
Req. Freeboard (ft): **0.00**
Channel Length (ft): **270.00**
Bottom Width (ft): **20.00**
Channel Depth (ft): **4.00**

**Channel Bend:**

Channel Bend: **No**
Bend Radius (ft): **1.00**
Outside Bend:

**Vegetation:**

Vegetated: **Yes**
Vegetation Class: **C**

**Soil Filled:**

Soil Filled: **No**

**Factor of Safety:** **1.10**

**Functional Longevity:** **999**

## Analysis Results:

| | Side | Lining Type | Manning's "n" | Velocity (ft/s) Actual | Velocity (ft/s) Max. Allowed | Velocity (ft/s) Safety Factor | Shear Stress (lbs/sqft) Actual | Shear Stress (lbs/sqft) Max. Allowed | Shear Stress (lbs/sqft) Safety Factor | Flow Depth (ft) | Discharge (cfs) | OK? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Analysis #1** | Left: | PYRAMAT | 0.0280 | 24.0 | 23.3 | 1.0 | 20.2 | 9.4 | 0.5 | 2.0857 | 1374.0 | No |
| | Bottom: | PYRAMAT | 0.0280 | 27.3 | 23.3 | 0.9 | 26.0 | 9.4 | 0.4 | | | |
| | Right: | PYRAMAT | 0.0280 | 24.0 | 23.3 | 1.0 | 20.2 | 9.4 | 0.5 | | | |
| **Analysis #2** | Left: | GABIONS | 0.0270 | 28.6 | 17.0 | 0.6 | 17.3 | 35.0 | 2.0 | 1.7968 | 1374.0 | No |
| | Bottom: | GABIONS | 0.0270 | 32.6 | 17.0 | 0.5 | 22.4 | 35.0 | 1.6 | | | |
| | Right: | GABIONS | 0.0270 | 28.6 | 17.0 | 0.6 | 17.3 | 35.0 | 2.0 | | | |
| **Analysis #3** | Left: | ROCK RIPRAP | 0.0300 | 26.6 | 50.0 | 1.9 | 18.3 | 45.0 | 2.5 | 1.9093 | 1374.0 | Yes |
| | Bottom: | ROCK RIPRAP | 0.0300 | 30.4 | 50.0 | 1.6 | 23.8 | 45.0 | 1.9 | | | |
| | Right: | ROCK RIPRAP | 0.0300 | 26.6 | 50.0 | 1.9 | 18.3 | 45.0 | 2.5 | | | |

## Channel Calculation Results:

| | Flow Area (sq ft) | Hydraulic Radius (ft) | Composite 'n' | Left Wetted Perimeter(ft) | Right Wetted Perimeter(ft) | Total Wetted Perimeter(ft) | Average Veleocity (ft/s) | Average Discharge (cfs) | Froude |
|---|---|---|---|---|---|---|---|---|---|
| **Analysis #1** | 50.4146 | 1.7190 | 0.0351 | 4.6638 | 4.6638 | 29.3276 | 27.2540 | 1374.0 | 3.06 |
| **Analysis #2** | 42.3935 | 1.5121 | 0.0270 | 4.0178 | 4.0178 | 28.0356 | 32.4106 | 1374.0 | 3.94 |
| **Analysis #3** | 45.4772 | 1.5935 | 0.0300 | 4.2694 | 4.2694 | 28.5387 | 30.2130 | 1374.0 | 3.55 |

# EC-Design 2000 Channel Analysis Report



## Channel Analysis Information:

**Name:**

Channel Analysis Name: **SE Ditch (2%)**

## Channel Geometry & Hydraulics:

**Design By:**

Designed By: **FLOW**

**Channel Side Slopes:**

Left Slope (xH:1V): **2.00**
Right Slope (xH:1V): **2.00**

**Flow\Velocity:**

Discharge (cfs): **1374.00**
Flow Duration (hrs): **1.00**
Average Velocity (ft/s): **0.00**

**Channel Geometry:**

Bed Slope (ft/ft): **0.02000**
Req. Freeboard (ft): **0.00**
Channel Length (ft): **200.00**
Bottom Width (ft): **20.00**
Channel Depth (ft): **5.00**

**Channel Bend:**

Channel Bend: **No**
Bend Radius (ft): **0.00**
Outside Bend:

**Vegetation:**

Vegetated: **Yes**
Vegetation Class: **C**

**Soil Filled:**

Soil Filled: **No**

**Factor of Safety:** **1.10**

**Functional Longevity:** **999**

## Analysis Results:

| | Side | Lining Type | Manning's "n" | Velocity (ft/s) Actual | Velocity (ft/s) Max. Allowed | Velocity (ft/s) Safety Factor | Shear Stress (lbs/sqft) Actual | Shear Stress (lbs/sqft) Max. Allowed | Shear Stress (lbs/sqft) Safety Factor | Flow Depth (ft) | Discharge (cfs) | OK? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Analysis #1** | Left: | LANDLOK TRM | 0.0250 | 10.0 | 16.5 | 1.6 | 4.2 | 4.7 | 1.1 | 4.2678 | 1374.0 | No |
| | Bottom: | LANDLOK TRM | 0.0250 | 11.3 | 16.5 | 1.5 | 5.3 | 4.7 | 0.9 | | | |
| | Right: | LANDLOK TRM 435 | 0.0250 | 10.0 | 16.5 | 1.6 | 4.2 | 4.7 | 1.1 | | | |
| **Analysis #2** | Left: | LANDLOK TRM | 0.0250 | 10.0 | 16.8 | 1.7 | 4.2 | 6.5 | 1.6 | 4.2678 | 1374.0 | Yes |
| | Bottom: | LANDLOK TRM | 0.0250 | 11.3 | 16.8 | 1.5 | 5.3 | 6.5 | 1.2 | | | |
| | Right: | LANDLOK TRM 450 | 0.0250 | 10.0 | 16.8 | 1.7 | 4.2 | 6.5 | 1.6 | | | |
| **Analysis #3** | Left: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0000 | 0.0 | No |
| | Bottom: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |
| | Right: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |

## Channel Calculation Results:

| | Flow Area (sq ft) | Hydraulic Radius (ft) | Composite 'n' | Left Wetted Perimeter(ft) | Right Wetted Perimeter(ft) | Total Wetted Perimeter(ft) | Average Veleocity (ft/s) | Average Discharge (cfs) | Froude |
|---|---|---|---|---|---|---|---|---|---|
| **Analysis #1** | 121.7841 | 3.1158 | 0.0397 | 9.5431 | 9.5431 | 39.0862 | 11.2823 | 1374.0 | .890 |
| **Analysis #2** | 121.7841 | 3.1158 | 0.0397 | 9.5431 | 9.5431 | 39.0862 | 11.2823 | 1374.0 | .890 |
| **Analysis #3** | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0 | .000 |

# EC-Design 2000 Channel Analysis Report



## Channel Analysis Information:

**Name:**

Channel Analysis Name: **SE Ditch (5%)**

## Channel Geometry & Hydraulics:

**Design By:**

Designed By: **FLOW**

**Channel Side Slopes:**

Left Slope (xH:1V): **2.00**
Right Slope (xH:1V): **2.00**

**Flow\Velocity:**

Discharge (cfs): **1374.00**
Flow Duration (hrs): **1.00**
Average Velocity (ft/s): **0.00**

**Channel Geometry:**

Bed Slope (ft/ft): **0.05000**
Req. Freeboard (ft): **0.00**
Channel Length (ft): **750.00**
Bottom Width (ft): **20.00**
Channel Depth (ft): **5.00**

**Channel Bend:**

Channel Bend: **No**
Bend Radius (ft): **0.00**
Outside Bend:

**Vegetation:**

Vegetated: **Yes**
Vegetation Class: **C**

**Soil Filled:**

Soil Filled: **No**

**Factor of Safety:** **1.10**

**Functional Longevity:** **999**

## Analysis Results:

| | Side | Lining Type | Manning's "n" | Velocity (ft/s) Actual | Velocity (ft/s) Max. Allowed | Velocity (ft/s) Safety Factor | Shear Stress (lbs/sqft) Actual | Shear Stress (lbs/sqft) Max. Allowed | Shear Stress (lbs/sqft) Safety Factor | Flow Depth (ft) | Discharge (cfs) | OK? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Analysis #1** | Left: | LANDLOK TRM | 0.0260 | 14.3 | 19.1 | 1.3 | 7.8 | 7.5 | 1.0 | 3.2178 | 1374.0 | No |
| | Bottom: | LANDLOK TRM | 0.0260 | 16.2 | 19.1 | 1.2 | 10.0 | 7.5 | 0.8 | | | |
| | Right: | LANDLOK TRM | 0.0260 | 14.3 | 19.1 | 1.3 | 7.8 | 7.5 | 1.0 | | | |
| **Analysis #2** | Left: | PYRAMAT | 0.0280 | 14.3 | 23.3 | 1.6 | 7.8 | 9.4 | 1.2 | 3.2184 | 1374.0 | No |
| | Bottom: | PYRAMAT | 0.0280 | 16.2 | 23.3 | 1.4 | 10.0 | 9.4 | 0.9 | | | |
| | Right: | PYRAMAT | 0.0280 | 14.3 | 23.3 | 1.6 | 7.8 | 9.4 | 1.2 | | | |
| **Analysis #3** | Left: | ROCK RIPRAP | 0.0300 | 17.6 | 50.0 | 2.8 | 6.6 | 45.0 | 6.8 | 2.7285 | 1374.0 | Yes |
| | Bottom: | ROCK RIPRAP | 0.0300 | 19.9 | 50.0 | 2.5 | 8.5 | 45.0 | 5.3 | | | |
| | Right: | ROCK RIPRAP | 0.0300 | 17.6 | 50.0 | 2.8 | 6.6 | 45.0 | 6.8 | | | |

## Channel Calculation Results:

| | Flow Area (sq ft) | Hydraulic Radius (ft) | Composite 'n' | Left Wetted Perimeter(ft) | Right Wetted Perimeter(ft) | Total Wetted Perimeter(ft) | Average Veleocity (ft/s) | Average Discharge (cfs) | Froude |
|---|---|---|---|---|---|---|---|---|---|
| **Analysis #1** | 85.0635 | 2.4735 | 0.0378 | 7.1952 | 7.1952 | 34.3903 | 16.1526 | 1374.0 | 1.47 |
| **Analysis #2** | 85.0856 | 2.4739 | 0.0378 | 7.1967 | 7.1967 | 34.3933 | 16.1484 | 1374.0 | 1.47 |
| **Analysis #3** | 69.4578 | 2.1569 | 0.0280 | 6.1010 | 6.1010 | 32.2020 | 19.7818 | 1374.0 | 1.96 |

# EC-Design 2000 Channel Analysis Report



## Channel Analysis Information:

**Name:**

Channel Analysis Name: **SE Ditch (1%)**

## Channel Geometry & Hydraulics:

**Design By:**

Designed By: **FLOW**

**Channel Side Slopes:**

Left Slope (xH:1V): **2.00**
Right Slope (xH:1V): **2.00**

**Flow\Velocity:**

Discharge (cfs): **1374.00**
Flow Duration (hrs): **1.00**
Average Velocity (ft/s): **0.00**

**Channel Geometry:**

Bed Slope (ft/ft): **0.01000**
Req. Freeboard (ft): **0.00**
Channel Length (ft): **1000.0**
Bottom Width (ft): **20.00**
Channel Depth (ft): **6.00**

**Channel Bend:**

Channel Bend: **No**
Bend Radius (ft): **0.00**
Outside Bend:

**Vegetation:**

Vegetated: **Yes**
Vegetation Class: **C**

**Soil Filled:**

Soil Filled: **No**

**Factor of Safety:** **1.10**

**Functional Longevity:** **999**

## Analysis Results:

| | Side | Lining Type | Manning's "n" | Velocity (ft/s) Actual | Velocity (ft/s) Max. Allowed | Velocity (ft/s) Safety Factor | Shear Stress (lbs/sqft) Actual | Shear Stress (lbs/sqft) Max. Allowed | Shear Stress (lbs/sqft) Safety Factor | Flow Depth (ft) | Discharge (cfs) | OK? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Analysis #1** | Left: | **LANDLOK TRM** | 0.0250 | 7.7 | 16.5 | 2.2 | 2.6 | 4.7 | 1.8 | 5.2542 | 1374.0 | Yes |
| | Bottom: | **LANDLOK TRM** | 0.0250 | 8.6 | 16.5 | 1.9 | 3.3 | 4.7 | 1.4 | | | |
| | Right: | **LANDLOK TRM** 435 | 0.0250 | 7.7 | 16.5 | 2.2 | 2.6 | 4.7 | 1.8 | | | |
| **Analysis #2** | Left: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0000 | 0.0 | No |
| | Bottom: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |
| | Right: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |
| **Analysis #3** | Left: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0000 | 0.0 | No |
| | Bottom: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |
| | Right: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |

## Channel Calculation Results:

| | Flow Area (sq ft) | Hydraulic Radius (ft) | Composite 'n' | Left Wetted Perimeter(ft) | Right Wetted Perimeter(ft) | Total Wetted Perimeter(ft) | Average Veleocity (ft/s) | Average Discharge (cfs) | Froude |
|---|---|---|---|---|---|---|---|---|---|
| **Analysis #1** | 160.2976 | 3.6852 | 0.0413 | 11.7488 | 11.7488 | 43.4975 | 8.5716 | 1374.0 | .615 |
| **Analysis #2** | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0 | .000 |
| **Analysis #3** | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0 | .000 |

# EC-Design 2000 Channel Analysis Report



## Channel Analysis Information:

**Name:**

Channel Analysis Name: **NE Ditch**

## Channel Geometry & Hydraulics:

**Design By:**

Designed By: **FLOW**

**Channel Side Slopes:**

Left Slope (xH:1V): **2.00**
Right Slope (xH:1V): **2.00**

**Flow\Velocity:**

Discharge (cfs): **399.00**
Flow Duration (hrs): **1.00**
Average Velocity (ft/s): **0.00**

**Channel Geometry:**

Bed Slope (ft/ft): **0.02000**
Req. Freeboard (ft): **0.00**
Channel Length (ft): **1800.0**
Bottom Width (ft): **10.00**
Channel Depth (ft): **5.00**

**Channel Bend:**

Channel Bend: **No**
Bend Radius (ft): **0.00**
Outside Bend:

**Vegetation:**

Vegetated: **Yes**
Vegetation Class: **C**

**Soil Filled:**

Soil Filled: **No**

**Factor of Safety:** **1.10**

**Functional Longevity:** **999**

## Analysis Results:

| | Side | Lining Type | Manning's "n" | Velocity (ft/s) Actual | Velocity (ft/s) Max. Allowed | Velocity (ft/s) Safety Factor | Shear Stress (lbs/sqft) Actual | Shear Stress (lbs/sqft) Max. Allowed | Shear Stress (lbs/sqft) Safety Factor | Flow Depth (ft) | Discharge (cfs) | OK? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Analysis #1** | Left: | **LANDLOK TRM** | 0.0250 | 7.1 | 16.5 | 2.3 | 3.1 | 4.7 | 1.5 | | | |
| | Bottom: | **LANDLOK TRM** | 0.0250 | 7.9 | 16.5 | 2.1 | 3.9 | 4.7 | 1.2 | 3.1235 | 399.0 | Yes |
| | Right: | **LANDLOK TRM** 435 | 0.0250 | 7.1 | 16.5 | 2.3 | 3.1 | 4.7 | 1.5 | | | |
| **Analysis #2** | Left: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |
| | Bottom: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0000 | 0.0 | No |
| | Right: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |
| **Analysis #3** | Left: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |
| | Bottom: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0000 | 0.0 | No |
| | Right: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |

## Channel Calculation Results:

| | Flow Area (sq ft) | Hydraulic Radius (ft) | Composite 'n' | Left Wetted Perimeter(ft) | Right Wetted Perimeter(ft) | Total Wetted Perimeter(ft) | Average Veleocity (ft/s) | Average Discharge (cfs) | Froude |
|---|---|---|---|---|---|---|---|---|---|
| **Analysis #1** | 50.7483 | 2.1173 | 0.0440 | 6.9844 | 6.9844 | 23.9689 | 7.8623 | 399.0 | .735 |
| **Analysis #2** | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0 | .000 |
| **Analysis #3** | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0 | .000 |

# EC-Design 2000 Channel Analysis Report



## Channel Analysis Information:

**Name:**

Channel Analysis Name: **East Ditch**

## Channel Geometry & Hydraulics:

**Design By:**

Designed By: **FLOW**

**Channel Side Slopes:**

Left Slope (xH:1V): **2.00**
Right Slope (xH:1V): **2.00**

**Flow\Velocity:**

Discharge (cfs): **509.00**
Flow Duration (hrs): **1.00**
Average Velocity (ft/s): **0.00**

**Channel Geometry:**

Bed Slope (ft/ft): **0.02000**
Req. Freeboard (ft): **0.00**
Channel Length (ft): **350.00**
Bottom Width (ft): **10.00**
Channel Depth (ft): **5.00**

**Channel Bend:**

Channel Bend: **Yes**
Bend Radius (ft): **200.00**
Outside Bend: **L**

**Vegetation:**

Vegetated: **Yes**
Vegetation Class: **C**

**Soil Filled:**

Soil Filled: **No**

**Factor of Safety:** 1.10

**Functional Longevity:** 999

## Analysis Results:

| | Side | Lining Type | Manning's "n" | Velocity (ft/s) Actual | Velocity (ft/s) Max. Allowed | Velocity (ft/s) Safety Factor | Shear Stress (lbs/sqft) Actual | Shear Stress (lbs/sqft) Max. Allowed | Shear Stress (lbs/sqft) Safety Factor | Flow Depth (ft) | Discharge (cfs) | OK? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Analysis #1** | Left: | LANDLOK TRM | 0.0250 | 7.8 | 16.5 | 2.1 | 3.6 | 4.7 | 1.3 | 3.4942 | 509.0 | No |
| | Bottom: | LANDLOK TRM | 0.0250 | 8.6 | 16.5 | 1.9 | 4.4 | 4.7 | 1.1 | | | |
| | Right: | LANDLOK TRM | 0.0250 | 7.8 | 16.5 | 2.1 | 3.6 | 4.7 | 1.3 | | | |
| **Analysis #2** | Left: | LANDLOK TRM | 0.0250 | 7.8 | 16.8 | 2.2 | 3.6 | 6.5 | 1.8 | 3.4942 | 509.0 | Yes |
| | Bottom: | LANDLOK TRM | 0.0250 | 8.6 | 16.8 | 1.9 | 4.4 | 6.5 | 1.5 | | | |
| | Right: | LANDLOK TRM 450 | 0.0250 | 7.8 | 16.8 | 2.2 | 3.6 | 6.5 | 1.8 | | | |
| **Analysis #3** | Left: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0000 | 0.0 | No |
| | Bottom: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |
| | Right: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |

## Channel Calculation Results:

| | Flow Area (sq ft) | Hydraulic Radius (ft) | Composite 'n' | Left Wetted Perimeter(ft) | Right Wetted Perimeter(ft) | Total Wetted Perimeter(ft) | Average Velocity (ft/s) | Average Discharge (cfs) | Froude |
|---|---|---|---|---|---|---|---|---|---|
| **Analysis #1** | 59.3615 | 2.3164 | 0.0429 | 7.8133 | 7.8133 | 25.6267 | 8.5746 | 509.0 | .760 |
| **Analysis #2** | 59.3615 | 2.3164 | 0.0429 | 7.8133 | 7.8133 | 25.6267 | 8.5746 | 509.0 | .760 |
| **Analysis #3** | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0 | .000 |

# EC-Design 2000 Channel Analysis Report



## Channel Analysis Information:

**Name:**

Channel Analysis Name: **NW Ditch**

## Channel Geometry & Hydraulics:

**Design By:**

Designed By: **FLOW**

**Channel Side Slopes:**

Left Slope (xH:1V): **2.00**
Right Slope (xH:1V): **2.00**

**Flow\Velocity:**

Discharge (cfs): **73.00**
Flow Duration (hrs): **1.00**
Average Velocity (ft/s): **0.00**

**Channel Geometry:**

Bed Slope (ft/ft): **0.01000**
Req. Freeboard (ft): **0.00**
Channel Length (ft): **1000.0**
Bottom Width (ft): **0.01**
Channel Depth (ft): **4.00**

**Channel Bend:**

Channel Bend: **No**
Bend Radius (ft): **0.00**
Outside Bend:

**Vegetation:**

Vegetated: **Yes**
Vegetation Class: **C**

**Soil Filled:**

Soil Filled: **No**

**Factor of Safety:** **1.10**

**Functional Longevity:** **999**

## Analysis Results:

| | Side | Lining Type | Manning's "n" | Velocity (ft/s) Actual | Velocity (ft/s) Max. Allowed | Velocity (ft/s) Safety Factor | Shear Stress (lbs/sqft) Actual | Shear Stress (lbs/sqft) Max. Allowed | Shear Stress (lbs/sqft) Safety Factor | Flow Depth (ft) | Discharge (cfs) | OK? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Analysis #1** | Left: | LANDLOK TRM | 0.0250 | 3.4 | 16.5 | 4.8 | 2.1 | 4.7 | 2.3 | 3.2826 | 73.0 | Yes |
| | Bottom: | LANDLOK TRM | 0.0250 | 3.4 | 16.5 | 4.8 | 2.0 | 4.7 | 2.3 | | | |
| | Right: | LANDLOK TRM | 0.0250 | 3.4 | 16.5 | 4.8 | 2.1 | 4.7 | 2.3 | | | |
| **Analysis #2** | Left: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0000 | 0.0 | No |
| | Bottom: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |
| | Right: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |
| **Analysis #3** | Left: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0000 | 0.0 | No |
| | Bottom: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |
| | Right: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |

## Channel Calculation Results:

| | Flow Area (sq ft) | Hydraulic Radius (ft) | Composite 'n' | Left Wetted Perimeter(ft) | Right Wetted Perimeter(ft) | Total Wetted Perimeter(ft) | Average Veleocity (ft/s) | Average Discharge (cfs) | Froude |
|---|---|---|---|---|---|---|---|---|---|
| **Analysis #1** | 21.5836 | 1.4693 | 0.0564 | 7.3401 | 7.3401 | 14.6902 | 3.3822 | 73.0 | .331 |
| **Analysis #2** | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0 | .000 |
| **Analysis #3** | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0 | .000 |

# EC-Design 2000 Channel Analysis Report



## Channel Analysis Information:

| Name: |
|---|
| Channel Analysis Name: **West Ditch** |

## Channel Geometry & Hydraulics:

| Design By: | Flow\Velocity: | Channel Geometry: |
|---|---|---|
| Designed By: **FLOW** | Discharge (cfs): **241.00**<br>Flow Duration (hrs): **1.00**<br>Average Velocity (ft/s): **0.00** | Bed Slope (ft/ft): **0.06000**<br>Req. Freeboard (ft): **0.00**<br>Channel Length (ft): **1020.0**<br>Bottom Width (ft): **10.00**<br>Channel Depth (ft): **6.00** |
| **Channel Side Slopes:**<br>Left Slope (xH:1V): **2.00**<br>Right Slope (xH:1V): **2.00** | | |
| **Channel Bend:** | **Vegetation:** | **Soil Filled:** |
| Channel Bend: **No**<br>Bend Radius (ft): **0.00**<br>Outside Bend: | Vegetated: **Yes**<br>Vegetation Class: **C** | Soil Filled: **No** |

**Factor of Safety:** 1.10 **Functional Longevity:** 999

## Analysis Results:

| | Side | Lining Type | Manning's "n" | Velocity (ft/s) Actual | Velocity (ft/s) Max. Allowed | Velocity (ft/s) Safety Factor | Shear Stress (lbs/sqft) Actual | Shear Stress (lbs/sqft) Max. Allowed | Shear Stress (lbs/sqft) Safety Factor | Flow Depth (ft) | Discharge (cfs) | OK? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Analysis #1** | Left: | PYRAMAT | 0.0280 | 8.9 | 23.3 | 2.6 | 5.1 | 9.4 | 1.8 | 1.7595 | 241.0 | Yes |
| | Bottom: | PYRAMAT | 0.0280 | 10.1 | 23.3 | 2.3 | 6.6 | 9.4 | 1.4 | | | |
| | Right: | PYRAMAT | 0.0280 | 8.9 | 23.3 | 2.6 | 5.1 | 9.4 | 1.8 | | | |
| **Analysis #2** | Left: | LANDLOK TRM | 0.0260 | 8.9 | 19.1 | 2.1 | 5.1 | 7.5 | 1.5 | 1.7684 | 241.0 | No |
| | Bottom: | LANDLOK TRM | 0.0260 | 10.1 | 19.1 | 1.9 | 6.6 | 7.5 | 1.1 | | | |
| | Right: | LANDLOK TRM | 0.0260 | 8.9 | 19.1 | 2.1 | 5.1 | 7.5 | 1.5 | | | |
| **Analysis #3** | Left: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0000 | 0.0 | No |
| | Bottom: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |
| | Right: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |

## Channel Calculation Results:

| | Flow Area (sq ft) | Hydraulic Radius (ft) | Composite 'n' | Left Wetted Perimeter(ft) | Right Wetted Perimeter(ft) | Total Wetted Perimeter(ft) | Average Veleocity (ft/s) | Average Discharge (cfs) | Froude |
|---|---|---|---|---|---|---|---|---|---|
| **Analysis #1** | 23.7860 | 1.3312 | 0.0439 | 3.9343 | 3.9343 | 17.8685 | 10.1320 | 241.0 | 1.24 |
| **Analysis #2** | 23.9376 | 1.3367 | 0.0438 | 3.9541 | 3.9541 | 17.9083 | 10.0679 | 241.0 | 1.23 |
| **Analysis #3** | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0 | .000 |

# EC-Design 2000 Channel Analysis Report



## Channel Analysis Information:

**Name:**

Channel Analysis Name: **SW Ditch (7%)**

## Channel Geometry & Hydraulics:

**Design By:**

Designed By: **FLOW**

**Channel Side Slopes:**

Left Slope (xH:1V): 2.00
Right Slope (xH:1V): 2.00

**Flow\Velocity:**

Discharge (cfs): 323.00
Flow Duration (hrs): 1.00
Average Velocity (ft/s): 0.00

**Channel Geometry:**

Bed Slope (ft/ft): 0.07000
Req. Freeboard (ft): 0.00
Channel Length (ft): 225.00
Bottom Width (ft): 10.00
Channel Depth (ft): 4.00

**Channel Bend:**

Channel Bend: No
Bend Radius (ft): 0.00
Outside Bend:

**Vegetation:**

Vegetated: Yes
Vegetation Class: C

**Soil Filled:**

Soil Filled: No

**Factor of Safety:** 1.10

**Functional Longevity:** 999

## Analysis Results:

| | Side | Lining Type | Manning's "n" | Velocity (ft/s) Actual | Velocity (ft/s) Max. Allowed | Velocity (ft/s) Safety Factor | Shear Stress (lbs/sqft) Actual | Shear Stress (lbs/sqft) Max. Allowed | Shear Stress (lbs/sqft) Safety Factor | Flow Depth (ft) | Discharge (cfs) | OK? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Analysis #1 | Left: | PYRAMAT | 0.0280 | 10.6 | 23.3 | 2.2 | 6.6 | 9.4 | 1.4 | 1.9335 | 323.0 | No |
| | Bottom: | PYRAMAT | 0.0280 | 12.0 | 23.3 | 1.9 | 8.4 | 9.4 | 1.1 | | | |
| | Right: | PYRAMAT | 0.0280 | 10.6 | 23.3 | 2.2 | 6.6 | 9.4 | 1.4 | | | |
| Analysis #2 | Left: | ROCK RIPRAP | 0.0300 | 13.4 | 50.0 | 3.7 | 5.5 | 45.0 | 8.2 | 1.6178 | 323.0 | Yes |
| | Bottom: | ROCK RIPRAP | 0.0300 | 15.2 | 50.0 | 3.3 | 7.1 | 45.0 | 6.4 | | | |
| | Right: | ROCK RIPRAP | 0.0300 | 13.4 | 50.0 | 3.7 | 5.5 | 45.0 | 8.2 | | | |
| Analysis #3 | Left: | | 0.0280 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0000 | 0.0 | No |
| | Bottom: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |
| | Right: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |

## Channel Calculation Results:

| | Flow Area (sq ft) | Hydraulic Radius (ft) | Composite 'n' | Left Wetted Perimeter(ft) | Right Wetted Perimeter(ft) | Total Wetted Perimeter(ft) | Average Veleocity (ft/s) | Average Discharge (cfs) | Froude |
|---|---|---|---|---|---|---|---|---|---|
| Analysis #1 | 26.8125 | 1.4379 | 0.0419 | 4.3235 | 4.3235 | 18.6470 | 12.0466 | 323.0 | 1.40 |
| Analysis #2 | 21.4118 | 1.2424 | 0.0300 | 3.6174 | 3.6174 | 17.2348 | 15.0851 | 323.0 | 1.94 |
| Analysis #3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0 | .000 |

# EC-Design 2000 Channel Analysis Report



## Channel Analysis Information:

**Name:**

Channel Analysis Name: **SW Ditch (2%)**

## Channel Geometry & Hydraulics:

**Design By:**

Designed By: **FLOW**

**Channel Side Slopes:**

Left Slope (xH:1V): **2.00**
Right Slope (xH:1V): **2.00**

**Flow\Velocity:**

Discharge (cfs): **323.00**
Flow Duration (hrs): **1.00**
Average Velocity (ft/s): **0.00**

**Channel Geometry:**

Bed Slope (ft/ft): **0.02000**
Req. Freeboard (ft): **0.00**
Channel Length (ft): **300.00**
Bottom Width (ft): **10.00**
Channel Depth (ft): **4.00**

**Channel Bend:**

Channel Bend: **No**
Bend Radius (ft): **0.00**
Outside Bend:

**Vegetation:**

Vegetated: **Yes**
Vegetation Class: **C**

**Soil Filled:**

Soil Filled: **No**

**Factor of Safety:** **1.10**

**Functional Longevity:** **999**

## Analysis Results:

| | Side | Lining Type | Manning's "n" | Velocity (ft/s) Actual | Velocity (ft/s) Max. Allowed | Velocity (ft/s) Safety Factor | Shear Stress (lbs/sqft) Actual | Shear Stress (lbs/sqft) Max. Allowed | Shear Stress (lbs/sqft) Safety Factor | Flow Depth (ft) | Discharge (cfs) | OK? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Analysis #1** | Left: | PYRAMAT | 0.0280 | 6.5 | 23.3 | 3.6 | 2.8 | 9.4 | 3.3 | 2.8325 | 323.0 | Yes |
| | Bottom: | PYRAMAT | 0.0280 | 7.3 | 23.3 | 3.2 | 3.5 | 9.4 | 2.7 | | | |
| | Right: | PYRAMAT | 0.0280 | 6.5 | 23.3 | 3.6 | 2.8 | 9.4 | 3.3 | | | |
| **Analysis #2** | Left: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0000 | 0.0 | No |
| | Bottom: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |
| | Right: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |
| **Analysis #3** | Left: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0000 | 0.0 | No |
| | Bottom: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |
| | Right: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |

## Channel Calculation Results:

| | Flow Area (sq ft) | Hydraulic Radius (ft) | Composite 'n' | Left Wetted Perimeter(ft) | Right Wetted Perimeter(ft) | Total Wetted Perimeter(ft) | Average Veleocity (ft/s) | Average Discharge (cfs) | Froude |
|---|---|---|---|---|---|---|---|---|---|
| **Analysis #1** | 44.3719 | 1.9575 | 0.0451 | 6.3337 | 6.3337 | 22.6675 | 7.2794 | 323.0 | .709 |
| **Analysis #2** | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0 | .000 |
| **Analysis #3** | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0 | .000 |

# EC-Design 2000 Channel Analysis Report



## Channel Analysis Information:

**Name:**

Channel Analysis Name: **SW Ditch (5%)**

## Channel Geometry & Hydraulics:

**Design By:**

Designed By: **FLOW**

**Channel Side Slopes:**

Left Slope (xH:1V): **2.00**
Right Slope (xH:1V): **2.00**

**Flow\Velocity:**

Discharge (cfs): **323.00**
Flow Duration (hrs): **1.00**
Average Velocity (ft/s): **0.00**

**Channel Geometry:**

Bed Slope (ft/ft): **0.05000**
Req. Freeboard (ft): **0.00**
Channel Length (ft): **240.00**
Bottom Width (ft): **10.00**
Channel Depth (ft): **4.00**

**Channel Bend:**

Channel Bend: **No**
Bend Radius (ft): **0.00**
Outside Bend:

**Vegetation:**

Vegetated: **Yes**
Vegetation Class: **C**

**Soil Filled:**

Soil Filled: **No**

**Factor of Safety:** **1.10**

**Functional Longevity:** **999**

## Analysis Results:

| | Side | Lining Type | Manning's "n" | Velocity (ft/s) Actual | Velocity (ft/s) Max. Allowed | Velocity (ft/s) Safety Factor | Shear Stress (lbs/sqft) Actual | Shear Stress (lbs/sqft) Max. Allowed | Shear Stress (lbs/sqft) Safety Factor | Flow Depth (ft) | Discharge (cfs) | OK? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Analysis #1** | Left: | PYRAMAT | 0.0280 | 9.3 | 23.3 | 2.5 | 5.2 | 9.4 | 1.8 | 2.1429 | 323.0 | Yes |
| | Bottom: | PYRAMAT | 0.0280 | 10.5 | 23.3 | 2.2 | 6.7 | 9.4 | 1.4 | | | |
| | Right: | PYRAMAT | 0.0280 | 9.3 | 23.3 | 2.5 | 5.2 | 9.4 | 1.8 | | | |
| **Analysis #2** | Left: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0000 | 0.0 | No |
| | Bottom: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |
| | Right: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |
| **Analysis #3** | Left: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0000 | 0.0 | No |
| | Bottom: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |
| | Right: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |

## Channel Calculation Results:

| | Flow Area (sq ft) | Hydraulic Radius (ft) | Composite 'n' | Left Wetted Perimeter(ft) | Right Wetted Perimeter(ft) | Total Wetted Perimeter(ft) | Average Veleocity (ft/s) | Average Discharge (cfs) | Froude |
|---|---|---|---|---|---|---|---|---|---|
| **Analysis #1** | 30.6135 | 1.5632 | 0.0427 | 4.7917 | 4.7917 | 19.5835 | 10.5509 | 323.0 | 1.17 |
| **Analysis #2** | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0 | .000 |
| **Analysis #3** | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0 | .000 |

# EC-Design 2000 Channel Analysis Report



## Channel Analysis Information:

**Name:**

Channel Analysis Name: **Main Channel**

## Channel Geometry & Hydraulics:

**Design By:**

Designed By: **FLOW**

**Channel Side Slopes:**

Left Slope (xH:1V): **2.00**
Right Slope (xH:1V): **2.00**

**Flow\Velocity:**

Discharge (cfs): **1660.00**
Flow Duration (hrs): **1.00**
Average Velocity (ft/s): **0.00**

**Channel Geometry:**

Bed Slope (ft/ft): **0.01300**
Req. Freeboard (ft): **0.00**
Channel Length (ft): **3500.0**
Bottom Width (ft): **20.00**
Channel Depth (ft): **6.00**

**Channel Bend:**

Channel Bend: **No**
Bend Radius (ft): **0.00**
Outside Bend:

**Vegetation:**

Vegetated: **Yes**
Vegetation Class: **C**

**Soil Filled:**

Soil Filled: **No**

**Factor of Safety:** 1.10

**Functional Longevity:** 999

## Analysis Results:

| | Side | Lining Type | Manning's "n" | Velocity (ft/s) Actual | Velocity (ft/s) Max. Allowed | Velocity (ft/s) Safety Factor | Shear Stress (lbs/sqft) Actual | Shear Stress (lbs/sqft) Max. Allowed | Shear Stress (lbs/sqft) Safety Factor | Flow Depth (ft) | Discharge (cfs) | OK? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Analysis #1 | Left: | LANDLOK TRM | 0.0250 | 9.1 | 16.5 | 1.8 | 3.4 | 4.7 | 1.4 | 5.3260 | 1660.0 | No |
| | Bottom: | LANDLOK TRM | 0.0250 | 10.2 | 16.5 | 1.6 | 4.3 | 4.7 | 1.1 | | | |
| | Right: | LANDLOK TRM | 0.0250 | 9.1 | 16.5 | 1.8 | 3.4 | 4.7 | 1.4 | | | |
| Analysis #2 | Left: | LANDLOK TRM | 0.0250 | 9.1 | 16.8 | 1.8 | 3.4 | 6.5 | 1.9 | 5.3260 | 1660.0 | Yes |
| | Bottom: | LANDLOK TRM | 0.0250 | 10.2 | 16.8 | 1.6 | 4.3 | 6.5 | 1.5 | | | |
| | Right: | LANDLOK TRM | 0.0250 | 9.1 | 16.8 | 1.8 | 3.4 | 6.5 | 1.9 | | | |
| Analysis #3 | Left: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0000 | 0.0 | No |
| | Bottom: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |
| | Right: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |

## Channel Calculation Results:

| | Flow Area (sq ft) | Hydraulic Radius (ft) | Composite 'n' | Left Wetted Perimeter(ft) | Right Wetted Perimeter(ft) | Total Wetted Perimeter(ft) | Average Veleocity (ft/s) | Average Discharge (cfs) | Froude |
|---|---|---|---|---|---|---|---|---|---|
| Analysis #1 | 163.2521 | 3.7256 | 0.0400 | 11.9093 | 11.9093 | 43.8185 | 10.1683 | 1660.0 | .723 |
| Analysis #2 | 163.2521 | 3.7256 | 0.0400 | 11.9093 | 11.9093 | 43.8185 | 10.1683 | 1660.0 | .723 |
| Analysis #3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0 | .000 |

# EC-Design 2000 Channel Analysis Report



## Channel Analysis Information:

**Name:**

Channel Analysis Name: **Area 1G Ditch**

## Channel Geometry & Hydraulics:

**Design By:**

Designed By: **FLOW**

**Channel Side Slopes:**

Left Slope (xH:1V): **2.00**
Right Slope (xH:1V): **2.00**

**Flow\Velocity:**

Discharge (cfs): **15.00**
Flow Duration (hrs): **1.00**
Average Velocity (ft/s): **0.00**

**Channel Geometry:**

Bed Slope (ft/ft): **0.08000**
Req. Freeboard (ft): **0.00**
Channel Length (ft): **140.00**
Bottom Width (ft): **0.10**
Channel Depth (ft): **4.00**

**Channel Bend:**

Channel Bend: **No**
Bend Radius (ft): **0.00**
Outside Bend:

**Vegetation:**

Vegetated: **Yes**
Vegetation Class: **C**

**Soil Filled:**

Soil Filled: **No**

**Factor of Safety:** **1.10**

**Functional Longevity:** **999**

## Analysis Results:

| | Side | Lining Type | Manning's "n" | Velocity (ft/s) Actual | Velocity (ft/s) Max. Allowed | Velocity (ft/s) Safety Factor | Shear Stress (lbs/sqft) Actual | Shear Stress (lbs/sqft) Max. Allowed | Shear Stress (lbs/sqft) Safety Factor | Flow Depth (ft) | Discharge (cfs) | OK? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Analysis #1 | Left: | LANDLOK TRM | 0.0250 | 4.7 | 16.5 | 3.5 | 6.3 | 4.7 | 0.8 | 1.2450 | 15.0 | No |
| | Bottom: | LANDLOK TRM | 0.0250 | 4.6 | 16.5 | 3.5 | 6.2 | 4.7 | 0.8 | | | |
| | Right: | LANDLOK TRM | 0.0250 | 4.7 | 16.5 | 3.5 | 6.3 | 4.7 | 0.8 | | | |
| Analysis #2 | Left: | LANDLOK TRM | 0.0250 | 4.7 | 16.8 | 3.6 | 6.3 | 6.5 | 1.0 | 1.2450 | 15.0 | No |
| | Bottom: | LANDLOK TRM | 0.0250 | 4.6 | 16.8 | 3.6 | 6.2 | 6.5 | 1.1 | | | |
| | Right: | LANDLOK TRM | 0.0250 | 4.7 | 16.8 | 3.6 | 6.3 | 6.5 | 1.0 | | | |
| Analysis #3 | Left: | PYRAMAT | 0.0280 | 4.7 | 23.3 | 5.0 | 6.3 | 9.4 | 1.5 | 1.2502 | 15.0 | Yes |
| | Bottom: | PYRAMAT | 0.0280 | 4.7 | 23.3 | 5.0 | 6.2 | 9.4 | 1.5 | | | |
| | Right: | PYRAMAT | 0.0280 | 4.7 | 23.3 | 5.0 | 6.3 | 9.4 | 1.5 | | | |

## Channel Calculation Results:

| | Flow Area (sq ft) | Hydraulic Radius (ft) | Composite 'n' | Left Wetted Perimeter(ft) | Right Wetted Perimeter(ft) | Total Wetted Perimeter(ft) | Average Veleocity (ft/s) | Average Discharge (cfs) | Froude |
|---|---|---|---|---|---|---|---|---|---|
| Analysis #1 | 3.2247 | 0.5689 | 0.0624 | 2.7840 | 2.7840 | 5.6680 | 4.6516 | 15.0 | .737 |
| Analysis #2 | 3.2247 | 0.5689 | 0.0624 | 2.7840 | 2.7840 | 5.6680 | 4.6516 | 15.0 | .737 |
| Analysis #3 | 3.2511 | 0.5713 | 0.0622 | 2.7956 | 2.7956 | 5.6912 | 4.6138 | 15.0 | .741 |

# EC-Design 2000 Channel Analysis Report



## Channel Analysis Information:

**Name:**

Channel Analysis Name: **Phase 2 Ditch**

## Channel Geometry & Hydraulics:

**Design By:**

Designed By: **FLOW**

**Channel Side Slopes:**

Left Slope (xH:1V): 4.00
Right Slope (xH:1V): 2.00

**Flow\Velocity:**

Discharge (cfs): 4.00
Flow Duration (hrs): 1.00
Average Velocity (ft/s): 0.00

**Channel Geometry:**

Bed Slope (ft/ft): 0.06000
Req. Freeboard (ft): 0.00
Channel Length (ft): 560.00
Bottom Width (ft): 0.01
Channel Depth (ft): 2.00

**Channel Bend:**

Channel Bend: No
Bend Radius (ft): 0.00
Outside Bend:

**Vegetation:**

Vegetated: Yes
Vegetation Class: C

**Soil Filled:**

Soil Filled: No

**Factor of Safety:** 1.10

**Functional Longevity:** 999

## Analysis Results:

| | Side | Lining Type | Manning's "n" | Velocity (ft/s) Actual | Velocity (ft/s) Max. Allowed | Velocity (ft/s) Safety Factor | Shear Stress (lbs/sqft) Actual | Shear Stress (lbs/sqft) Max. Allowed | Shear Stress (lbs/sqft) Safety Factor | Flow Depth (ft) | Discharge (cfs) | OK? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Analysis #1 | Left: | LANDLOK TRM | 0.0250 | 2.3 | 16.5 | 7.1 | 4.0 | 4.7 | 1.2 | 0.8207 | 4.0 | Yes |
| | Bottom: | LANDLOK TRM | 0.0250 | 2.0 | 16.5 | 8.1 | 3.1 | 4.7 | 1.5 | | | |
| | Right: | LANDLOK TRM | 0.0250 | 2.1 | 16.5 | 8.0 | 3.1 | 4.7 | 1.5 | | | |
| Analysis #2 | Left: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0000 | 0.0 | No |
| | Bottom: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |
| | Right: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |
| Analysis #3 | Left: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0000 | 0.0 | No |
| | Bottom: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |
| | Right: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |

## Channel Calculation Results:

| | Flow Area (sq ft) | Hydraulic Radius (ft) | Composite 'n' | Left Wetted Perimeter(ft) | Right Wetted Perimeter(ft) | Total Wetted Perimeter(ft) | Average Veleocity (ft/s) | Average Discharge (cfs) | Froude |
|---|---|---|---|---|---|---|---|---|---|
| Analysis #1 | 2.0287 | 0.3880 | 0.0955 | 3.3837 | 1.8351 | 5.2288 | 1.9717 | 4.0 | .415 |
| Analysis #2 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0 | .000 |
| Analysis #3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0 | .000 |

## Suggested Vegetation for: La Crosse,WI

| All Season Grasses | | | | | |
|---|---|---|---|---|---|
| Species | Scentific Name | Retardance Class | Seed Rate (lbs/ac) | Height at Maturity (in) | Recommended Planting Dates |
| Alsike Clover | Trifolium hybridum | A - E | 15 | | 4/1 - 5/31 or8/16 - 10/15 |
| Reed Canarygrass | Phalaris arundinacea | A- E | 20 | | 4/1 - 5/31 or 8/16 - 10/15 |
| Colonial Bentgrass | Agrostis tenius | A - E | 50 | | 4/1 - 5/31 or 8/16 - 10/15 |
| Creeping Bentgrass | Agrostis palustris | A - E | 50 | | 4/1 - 5/31 or 8/16 - 10/15 |
| Poa Trivialis | Poa trivialis | A - E | 50 | | 4/1 - 5/31 or 8/16 - 10/15 |
| Creeping Foxtrail | Alopecurus arundinaceus | A - E | 50 | | 4/1 - 5/31 or 8/16 - 10/15 |
| Meadow Foxtail | Alopecurus pratensis | A - E | 50 | | 4/1 - 5/31 or 8/16 - 10/15 |
| Perennial Ryegrass | Lolium perenne | A - E | 240 | | 4/1 - 5/31 or 8/16 - 10/15 |
| RedTop | Agrostis alba | A - E | 80 | | 4/1 - 5/31 or 8/16 - 10/15 |
| Meadow Fescue | Festuca elatior | A - E | 160 | | 4/1 - 5/31 or 8/16 - 10/15 |
| **Cold Season Grasses** | | | | | |
| Species | Scentific Name | Retardance Class | Seed Rate (lbs/ac) | Height at Maturity (in) | Recommended Planting Dates |
| Crested Wheatgrass | Agropyron desertorum | A | | 2 - 3 | |
| Green Needlegrass | Stipa viridula | A | | 3 - 4 | |
| Russian WildRye | Psathyrostachys gunceus | A | | 3 - 4 | |
| Smooth Bromegrass | Bromus inermis | A | | 3 - 4 | |
| Tall Fescue | Festuca arundinacea | A | | 3 - 4 | |
| Tall Wheatgrass | Elytriga pontica | A | | 4 - 5 | |
| Western Wheatgrass | Agropyron smithii | A | | 2 - 3 | |
| **Warm Season Grasses** | | | | | |
| Species | Scentific Name | Retardance Class | Seed Rate (lbs/ac) | Height at Maturity (in) | Recommended Planting Dates |
| Bermuda Grass | Cynodon dactylon | C | | 3/4 - 2 | |
| Big Bluestem | Andropogon gerardii | B | | 4 - 6 | |
| Blue grama | Boutelova gracillis | B | | 1 - 2 | |
| Buffalo grass | Buchloe dactyloides | D | | 1/3 - 1 | |
| Green Sprangletop | Leptochloa dubia | A | | 3 - 4 | |
| Indian grass | Sorghastrum nutans | A | | 5 - 6 | |
| Kleingrass | Panicum coloratum | A | | 3 - 4 | |
| Little bluestem | Schizachyrium scoparium | A | | 3 - 4 | |
| Plains bristlegrass | Setaria macrostachya | B | | 1 - 2 | |
| Sand bluestem | Andropogon hallii | A | | 5 - 6 | |
| Sideoats grama | Bouteloua curtipendula | A | | 2 - 3 | |
| Switch grass | Panicum Virgatum | A | | 4 - 5 | |
| Vine mesquitegrass | Panicum Obtusum | B | | 1 - 2 | |
| Weeping lovegrass | Eragrostis Curvula | A | | 3 - 4 | |

# Calculations – Operational Landfill Conditions

RMT
744 Heartland Trail
Madison, WI 53717-1934
Tel. (608) 831-4444 • Fax (608) 831-3334



| | | |
|---|---|---|
| PROJECT / PROPOSAL NAME / LOCATION: DPC - POO | | PROJECT / PROPOSAL NO. 3078.40 |
| SUBJECT: OPERATIONAL DITCH SIZING | | |
| PREPARED BY: BJF | DATE: 10/00 | FINAL ☒ |
| CHECKED BY: | DATE: | REVISION ☐ |

OPERATIONAL DITCHES (SEE FIGURES K-4 to K-9, OPERATIONAL RUNOFF CALCULATIONS)

| DITCH | LOCATION | 100-YR FLOW | SLOPE | SHAPE |
|---|---|---|---|---|
| V-NOTCH DITCH A | CELL 1 ACTIVE | 5 CFS | 6% | V-NOTCH |
| DITCH B | CELL 1 ACTIVE | ~~583~~ 561 CFS[1] | 2% | 10' FLAT |
| DITCH C | CELL 2A ACTIVE | 6 CFS | 6.3% | V-NOTCH |
| DITCH D | CELL 2B ACTIVE | 3 CFS | 12% | V-NOTCH |
| DITCH E | CELL 3 ACTIVE | ~~583~~ 561 CFS[1] ✓ | 1% | 10' FLAT |
| DITCH F | CELL 4A ACTIVE | ~~433~~ 373 CFS[2] | 1% | 10' FLAT |
| DITCH G | CELL 2A ACTIVE | 360 CFS[4] | | |

NOTES
1. FLOWS FROM PREDEVELOPMENT AREAS NORTH + WEST (See p. 96) @ 12.6 hrs
2. FLOWS FROM PREDEVELOPMENT AREAS NORTH + 2B @ 12.6 HRS (See p. 66/96)
3. PERMANANT DITCHES SIZED UNDER POST-DEVELOPMENT CALCULATIONS.
4. FLOW FROM PREDEVELOPMENT ~~AREA~~ AREA NORTH (See p. 95)

| | | | | |
|---|---|---|---|---|
| SW DITCH | CELL 2A ACTIVE | 561 CFS[1] | 5% | 10' FLAT |

RMT, Inc.
Grass Channel Sizing Calculations

| | | | |
|---|---|---|---|
| Site: | Dairyland Power Cooperative | Date: | 10/00 |
| Project #: | 3081.40 | User: | BJK |
| Channel: | Ditch A | | |

==========

I. Input Parameters.

| | | |
|---|---|---|
| A. Side slope, Z1 (hor/vert) = | 3.000 | ft/ft |
| B. Side slope, Z2 (hor/vert) = | 16.000 | ft/ft |
| C. Bottom width, B = | 0.000 | ft |
| D. Design channel slope, S = | 0.060 | ft/ft |
| E. Channel Peak Flow, Q = | 5.000 | cfs |
| F. Enter - 1 - for Type "C" Veg. Retardence<br>- 2 - for Type "D" Veg. Retardence | 2 | |

II. Peak Flow Calculations.

| | | |
|---|---|---|
| **A. Trial flow depth, D =**<br>(Bisection method until Va=Vb) | **0.533** | **ft** |
| B. Channel flow area, Ac =<br>(.5*Z1*D^2) + (B*D) + (.5*Z2*D^2) | 2.703 | sq ft |
| C. Wetted Perimeter, Pw =<br>(D*(Z1^2+1)^.5) + B + (D*(Z2^2+1)^.5) | 10.239 | ft |
| D. Hydraulic radius, Rh =<br>(Ac/Pw) | 0.264 | ft |
| E. Velocity and hydraulic radius, VR =<br>(Va * Rh) | 0.488 | sfps |
| F. Channel flow Manning's coeff, nc =<br>0 | 0.081 | |
| G. Trial velocity, Va =<br>(Q/Ac) | 1.850 | fps |
| **H. Resultant velocity, Vb =**<br>(1.49/nc) * (Rh^.667) * (S^.5) | **1.850** | **fps** ✓ok |

Invoke Solution Macro by typing - 'ctrl' D

# EC-Design 2000 Channel Analysis Report



## Channel Analysis Information:

**Name:**

Channel Analysis Name: **Ditch B**

## Channel Geometry & Hydraulics:

**Design By:**

Designed By: **FLOW**

**Channel Side Slopes:**

Left Slope (xH:1V): 3.00
Right Slope (xH:1V): 3.00

**Flow\Velocity:**

Discharge (cfs): 583.00
Flow Duration (hrs): 1.00
Average Velocity (ft/s): 0.00

**Channel Geometry:**

Bed Slope (ft/ft): 0.02000
Req. Freeboard (ft): 0.00
Channel Length (ft): 530.00
Bottom Width (ft): 10.00
Channel Depth (ft): 4.00

**Channel Bend:**

Channel Bend: No
Bend Radius (ft): 0.00
Outside Bend:

**Vegetation:**

Vegetated: No
Vegetation Class:

**Soil Filled:**

Soil Filled: Yes

**Factor of Safety:** 1.00

**Functional Longevity:** 48

## Analysis Results:

| | Side | Lining Type | Manning's "n" | Velocity (ft/s) Actual | Velocity (ft/s) Max. Allowed | Velocity (ft/s) Safety Factor | Shear Stress (lbs/sqft) Actual | Shear Stress (lbs/sqft) Max. Allowed | Shear Stress (lbs/sqft) Safety Factor | Flow Depth (ft) | Discharge (cfs) | OK? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Analysis #1 | Left: | LANDLOK TRM | 0.0250 | 13.4 | 16.5 | 1.2 | 2.5 | 6.2 | 2.5 | 2.3594 | 583.0 | Yes |
| | Bottom: | LANDLOK TRM | 0.0250 | 14.5 | 16.5 | 1.1 | 2.9 | 6.2 | 2.1 | | | |
| | Right: | LANDLOK TRM 450 | 0.0250 | 13.4 | 16.5 | 1.2 | 2.5 | 6.2 | 2.5 | | | |
| Analysis #2 | Left: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0000 | 0.0 | No |
| | Bottom: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |
| | Right: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |
| Analysis #3 | Left: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0000 | 0.0 | No |
| | Bottom: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |
| | Right: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |

## Channel Calculation Results:

| | Flow Area (sq ft) | Hydraulic Radius (ft) | Composite 'n' | Left Wetted Perimeter(ft) | Right Wetted Perimeter(ft) | Total Wetted Perimeter(ft) | Average Veleocity (ft/s) | Average Discharge (cfs) | Froude |
|---|---|---|---|---|---|---|---|---|---|
| Analysis #1 | 40.2945 | 1.6168 | 0.0200 | 7.4611 | 7.4611 | 24.9222 | 14.4685 | 583.0 | 1.58 |
| Analysis #2 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0 | .000 |
| Analysis #3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0 | .000 |

RMT, Inc.
Grass Channel Sizing Calculations

| | | | |
|---|---|---|---|
| Site: | Dairyland Power Cooperative | Date: | 10/00 |
| Project #: | 3081.40 | User: | BJK |
| Channel: | Ditch C | | |

==========

I. Input Parameters.

| | | |
|---|---|---|
| A. Side slope, Z1 (hor/vert) = | 3.000 | ft/ft |
| B. Side slope, Z2 (hor/vert) = | 16.000 | ft/ft |
| C. Bottom width, B = | 0.000 | ft |
| D. Design channel slope, S = | 0.063 | ft/ft |
| E. Channel Peak Flow, Q = | 6.000 | cfs |
| F. Enter - 1 - for Type "C" Veg. Retardence<br>- 2 - for Type "D" Veg. Retardence | 2 | |

II. Peak Flow Calculations.

| | | |
|---|---|---|
| **A. Trial flow depth, D =**<br>(Bisection method until Va=Vb) | **0.550** | **ft** |
| B. Channel flow area, Ac =<br>(.5*Z1*D^2) + (B*D) + (.5*Z2*D^2) | 2.870 | sq ft |
| C. Wetted Perimeter, Pw =<br>(D*(Z1^2+1)^.5) + B + (D*(Z2^2+1)^.5) | 10.549 | ft |
| D. Hydraulic radius, Rh =<br>(Ac/Pw) | 0.272 | ft |
| E. Velocity and hydraulic radius, VR =<br>(Va * Rh) | 0.569 | sfps |
| F. Channel flow Manning's coeff, nc =<br>0 | 0.075 | |
| G. Trial velocity, Va =<br>(Q/Ac) | 2.091 | fps |
| **H. Resultant velocity, Vb =**<br>(1.49/nc) * (Rh^.667) * (S^.5) | **2.091** | **fps** ✓OK |

Invoke Solution Macro by typing - 'ctrl' D

RMT, Inc.
Grass Channel Sizing Calculations

| | | | |
|---|---|---|---|
| Site: | Dairyland Power Cooperative | Date: | 10/00 |
| Project #: | 3081.40 | User: | BJK |
| Channel: | Ditch D | | |

==========

I. Input Parameters.

| | | |
|---|---|---|
| A. Side slope, Z1 (hor/vert) = | 3.000 | ft/ft |
| B. Side slope, Z2 (hor/vert) = | 3.000 | ft/ft |
| C. Bottom width, B = | 0.000 | ft |
| D. Design channel slope, S = | 0.120 | ft/ft |
| E. Channel Peak Flow, Q = | 3.000 | cfs |
| F. Enter - 1 - for Type "C" Veg. Retardence<br>- 2 - for Type "D" Veg. Retardence | 2 | |

II. Peak Flow Calculations.

| | | |
|---|---|---|
| **A. Trial flow depth, D =**<br>(Bisection method until Va=Vb) | **0.547** | **ft** |
| B. Channel flow area, Ac =<br>(.5*Z1*D^2) + (B*D) + (.5*Z2*D^2) | 0.897 | sq ft |
| C. Wetted Perimeter, Pw =<br>(D*(Z1^2+1)^.5) + B + (D*(Z2^2+1)^.5) | 3.459 | ft |
| D. Hydraulic radius, Rh =<br>(Ac/Pw) | 0.259 | ft |
| E. Velocity and hydraulic radius, VR =<br>(Va * Rh) | 0.867 | sfps |
| F. Channel flow Manning's coeff, nc =<br>0 | 0.063 | |
| G. Trial velocity, Va =<br>(Q/Ac) | 3.344 | fps |
| **H. Resultant velocity, Vb =**<br>(1.49/nc) * (Rh^.667) * (S^.5) | **3.344** | **fps** ✓ ok |

Invoke Solution Macro by typing - 'ctrl' D

# EC-Design 2000 Channel Analysis Report



## Channel Analysis Information:

Name:

Channel Analysis Name: Ditch E

## Channel Geometry & Hydraulics:

| Design By: | Flow\Velocity: | Channel Geometry: |
|---|---|---|
| Designed By: FLOW | Discharge (cfs): 583.00<br>Flow Duration (hrs): 1.00<br>Average Velocity (ft/s): 0.00 | Bed Slope (ft/ft): 0.01000<br>Req. Freeboard (ft): 0.00<br>Channel Length (ft): 1000.0<br>Bottom Width (ft): 10.00<br>Channel Depth (ft): 3.00 |
| **Channel Side Slopes:**<br>Left Slope (xH:1V): 3.00<br>Right Slope (xH:1V): 10.00 | | |
| **Channel Bend:** | **Vegetation:** | **Soil Filled:** |
| Channel Bend: No<br>Bend Radius (ft): 0.00<br>Outside Bend: | Vegetated: No<br>Vegetation Class: | Soil Filled: Yes |

**Factor of Safety:** 1.00 **Functional Longevity:** 60

## Analysis Results:

| | Side | Lining Type | Manning's "n" | Velocity (ft/s) Actual | Velocity (ft/s) Max. Allowed | Velocity (ft/s) Safety Factor | Shear Stress (lbs/sqft) Actual | Shear Stress (lbs/sqft) Max. Allowed | Shear Stress (lbs/sqft) Safety Factor | Flow Depth (ft) | Discharge (cfs) | OK? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Analysis #1 | Left: | LANDLOK TRM | 0.0250 | 8.9 | 16.5 | 1.9 | 1.3 | 6.2 | 4.9 | 2.3865 | 583.0 | Yes |
| | Bottom: | LANDLOK TRM | 0.0250 | 9.6 | 16.5 | 1.7 | 1.5 | 6.2 | 4.2 | | | |
| | Right: | LANDLOK TRM | 0.0250 | 9.3 | 16.5 | 1.8 | 1.4 | 6.2 | 4.5 | | | |
| Analysis #2 | Left: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0000 | 0.0 | No |
| | Bottom: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |
| | Right: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |
| Analysis #3 | Left: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0000 | 0.0 | No |
| | Bottom: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |
| | Right: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |

## Channel Calculation Results:

| | Flow Area (sq ft) | Hydraulic Radius (ft) | Composite 'n' | Left Wetted Perimeter(ft) | Right Wetted Perimeter(ft) | Total Wetted Perimeter(ft) | Average Veleocity (ft/s) | Average Discharge (cfs) | Froude |
|---|---|---|---|---|---|---|---|---|---|
| Analysis #1 | 60.8850 | 1.4660 | 0.0200 | 7.5468 | 23.9840 | 41.5308 | 9.5754 | 583.0 | 1.06 |
| Analysis #2 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0 | .000 |
| Analysis #3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0 | .000 |

# EC-Design 2000 Channel Analysis Report



## Channel Analysis Information:

Name:

Channel Analysis Name: **Ditch F**

## Channel Geometry & Hydraulics:

| Design By: | Flow\Velocity: | Channel Geometry: |
|---|---|---|
| Designed By: **FLOW** | Discharge (cfs): **433.00**<br>Flow Duration (hrs): **1.00**<br>Average Velocity (ft/s): **0.00** | Bed Slope (ft/ft): **0.01000**<br>Req. Freeboard (ft): **0.00**<br>Channel Length (ft): **750.00**<br>Bottom Width (ft): **10.00**<br>Channel Depth (ft): **3.00** |
| **Channel Side Slopes:**<br>Left Slope (xH:1V): **3.00**<br>Right Slope (xH:1V): **5.00** | | |
| **Channel Bend:** | **Vegetation:** | **Soil Filled:** |
| Channel Bend: **No**<br>Bend Radius (ft): **0.00**<br>Outside Bend: | Vegetated: **No**<br>Vegetation Class: | Soil Filled: **Yes** |

**Factor of Safety:** 1.00 **Functional Longevity:** 0

## Analysis Results:

| | Side | Lining Type | Manning's "n" | Velocity (ft/s) Actual | Velocity (ft/s) Max. Allowed | Velocity (ft/s) Safety Factor | Shear Stress (lbs/sqft) Actual | Shear Stress (lbs/sqft) Max. Allowed | Shear Stress (lbs/sqft) Safety Factor | Flow Depth (ft) | Discharge (cfs) | OK? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Analysis #1** | Left: | LANDLOK TRM | 0.0250 | 9.1 | 16.5 | 1.8 | 1.2 | 6.2 | 5.1 | 2.2978 | 433.0 | Yes |
| | Bottom: | LANDLOK TRM | 0.0250 | 9.9 | 16.5 | 1.7 | 1.4 | 6.2 | 4.4 | | | |
| | Right: | LANDLOK TRM | 0.0250 | 9.5 | 16.5 | 1.7 | 1.3 | 6.2 | 4.7 | | | |
| **Analysis #2** | Left: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0000 | 0.0 | No |
| | Bottom: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |
| | Right: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |
| **Analysis #3** | Left: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0000 | 0.0 | No |
| | Bottom: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |
| | Right: | | 0.0000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |

## Channel Calculation Results:

| | Flow Area (sq ft) | Hydraulic Radius (ft) | Composite 'n' | Left Wetted Perimeter(ft) | Right Wetted Perimeter(ft) | Total Wetted Perimeter(ft) | Average Veleocity (ft/s) | Average Discharge (cfs) | Froude |
|---|---|---|---|---|---|---|---|---|---|
| **Analysis #1** | 44.0967 | 1.5215 | 0.0200 | 7.2662 | 11.7164 | 28.9826 | 9.8193 | 433.0 | 1.10 |
| **Analysis #2** | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0 | .000 |
| **Analysis #3** | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0 | .000 |

# EC-DESIGN(R) 2000 Channel Analysis Report

## Project Information

| | | | |
|---|---|---|---|
| **Project Name:** | DPC | **Last Update:** | 8/25/2003 10:58:10 A |
| **Description:** | Cell 2A operational Calcs | **Units:** | English |
| | | **Nearest City:** | |

**Notes:** Calculated for 1% slope section
Backwater from culvert 1 will
Protect 5% slope section

## Channel Design

**Channel Name:** SW Ditch - Operational 100 yr **Units:** English **Design life:** 1,200 months

| Design Criteria | |
|---|---|
| Flow Rate (Q) | |

| Vegetation and Soil | |
|---|---|
| **Vegetated** | Yes |
| **Vegetation Class** | B |
| **Soil Filled** | No |

| Channel Geometry | |
|---|---|
| **Bed Slope (ft/ft)** | 0.010 |
| **Req. Freeboard (ft)** | 0.000 |
| **Channel Length (ft)** | 475.000 |
| **Bottom Width (ft)** | 10.000 |
| **Channel Depth (ft)** | 6.000 |

| Flow/Velocity | |
|---|---|
| **Discharge (cf/s)** | 561.000 |
| **Flow Duration (hrs)** | 1.000 |
| **Avg. Velocity (ft/s)** | 5.490 |

| Channel Side Slopes | |
|---|---|
| **Left (H:1 V)** | 2.000 |
| **Right (H:1 V)** | 2.000 |

| Channel Bend | No |
|---|---|
| **Bend Radius (ft)** | 0.000 |
| **Outside Bend** | |

**Required Factor of Safety** 1.00

## Results

| Lining Materials | | Velocity (ft/s) | | | Shear Stress (lbs/sqft) | | |
|---|---|---|---|---|---|---|---|
| | | Computed | Max Allowed | Safety Factor | Computed | Max Allowed | Safety Factor |
| Left | PYRAMAT | 5.100 | 23.340 | 4.580 | 2.720 | 9.400 | 3.460 |
| Bottom | PYRAMAT | 5.510 | 23.340 | 4.240 | 3.170 | 9.400 | 2.970 |
| Right | PYRAMAT | 5.100 | 23.340 | 4.580 | 2.720 | 9.400 | 3.460 |

**Avg. Flow Depth (ft)** 5.070

## Calculation Results:

| | | | |
|---|---|---|---|
| **Flow Depth (ft)** | 5.070 | **Left Wetted Perimeter (ft)** | 11.350 |
| **Flow Area (ft)** | 102.230 | **Bottom Wetted Perimeter (ft)** | 9.990 |
| | | **Right Wetted Perimeter (ft)** | 11.350 |
| | | **Total Wetted Perimeter (ft)** | 32.690 |
| **Hydraulic Radius (ft)** | 3.130 | **Avg. Velocity (ft/s)** | 5.490 |
| **Composite 'n'** | 0.0580 | **Avg. Discharge (cf/s)** | 561.000 |

# EC-DESIGN(R) 2000 Channel Analysis Report

## Project Information

| | | | |
|---|---|---|---|
| Project Name: | DPC | Last Update: | 8/25/2003 10:53:12 A |
| Description: | Cell 2A operational Calcs | Units: | English |
| | | Nearest City: | |

Notes: FOR 5% SLOPE
SECTION 25-YR STORM

## Channel Design

Channel Name: SW Ditch - Operational 25 yr  Units: English  Design life: 48 months

| Design Criteria | |
|---|---|
| Flow Rate (Q) | |

| Vegetation and Soil | |
|---|---|
| Vegetated | Yes |
| Vegetation Class | B |
| Soil Filled | No |

| Channel Geometry | |
|---|---|
| Bed Slope (ft/ft) | 0.050 |
| Req. Freeboard (ft) | 0.000 |
| Channel Length (ft) | 450.000 |
| Bottom Width (ft) | 10.000 |
| Channel Depth (ft) | 4.000 |

| Flow/Velocity | |
|---|---|
| Discharge (cf/s) | 355.000 |
| Flow Duration (hrs) | 1.000 |
| Avg. Velocity (ft/s) | 8.940 |

| Channel Side Slopes | |
|---|---|
| Left (H:1 V) | 2.000 |
| Right (H:1 V) | 2.000 |

| Channel Bend | No |
|---|---|
| Bend Radius (ft) | 0.000 |
| Outside Bend | |

Required Factor of Safety 1.00

## Results

| Lining Materials | | Velocity (ft/s) | | | Shear Stress (lbs/sqft) | | |
|---|---|---|---|---|---|---|---|
| | | Computed | Max Allowed | Safety Factor | Computed | Max Allowed | Safety Factor |
| Left | PYRAMAT | 8.030 | 23.340 | 2.910 | 6.450 | 9.400 | 1.460 |
| Bottom | PYRAMAT | 9.020 | 23.340 | 2.590 | 8.140 | 9.400 | 1.150 |
| Right | PYRAMAT | 8.030 | 23.340 | 2.910 | 6.450 | 9.400 | 1.460 |

Avg. Flow Depth (ft) 2.610

## Calculation Results:

| | | | |
|---|---|---|---|
| Flow Depth (ft) | 2.610 | Left Wetted Perimeter (ft) | 5.830 |
| Flow Area (ft) | 39.690 | Bottom Wetted Perimeter (ft) | 10.000 |
| | | Right Wetted Perimeter (ft) | 5.830 |
| | | Total Wetted Perimeter (ft) | 21.660 |
| Hydraulic Radius (ft) | 1.830 | Avg. Velocity (ft/s) | 8.940 |
| Composite 'n' | 0.0554 | Avg. Discharge (cf/s) | 355.000 |

# EC-DESIGN(R) 2000 Channel Analysis Report

## Project Information

| | | | |
|---|---|---|---|
| **Project Name:** | DPC | **Last Update:** | 8/25/2003 11:00:48 A |
| **Description:** | Cell 2A operational Calcs | **Units:** | English |
| | | **Nearest City:** | |
| **Notes:** | | | |

## Channel Design

**Channel Name:** Phase III South Slope Ditch **Units:** English **Design life:** 24 months

| Design Criteria | |
|---|---|
| Flow Rate (Q) | |

| Vegetation and Soil | |
|---|---|
| Vegetated | No |
| Vegetation Class | |
| Soil Filled | Yes |

| Channel Geometry | |
|---|---|
| Bed Slope (ft/ft) | 0.060 |
| Req. Freeboard (ft) | 0.000 |
| Channel Length (ft) | 500.000 |
| Bottom Width (ft) | 1.000 |
| Channel Depth (ft) | 1.500 |

| Flow/Velocity | |
|---|---|
| Discharge (cf/s) | 4.000 |
| Flow Duration (hrs) | 1.000 |
| Avg. Velocity (ft/s) | 6.280 |

| Channel Side Slopes | |
|---|---|
| Left (H:1 V) | 2.000 |
| Right (H:1 V) | 3.000 |

| Channel Bend | No |
|---|---|
| Bend Radius (ft) | 0.000 |
| Outside Bend | |

Required Factor of Safety 1.00

## Results

| Lining Materials | | Velocity (ft/s) | | | Shear Stress (lbs/sqft) | | |
|---|---|---|---|---|---|---|---|
| | | Computed | Max Allowed | Safety Factor | Computed | Max Allowed | Safety Factor |
| Left | LANDLOK TRM 450 | 6.080 | 16.490 | 2.710 | 1.050 | 6.250 | 5.950 |
| Bottom | LANDLOK TRM 450 | 6.730 | 16.490 | 2.450 | 1.280 | 6.250 | 4.880 |
| Right | LANDLOK TRM 450 | 6.350 | 16.490 | 2.600 | 1.140 | 6.250 | 5.480 |

Avg. Flow Depth (ft) 0.340

## Calculation Results:

| | | | |
|---|---|---|---|
| **Flow Depth (ft)** | 0.340 | **Left Wetted Perimeter (ft)** | 0.770 |
| **Flow Area (ft)** | 0.640 | **Bottom Wetted Perimeter (ft)** | 1.000 |
| | | **Right Wetted Perimeter (ft)** | 1.080 |
| | | **Total Wetted Perimeter (ft)** | 2.850 |
| **Hydraulic Radius (ft)** | 0.220 | **Avg. Velocity (ft/s)** | 6.280 |
| **Composite 'n'** | 0.0200 | **Avg. Discharge (cf/s)** | 4.000 |

# EC-DESIGN(R) 2000 Channel Analysis Report

## Project Information

| | | | |
|---|---|---|---|
| Project Name: | DPC | Last Update: | 8/25/2003 11:00:48 A |
| Description: | Cell 2A operational Calcs | Units: | English |
| | | Nearest City: | |
| Notes: | | | |

## Channel Design

Channel Name: Ditch G  Units: English  Design life: 48 months

| Design Criteria | |
|---|---|
| Flow Rate (Q) | |

| Vegetation and Soil | |
|---|---|
| Vegetated | No |
| Vegetation Class | |
| Soil Filled | No |

| Channel Geometry | |
|---|---|
| Bed Slope (ft/ft) | 0.015 |
| Req. Freeboard (ft) | 0.000 |
| Channel Length (ft) | 1.000 |
| Bottom Width (ft) | 10.000 |
| Channel Depth (ft) | 4.000 |

| Flow/Velocity | |
|---|---|
| Discharge (cf/s) | 360.000 |
| Flow Duration (hrs) | 1.000 |
| Avg. Velocity (ft/s) | 10.930 |

| Channel Side Slopes | |
|---|---|
| Left (H:1 V) | 3.000 |
| Right (H:1 V) | 3.000 |

| Channel Bend | No |
|---|---|
| Bend Radius (ft) | 0.000 |
| Outside Bend | |

Required Factor of Safety 1.00

## Results

| Lining Materials | | Velocity (ft/s) | | | Shear Stress (lbs/sqft) | | |
|---|---|---|---|---|---|---|---|
| | | Computed | Max Allowed | Safety Factor | Computed | Max Allowed | Safety Factor |
| Left | LANDLOK TRM 450 | 10.170 | 16.490 | 1.620 | 1.610 | 6.250 | 3.880 |
| Bottom | LANDLOK TRM 450 | 11.090 | 16.490 | 1.490 | 1.910 | 6.250 | 3.270 |
| Right | LANDLOK TRM 450 | 10.170 | 16.490 | 1.620 | 1.610 | 6.250 | 3.880 |

Avg. Flow Depth (ft) 2.040

## Calculation Results:

| | | | |
|---|---|---|---|
| Flow Depth (ft) | 2.040 | Left Wetted Perimeter (ft) | 6.460 |
| Flow Area (ft) | 32.920 | Bottom Wetted Perimeter (ft) | 9.990 |
| | | Right Wetted Perimeter (ft) | 6.460 |
| | | Total Wetted Perimeter (ft) | 22.910 |
| Hydraulic Radius (ft) | 1.440 | Avg. Velocity (ft/s) | 10.930 |
| Composite 'n' | 0.0210 | Avg. Discharge (cf/s) | 360.000 |

# Reference Information

roughness) varies with VR. The term VR is the product of velocity and the hydraulic radius. This relationship will be referred to as the "n-VR relationship", which is the recommended basis for vegetated channel design.

The five general retardance curves, designated as A, B, C, D, and E in Exhibit 7-1, have been developed for various cover conditions. The vegetal conditions under which the various retardance values apply are shown in Exhibit 7-2. These cover classifications are based on tests in experimental channels when the covers were green and generally uniform.

Most of the vegetation used in waterways does not exceed 18 inches in height and may be much shorter at times during the year. Therefore, it is recommended that when designing the channel for safe velocity, a retardance not greater than "D" be used. After designing the channel for safe velocity, it must be checked for capacity to accommodate the peak flow under conditions where vegetation gives the highest retardance. The retardance used in this instance is the curve corresponding to the expected vegetal cover and, in most cases, it will be retardance "C", though curve "B" may be used where considered appropriate.

All pertinent design data and computations should be recorded.

## DESIGN DATA

The following information is required for designing a waterway:

1. Watershed area in acres, together with the soil characteristics, cover and topography. This information is used to estimate runoff by the procedures set forth in Chapter 2 of this manual.
2. Grade of the proposed waterway in percent slope (this is the fall in feet per 100 feet of length).
3. Vegetal cover adapted to site conditions.
4. Erodibility of the soil in the waterway.
5. Expected height at which vegetative cover will be maintained.
6. The permissible velocity for the conditions encountered.
7. Allowance for space that will be occupied by the vegetative lining.
8. Allowance for freeboard, if required by State Standards and Specifications.

## NON-EROSIVE VELOCITY OF FLOW

In designing grassed waterways, care must be taken to insure that the design velocity is well within the limits of permissible velocities given in Exhibit 7-3. These values apply to average, uniform stands of each type of cover.

Source: U.S. Department of Agriculture, Soil Conservation Service. Engineering Field Manual. November 1986.

| Cover | Slope range 2/ (percent) | Permissible velocity 1/ | |
|---|---|---|---|
| | | Erosion resistant soils (ft.per sec.) | Easily eroded soils (ft.per sec.) |
| Bermudagrass | 0-5<br>5-10<br>over 10 | 8<br>7<br>6 | 6<br>5<br>4 |
| Bahia<br>Buffalograss<br>Kentucky bluegrass<br>Smooth brome<br>Blue grama<br>Tall fescue | 0-5<br>5-10<br>over 10 | 7<br>6<br>5 | 5<br>4<br>3 |
| Grass mixtures<br>Reed canarygrass | 2/ 0-5<br>5-10 | 5<br>4 | 4<br>3 |
| Lespedeza sericea<br>Weeping lovegrass<br>Yellow bluestem<br>Redtop<br>Alfalfa<br>Red fescue | 3/ 0-5 | 3.5 | 2.5 |
| Common lespedeza 4/<br>Sudangrass 4/ | 5/ 0-5 | 3.5 | 2.5 |

use 4 fps may

1/ Use velocities exceeding 5 feet per second only where good covers and proper maintenance can be obtained.

2/ Do not use on slopes steeper than 10 percent except for vegetated side slopes in combination with a stone, concrete, or highly resistant vegetative center section.

3/ Do not use on slopes steeper than 5 percent except for vegetated side slopes in combination with a stone, concrete, or highly resistant vegetative center section.

4/ Annuals--use on mild slopes or as temporary protection until permanent covers are established.

5/ Use on slopes steeper than 5 percent is not recommended.

Exhibit 7-3. Permissible velocities for channels lined with vegetation

Source: U.S. Department of Agriculture, Soil Conservation Service. Engineering Field Manual. November 1986.

# Culvert/Downslope Flume Design Calculations

# Purpose/Methodology/Assumptions/Results/References

744 Heartland Trail (53717-8923) P. O. Box 8923 (53708-8923) Madison, WI (608) 831-4444 FAX: (608) 831-3334 VOICE: (608) 831-1989

| PROJECT/PROPOSAL NAME | PREPARED By: | PREPARED Date: | CHECKED By: | CHECKED Date: | PROJECT/PROPOSAL NO. |
|---|---|---|---|---|---|
| Dairyland Power Cooperative | BJK | 9/00 | RAA | 10/00 | 3081.40 |

# CULVERT DESIGN CALCULATIONS

## Purpose

To determine the appropriate culvert and downslope flume sizes for the anticipated peak flows resulting from the 100-year, 24-hour storm at the proposed Dairyland Power Cooperative Landfill.

## Methodologies

Culvert design involves the process of selecting an appropriate culvert size capable of allowing the estimated peak storm water runoff to pass through it without creating surface water breaching (i.e., berm overflow) or excessive backwater levels. Culvert sizing was performed using design charts developed by the U.S. Department of Transportation Federal Highway Administration.

Downslope flumes will convey flow from the final cover diversion berms to the sedimentation basin. Downslope flumes were also sized using design charts developed by the U.S. Department of Transportation Federal Highway Administration. The energy dissipater for the downslope flume was sized using design guidance from the US Department of the Interior, Bureau of Reclamation.

## Assumptions

The following assumptions were used in the culvert and downslope flume sizing analysis:

1. Culvert and downslope flume layout and allowable headwater levels are shown on the accompanying plan set.
2. Tailwater depths were assumed based on anticipated flows within the ditching. For culverts discharging into sedimentation basins, the tailwater elevation in the basin from the routing calculations.
3. Culverts are assumed to be corrugated metal culvert pipes or concrete box culverts.
4. Culverts were designed to maintain a minimum 1 to 2 feet of freeboard, depending on the location.

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|---|---|---|---|---|---|
| Dairyland Power Cooperative | BJK | 9/00 | RAA | 10/00 | 3081.40 |

## Results

The table below summarizes the results of the culvert pipe sizing analyses:

| CULVERT | SLOPE (%) | LENGTH (ft) | 100-YR. FLOW (cfs) | SIZE |
|---|---|---|---|---|
| Culvert #1 | 7.0 | 96 | 323 | 4'x 7' Box |
| Culvert #2 | 7.7 | 126 | 323 | 4'x 7' Box |
| Culvert #3 | 11.2 | 125 | 15 | 30" CMP |
| Culvert #4 | 9.3 | 75 | 15 | 30" CMP |
| Culvert #5 | 5 | 85 | 323 | 4' x 7' Box |

Note:
Culvert lengths to be adjusted based on available culvert section lengths.

Downslope pipe and energy dissipater sizing are shown on the engineering details included in the Plan Set.

## References

U.S. Department of Transportation. Hydraulics charts for the selection of highway culverts. Hydraulic engineering circular no. 5. December 1965.

U.S. Department of the Interior, Bureau of Reclamation. Hydraulic Design of Stilling Basins and Energy Dissipaters. Engineering Nomograph No. 25. May 1984.

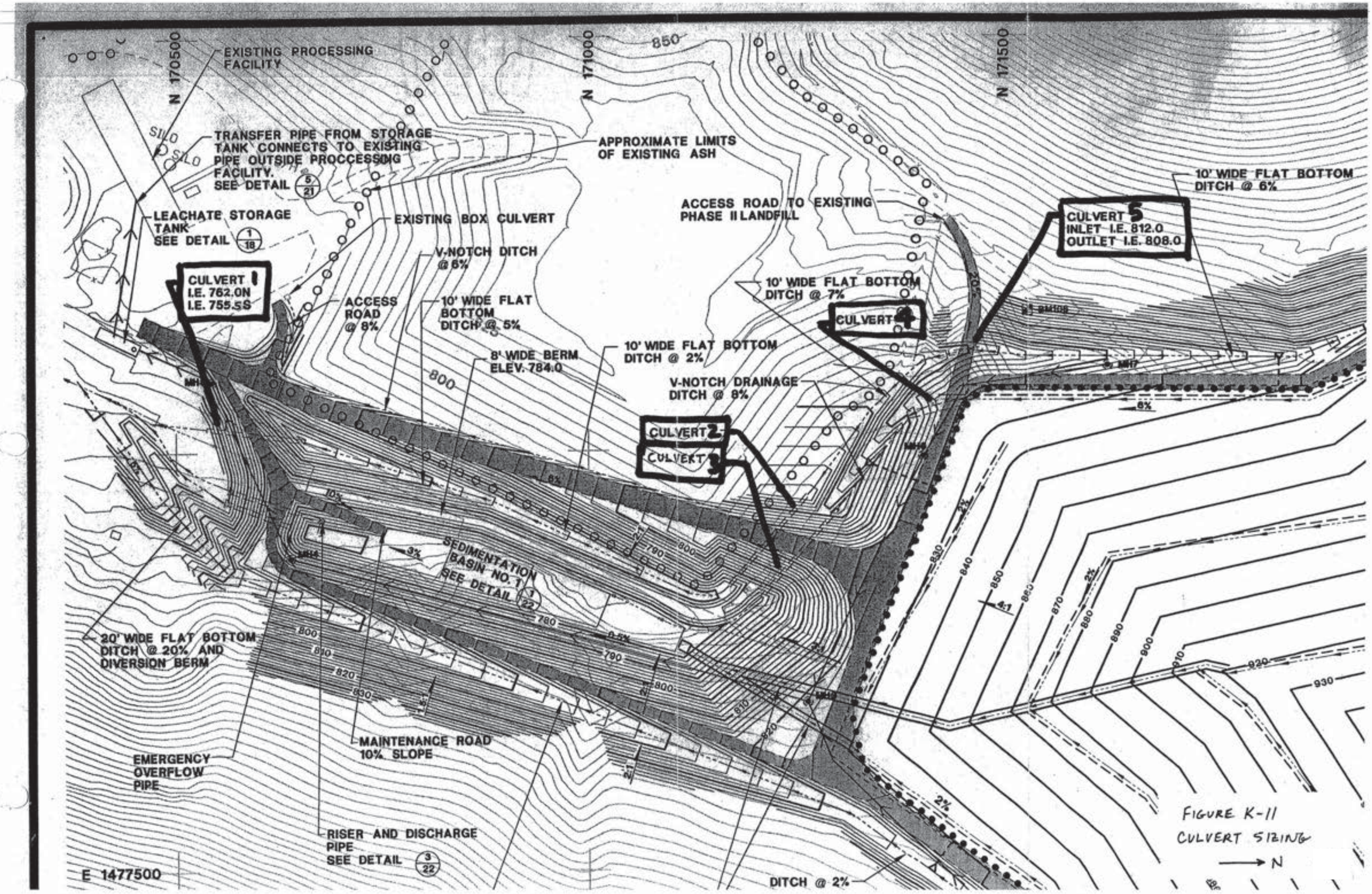


FIGURE K-11
CULVERT SIZING

# Calculations – Post-closure Landfill Conditions

# COMPUTATION SHEET

RMT INC.

SHEET ____ OF ____

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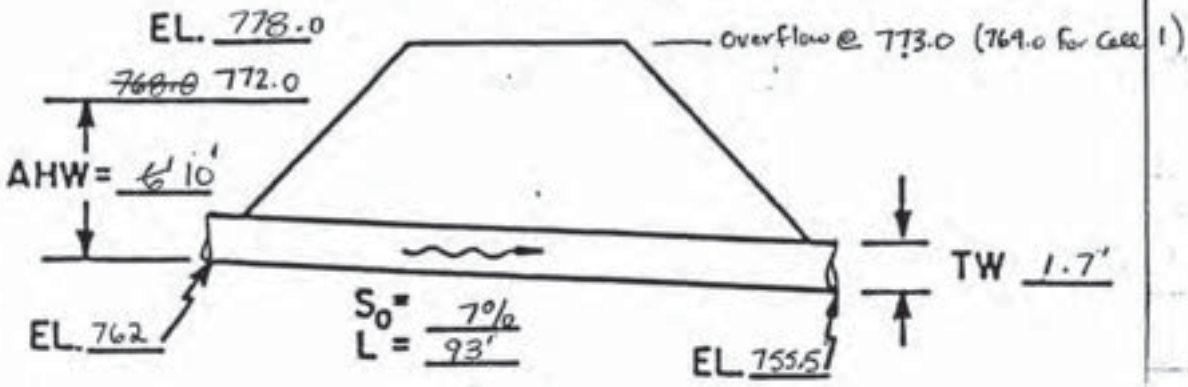
|---|---|---|---|---|---|
| DPC - PLAN OF OPERATION | BJK | 9/00 | | | 3081.40 |

Rev. 7/03
BJK

## SKETCH

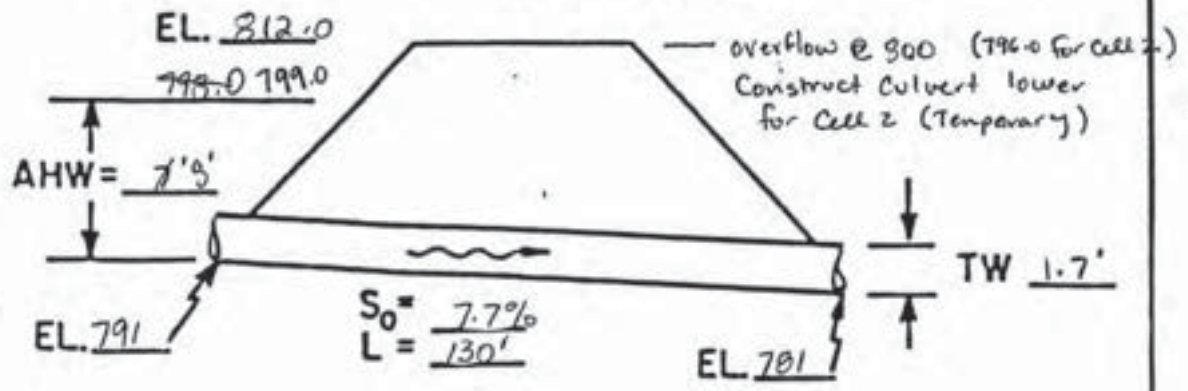
STATION: CULVERT #1




MAX. STREAM FLOW= 323 cfs

## SKETCH

STATION: CULVERT #2




MAX. STREAM FLOW= 323 cfs

# COMPUTATION SHEET

RMT INC.

SHEET ____ OF ____

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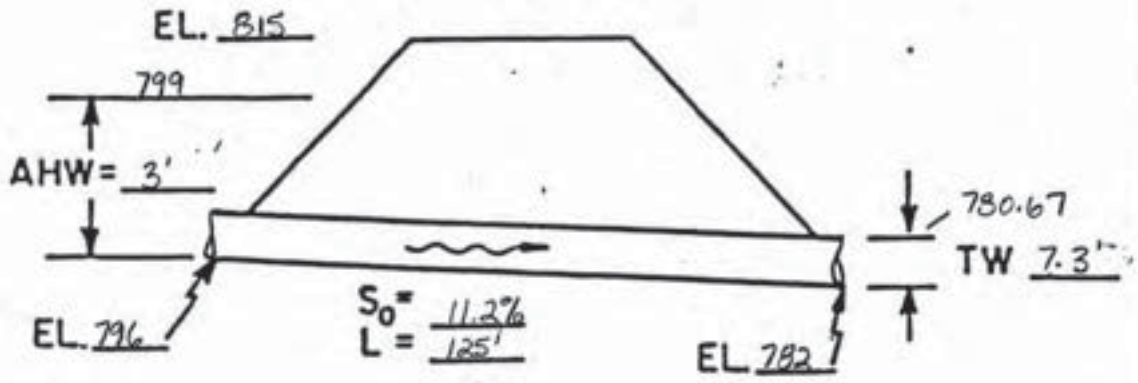
| PROJECT / PROPOSAL NAME | PREPARED By: BJN | Date: 9/00 | CHECKED By: | Date: | PROJECT/PROPOSAL NO. |
|---|---|---|---|---|---|
| DPC - PLAN OF OPERATION | | | | | 3081.40 |

## SKETCH

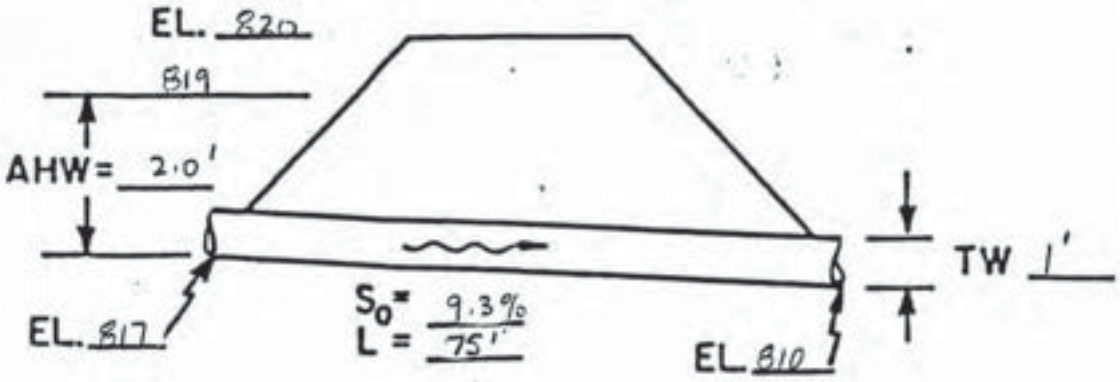
STATION : CULVERT #3




MAX. STREAM FLOW= 15 cfs

## SKETCH

STATION : CULVERT #4




MAX. STREAM FLOW= 15 cfs

# COMPUTATION SHEET

RMT INC.

SHEET ____ OF ____

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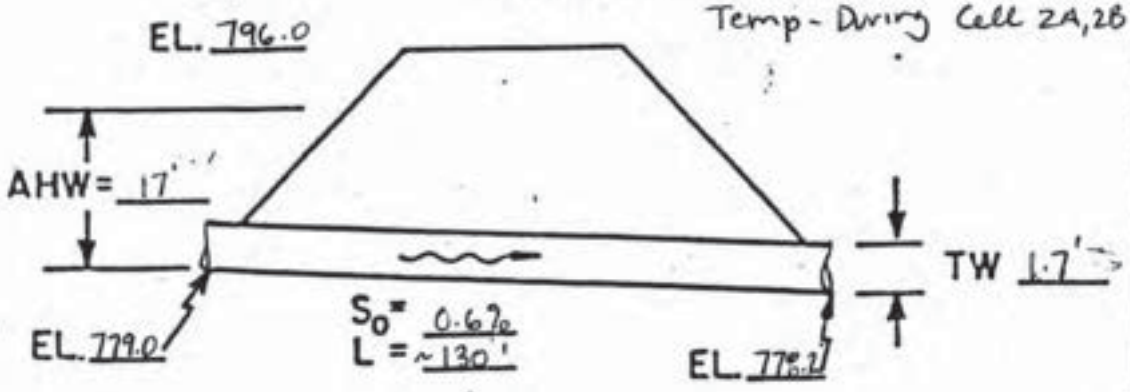
|---|---|---|---|---|---|
| Dairyland Power - Phase II | BJT | 7/03 | | | 3081.56 |

## SKETCH

STATION: Culvert #2

Temp - During Cell 2A, 2B

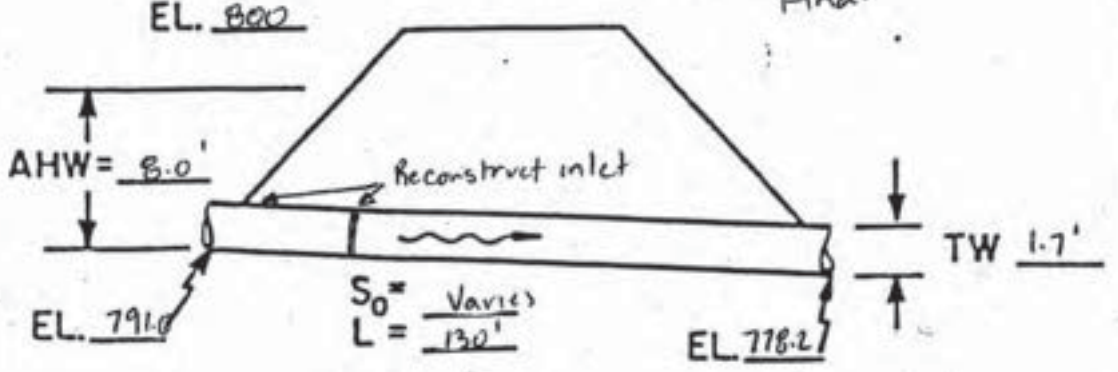



MAX. STREAM FLOW= ~~323~~ 561 cfs

## SKETCH

STATION: Culvert #2

Final




MAX. STREAM FLOW= 323 cfs

# Culvert Calculator Report
## Culvert 2 - Operational

Solve For: Headwater Elevation

| Culvert Summary | | | |
|---|---|---|---|
| Allowable HW Elevation | 796.00 ft | Headwater Depth/ Height | 3.86 |
| Computed Headwater Elevation | 794.45 ft | Discharge | 561.00 cfs |
| Inlet Control HW Elev | 792.30 ft | Tailwater Elevation | 779.90 ft |
| Outlet Control HW Elev | 794.45 ft | Control Type | Outlet Control |

| Grades | | | |
|---|---|---|---|
| Upstream Invert | 779.00 ft | Downstream Invert | 778.20 ft |
| Length | 130.00 ft | Constructed Slope | 0.006154 ft/ft |

| Hydraulic Profile | | | |
|---|---|---|---|
| Profile | Pressure | Depth, Downstream | 4.00 ft |
| Slope Type | N/A | Normal Depth | N/A ft |
| Flow Regime | N/A | Critical Depth | 4.00 ft |
| Velocity Downstream | 20.04 ft/s | Critical Slope | 0.022277 ft/ft |

| Section | | | |
|---|---|---|---|
| Section Shape | Box | Mannings Coefficient | 0.013 |
| Section Material | Concrete | Span | 7.00 ft |
| Section Size | 7 x 4 ft | Rise | 4.00 ft |
| Number Sections | 1 | | |

| Outlet Control Properties | | | |
|---|---|---|---|
| Outlet Control HW Elev | 794.45 ft | Upstream Velocity Head | 6.24 ft |
| Ke | 0.50 | Entrance Loss | 3.12 ft |

| Inlet Control Properties | | | |
|---|---|---|---|
| Inlet Control HW Elev | 792.30 ft | Flow Control | Submerged |
| Inlet Type | 18 to 33.7 " wingwall flare, d=0.0830 | Area Full | 28.0 ft² |
| K | 0.48600 | HDS 5 Chart | 9 |
| M | 0.66700 | HDS 5 Scale | 2 |
| C | 0.02490 | Equation Form | 2 |
| Y | 0.83000 | | |

# Culvert Calculator Report
## Culvert 2 - Final

Solve For: Headwater Elevation

| Culvert Summary | | | |
|---|---|---|---|
| Allowable HW Elevation | 799.00 ft | Headwater Depth/ Height | 1.78 |
| Computed Headwater Elevation | 798.10 ft | Discharge | 323.00 cfs |
| Inlet Control HW Elev | 797.44 ft | Tailwater Elevation | 779.90 ft |
| Outlet Control HW Elev | 798.10 ft | Control Type | Entrance Control |

| Grades | | | |
|---|---|---|---|
| Upstream Invert | 791.00 ft | Downstream Invert | 778.20 ft |
| Length | 130.00 ft | Constructed Slope | 0.098462 ft/ft |

| Hydraulic Profile | | | |
|---|---|---|---|
| Profile | S2 | Depth, Downstream | 1.60 ft |
| Slope Type | Steep | Normal Depth | 1.32 ft |
| Flow Regime | Supercritical | Critical Depth | 4.00 ft |
| Velocity Downstream | 28.87 ft/s | Critical Slope | 0.007385 ft/ft |

| Section | | | |
|---|---|---|---|
| Section Shape | Box | Mannings Coefficient | 0.013 |
| Section Material | Concrete | Span | 7.00 ft |
| Section Size | 7 x 4 ft | Rise | 4.00 ft |
| Number Sections | 1 | | |

| Outlet Control Properties | | | |
|---|---|---|---|
| Outlet Control HW Elev | 798.10 ft | Upstream Velocity Head | 2.07 ft |
| Ke | 0.50 | Entrance Loss | 1.03 ft |

| Inlet Control Properties | | | |
|---|---|---|---|
| Inlet Control HW Elev | 797.44 ft | Flow Control | Submerged |
| Inlet Type | 18 to 33.7 ° wingwall flare, d=0.0830 | Area Full | 28.0 ft² |
| K | 0.48600 | HDS 5 Chart | 9 |
| M | 0.66700 | HDS 5 Scale | 2 |
| C | 0.02490 | Equation Form | 2 |
| Y | 0.83000 | | |

# COMPUTATION SHEET

RMT INC.

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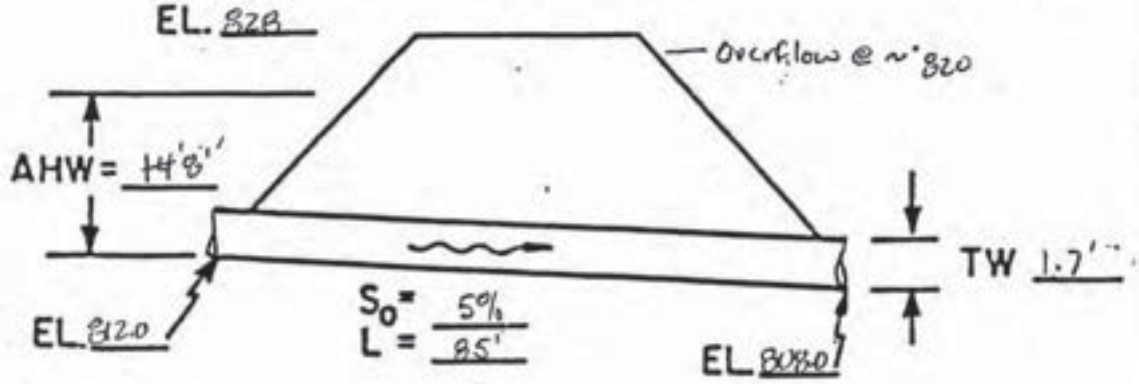
| PROJECT / PROPOSAL NAME | PREPARED By: | Date: | CHECKED By: | Date: | PROJECT/PROPOSAL NO. |
|---|---|---|---|---|---|
| OPC P00 | BJD | 9/00 | | | 3081.40 |

## SKETCH

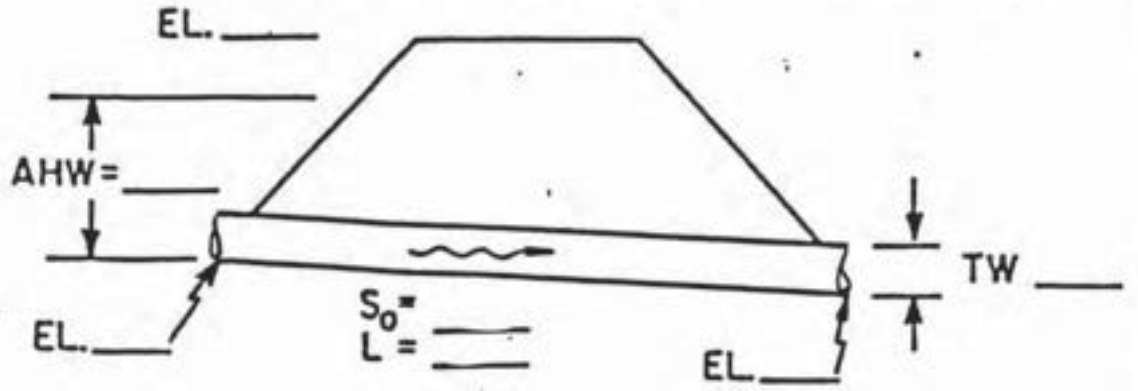
STATION : CULVERT # 5




MAX. STREAM FLOW= 323

## SKETCH

STATION : ____




MAX. STREAM FLOW= ____

PROJECT: DPC POO

DESIGNER: BJK

DATE: 9/2000

## HYDROLOGIC AND CHANNEL INFORMATION

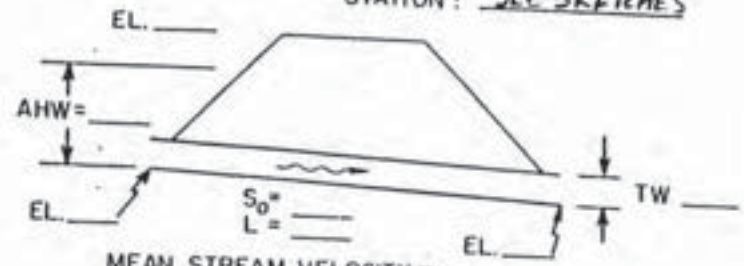
$Q_1$ = SEE SKETCHES  $TW_1$ = _____

$Q_2$ = _____  $TW_2$ = _____

( $Q_1$ = DESIGN DISCHARGE, SAY $Q_{25}$
$Q_2$ = CHECK DISCHARGE, SAY $Q_{50}$ OR $Q_{100}$ )

## SKETCH

STATION: SEE SKETCHES




MEAN STREAM VELOCITY = _____

MAX. STREAM VELOCITY = _____

| CULVERT DESCRIPTION (ENTRANCE TYPE) | Q | SIZE | HEADWATER COMPUTATION: INLET CONT. HW/D | INLET CONT. HW | OUTLET CONTROL HW=H+$h_o$−$LS_o$: $K_e$ | H | $d_c$ | $\frac{d_c+D}{2}$ | TW | $h_o$ | $LS_o$ | HW | CONTROLLING HW | OUTLET VELOCITY | COST | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CULVERT #1 CMP | 162 EA | 2-60" | 1.2 | 6' | | | | | | | | | | | | |
| CULVERT #1 BOX CULVERT | 323 46/ft | 7'x 4' | ~~1.45~~ 1.95 | ~~5.8~~ 7.8 | 0.4 | 3.8' | 4.0' | 4.0' | 1.7' | 4.0 | 6.5' | 1.3 | ~~5.8~~ 7.8 | | | Not Rec. |
| | | | | | | | | | | | | | | | | Recommended |
| CULVERT #2 BOX CULVERT | 323 46/ft | 7'x 4' | ~~1.45~~ 1.95 | ~~5.8'~~ 7.8 | 0.4 | 3.8 | 4.0' | 4.0' | 1.7 | 4.0 | 10' | — | ~~5.8'~~ 7.8 | | | |
| | | | | | | | | | | | | | | | | Recommended |
| CULVERT #3 CMP | 15 | 24" | 1.15 | 2.3' | 0.5 | 2.8' | 1.4 | 1.7 | 7.3' | 7.3' | 6' | 4.1 | | | | |
| CULVERT #3 CMP | 15 | 30" | 0.77 | 1.9 | 0.5 | 0.8 | 1.3 | 1.9 | 7.3' | 7.3' | 6' | 2.1 | | | | Not Rec. |
| | | | | | | | | | | | | | | | | Recommended |

SUMMARY & RECOMMENDATIONS:

ACTUAL LENGTHS OF CULVERTS #1 + 2 = 96' and 126' RESPECTIVELY
BASED ON 6' CULVERT SECTION LENGTHS

Figure 7

PROJECT: DPC - POO

DESIGNER: BJK

DATE: 9/2000

## HYDROLOGIC AND CHANNEL INFORMATION

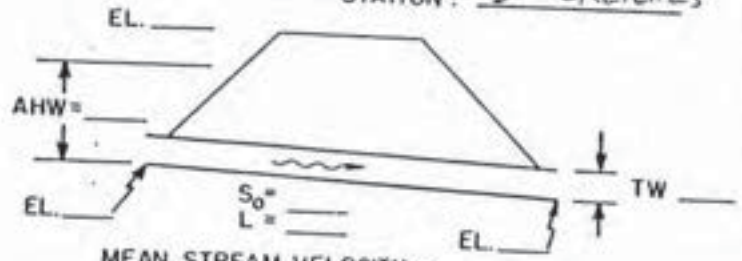
$Q_1$ = SEE SKETCHES  $TW_1$ = _____

$Q_2$ = _____  $TW_2$ = _____

( $Q_1$ = DESIGN DISCHARGE, SAY $Q_{25}$
$Q_2$ = CHECK DISCHARGE, SAY $Q_{50}$ OR $Q_{100}$ )

## SKETCH

STATION: SEE SKETCHES




MEAN STREAM VELOCITY = _____

MAX. STREAM VELOCITY = _____

| CULVERT DESCRIPTION (ENTRANCE TYPE) | Q | SIZE | HEADWATER COMPUTATION: INLET CONT. $\frac{HW}{D}$ | INLET CONT. HW | OUTLET CONTROL $HW = H + h_o - LS_o$: $K_e$ | H | $d_c$ | $\frac{d_c+D}{2}$ | TW | $h_o$ | $LS_o$ | HW | CONTROLLING HW | OUTLET VELOCITY | COST | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CULVERT #4 CMP | 15 | 30" | 0.77 | 1.9' | 0.5 | 0.7 | 1.3 | 1.9 | 1.0 | 1.9 | 7' | — | 1.9' | | | Recommended |
| CULVERT #5 BOX CULVERT | 323 46/FT | 7'x 4' | ~~1.45~~ 1.95 | ~~5.0~~ 7.8 | 0.4 | 3.8 | 4.0 | 4.0 | 1.7 | 4.0 | 4' | 3.8 | ~~5.8~~ 7.8 | | | Recommended |

SUMMARY & RECOMMENDATIONS:

Figure 7

## TABLE 1 - ENTRANCE LOSS COEFFICIENTS

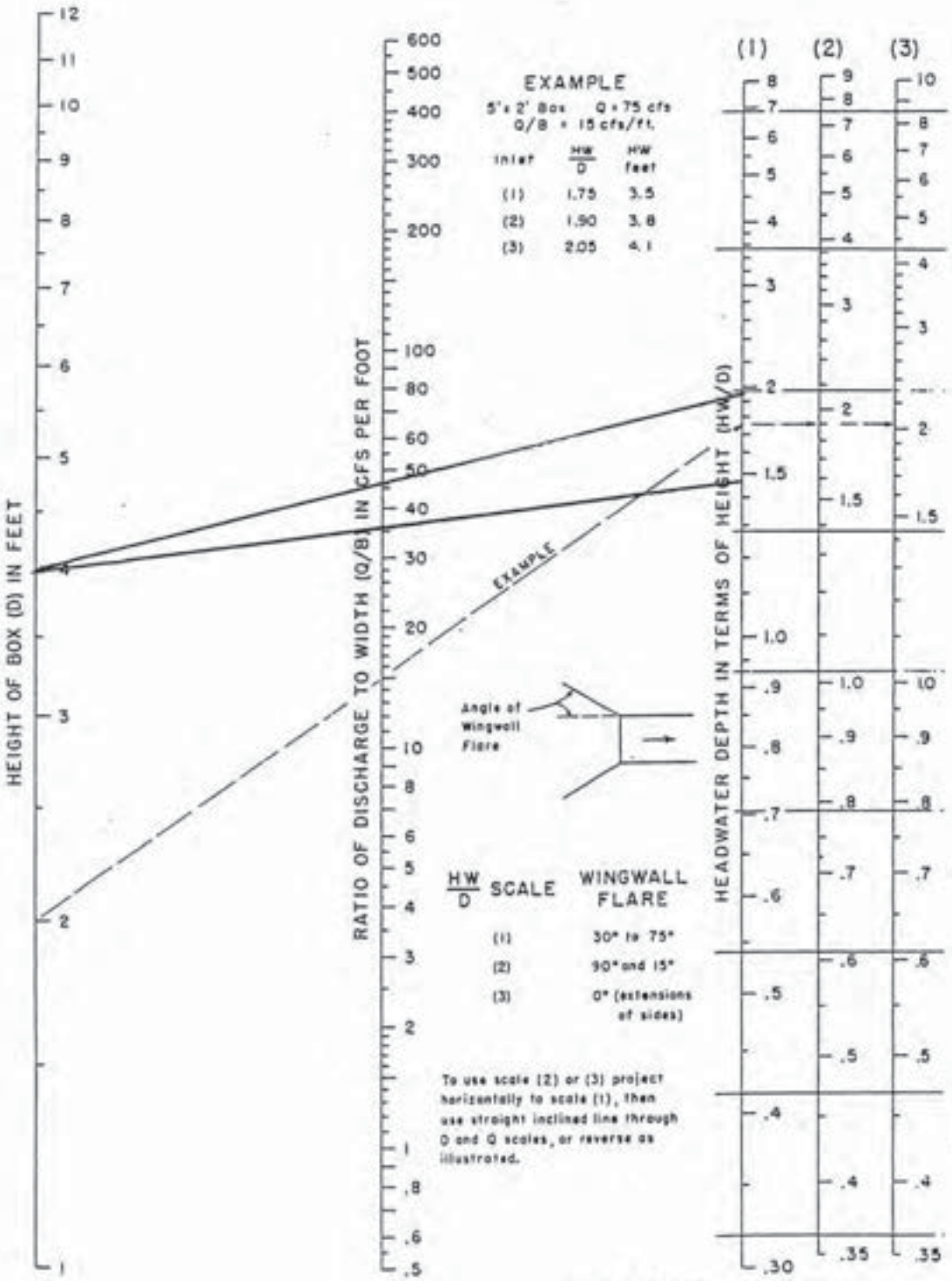
Outlet Control, Full or Partly Full

Entrance head loss $H_e = k_e \frac{V^2}{2g}$

| Type of Structure and Design of Entrance | Coefficient $k_e$ |
|---|---|
| **Pipe, Concrete** | |
| Projecting from fill, socket end (groove-end) . . . | 0.2 |
| Projecting from fill, sq. cut end . . . . . | 0.5 |
| Headwall or headwall and wingwalls | |
| Socket end of pipe (groove-end) . . . . . | 0.2 |
| Square-edge . . . . . | 0.5 |
| Rounded (radius = 1/12D) . . . . . | 0.2 |
| Mitered to conform to fill slope . . . . . | 0.7 |
| *End-Section conforming to fill slope . . . . . | 0.5 |
| Beveled edges, 33.7° or 45° bevels . . . . . | 0.2 |
| Side-or slope-tapered inlet . . . . . | 0.2 |
| **Pipe, or Pipe-Arch, Corrugated Metal** | |
| Projecting from fill (no headwall) . . . . . | 0.9 |
| Headwall or headwall and wingwalls square-edge . . | 0.5 |
| Mitered to conform to fill slope, paved or unpaved slope . . . . . | 0.7 |
| *End-Section conforming to fill slope . . . . . | 0.5 ← CULVERTS 3,4 |
| Beveled edges, 33.7° or 45° bevels . . . . . | 0.2 |
| Side-or slope-tapered inlet . . . . . | 0.2 |
| **Box, Reinforced Concrete** | |
| Headwall parallel to embankment (no wingwalls) | |
| Square-edged on 3 edges . . . . . | 0.5 |
| Rounded on 3 edges to radius of 1/12 barrel dimension, or beveled edges on 3 sides . . . | 0.2 |
| Wingwalls at 30° to 75° to barrel | |
| Square-edged at crown . . . . . | 0.4 ← CULVERTS 1,2 |
| Crown edge rounded to radius of 1/12 barrel dimension, or beveled top edge . . . . . | 0.2 |
| Wingwall at 10° to 25° to barrel | |
| Square-edged at crown . . . . . | 0.5 |
| Wingwalls parallel (extension of sides) | |
| Square-edged at crown . . . . . | 0.7 |
| Side-or slope-tapered inlet . . . . . | 0.2 |

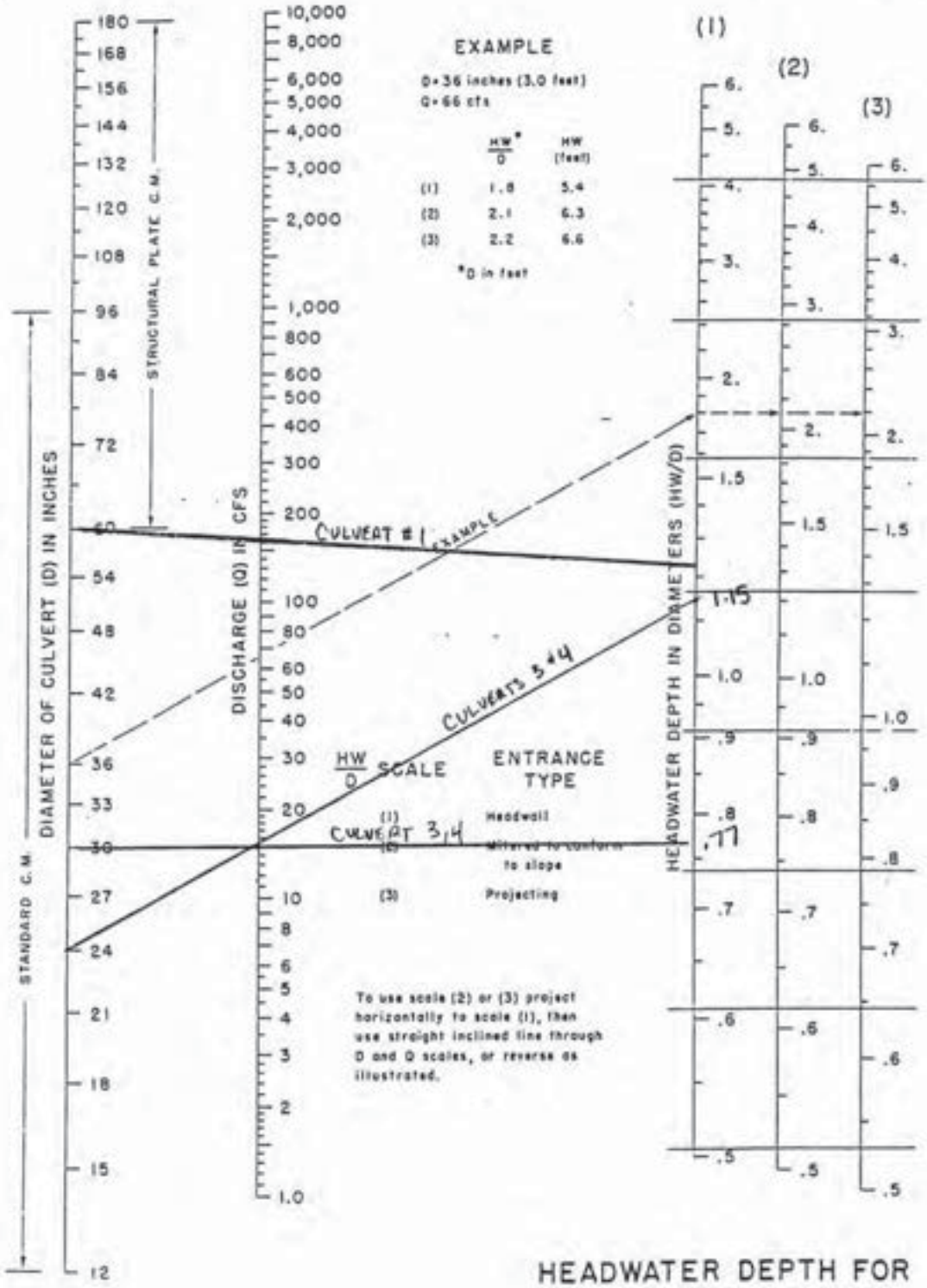
*Note: "End Section conforming to fill slope," made of either metal or concrete, are the sections commonly available from manufacturers. From limited hydraulic tests they are equivalent in operation to a headwall in both inlet and outlet control. Some end sections, incorporating a closed taper in their design have a superior hydraulic performance. These latter sections can be designed using the information given for the beveled inlet, p. 5-13.

# CHART I



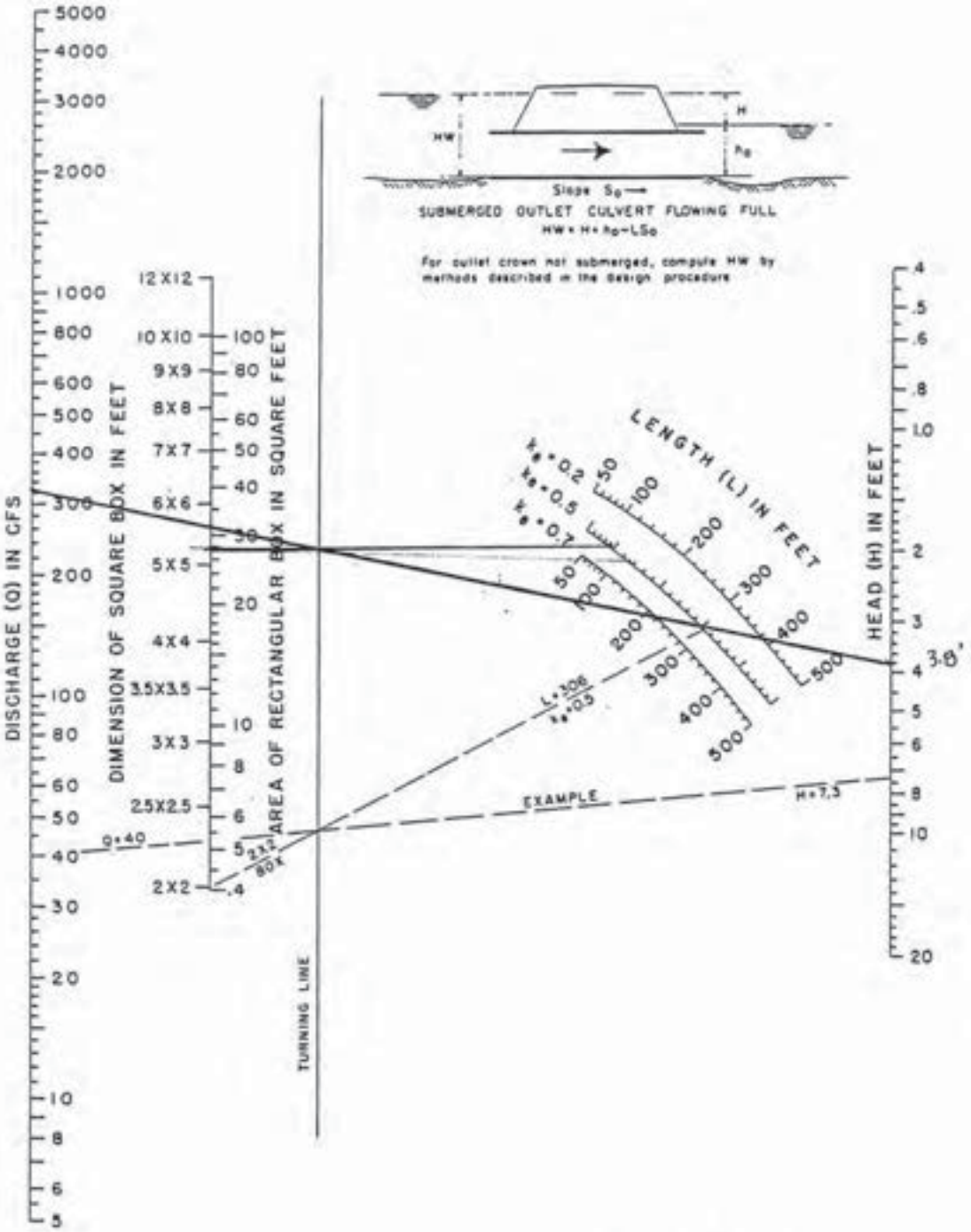

HEADWATER DEPTH
FOR BOX CULVERTS
WITH INLET CONTROL

# CHART 5



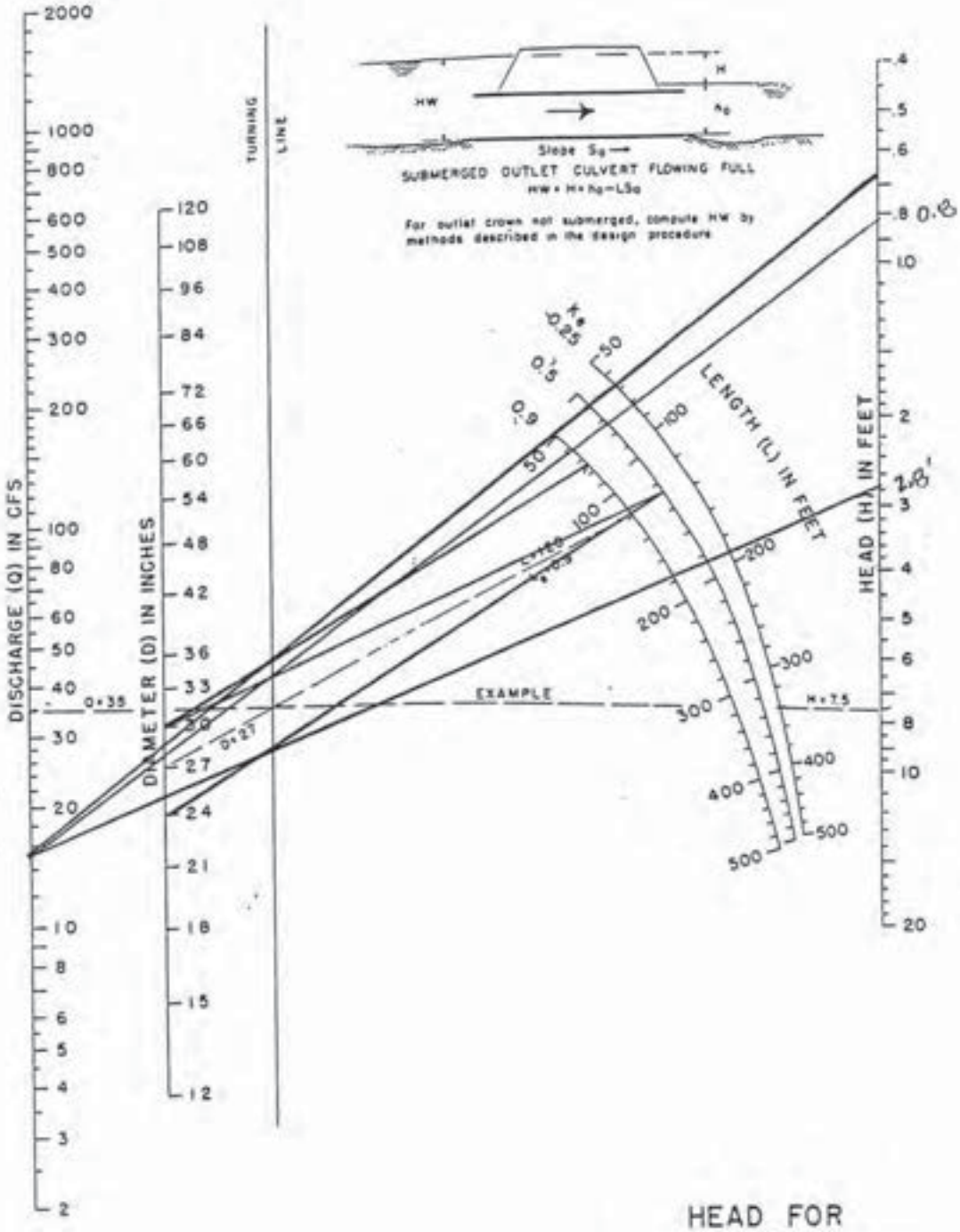

HEADWATER DEPTH FOR
C. M. PIPE CULVERTS
WITH INLET CONTROL

# CHART 8



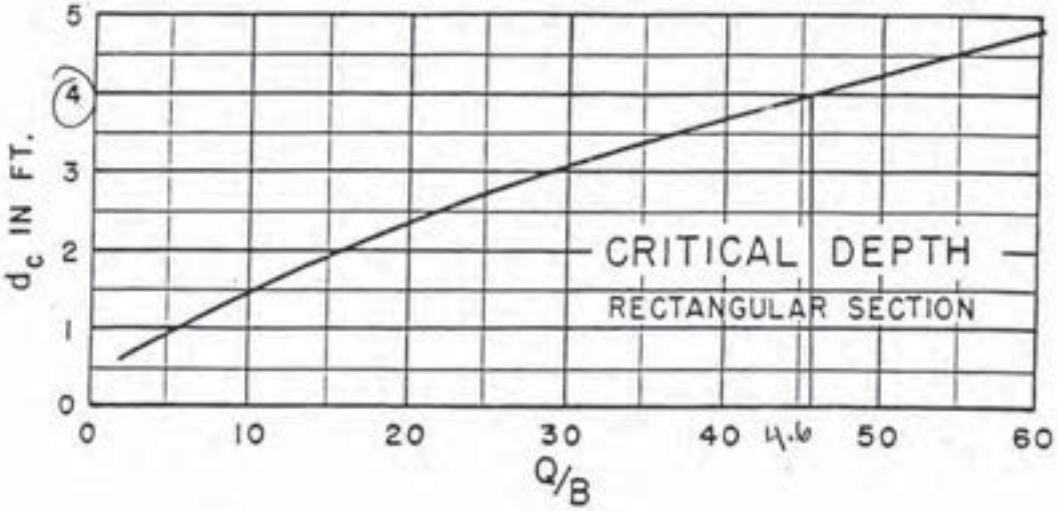

HEAD FOR
CONCRETE BOX CULVERTS
FLOWING FULL
n = 0.012

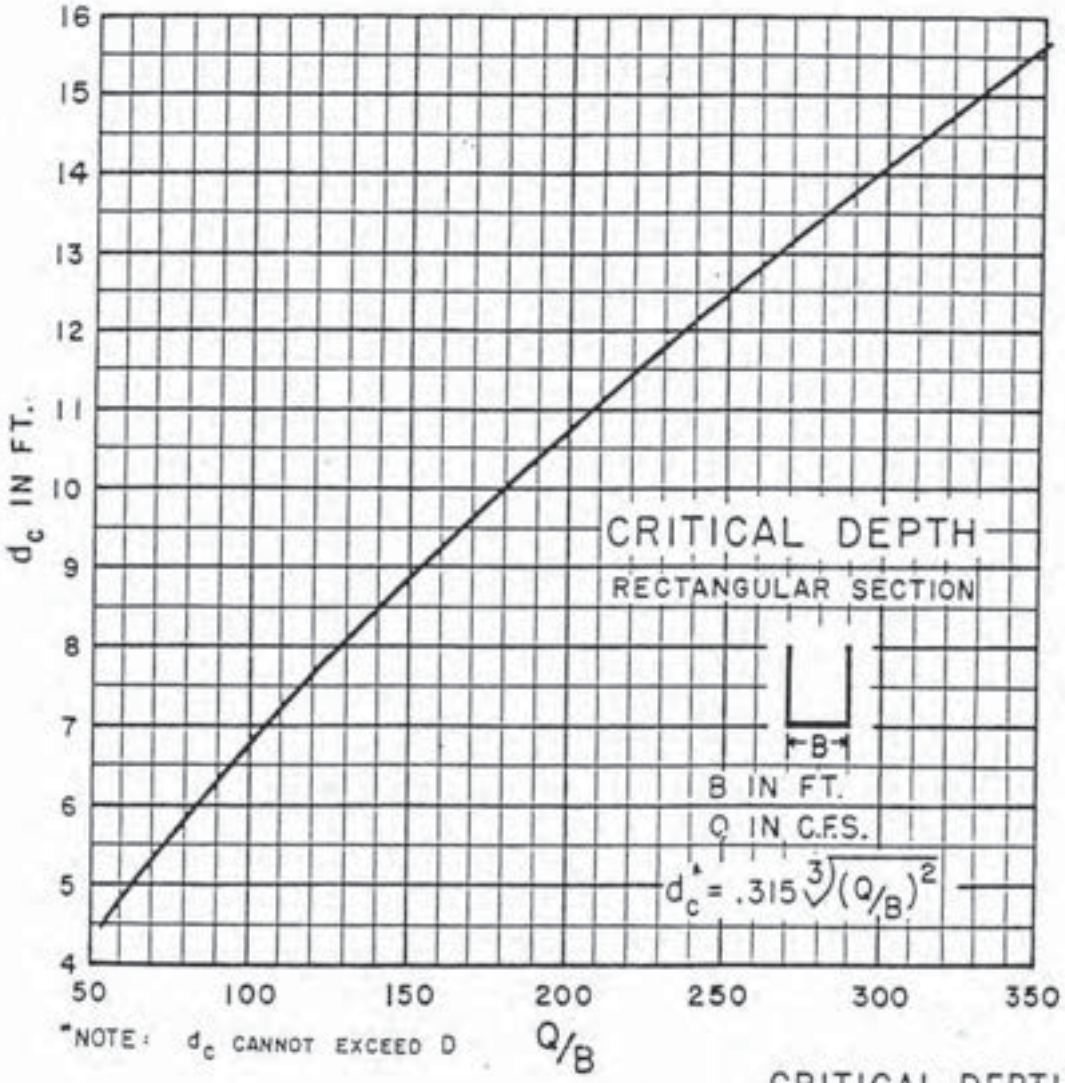
# CHART 11




HEAD FOR
STANDARD
C. M. PIPE CULVERTS
FLOWING FULL
n = 0.024

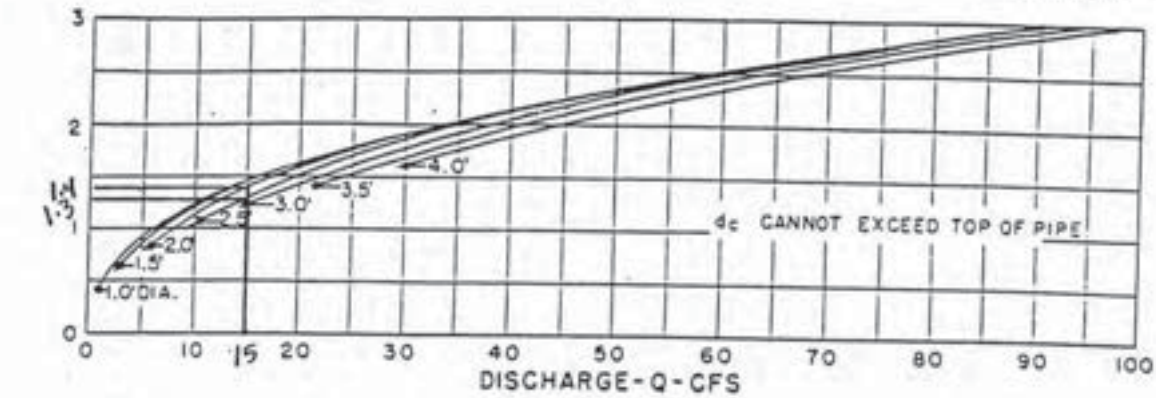
Chart 15

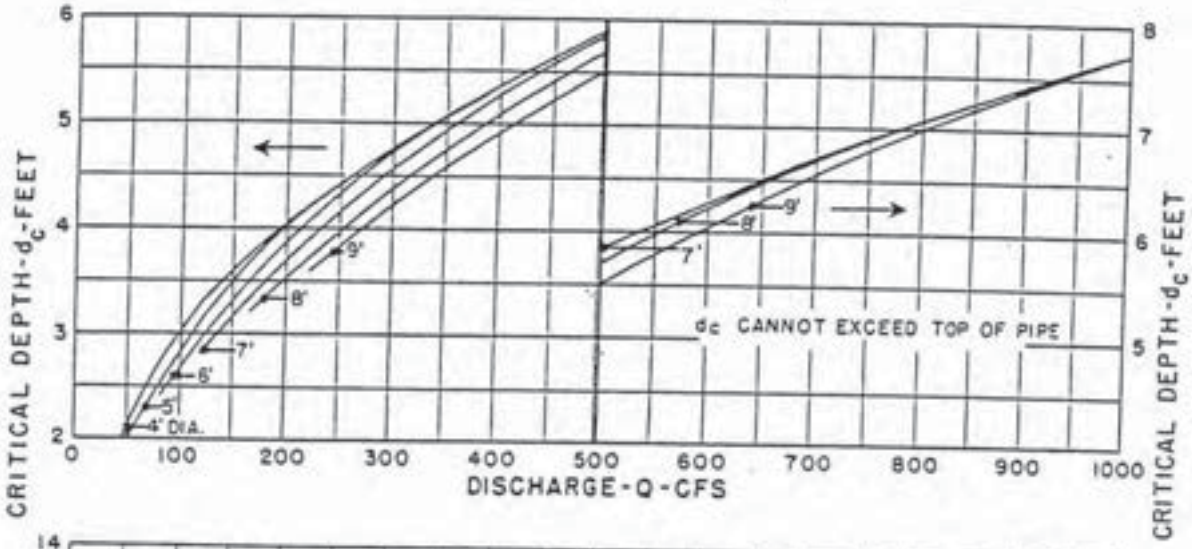


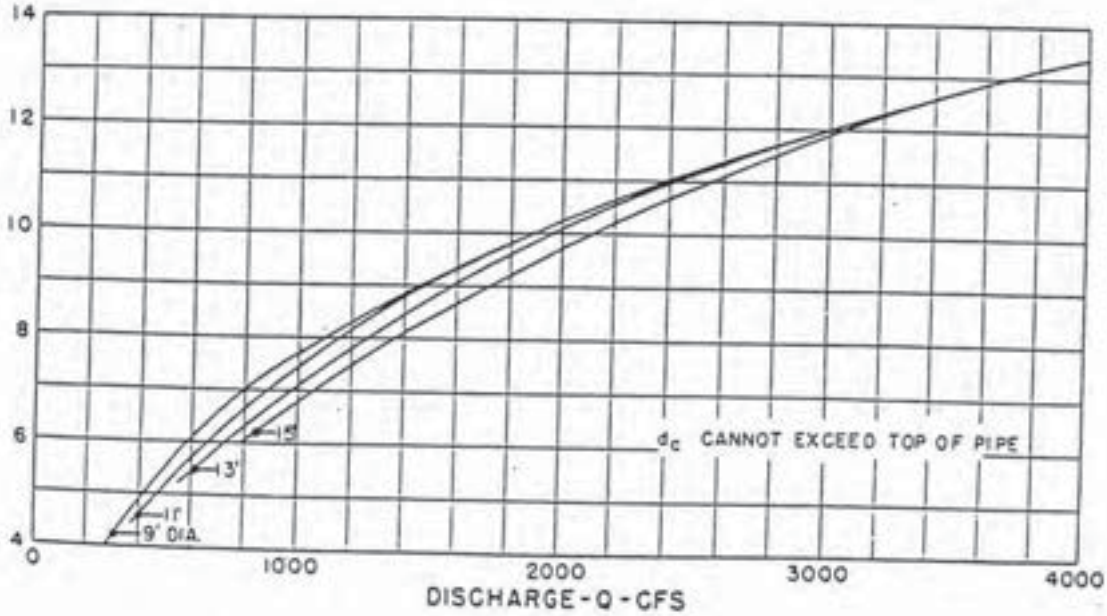




CRITICAL DEPTH
RECTANGULAR SECTION

CHART 16




CRITICAL DEPTH
CIRCULAR PIPE

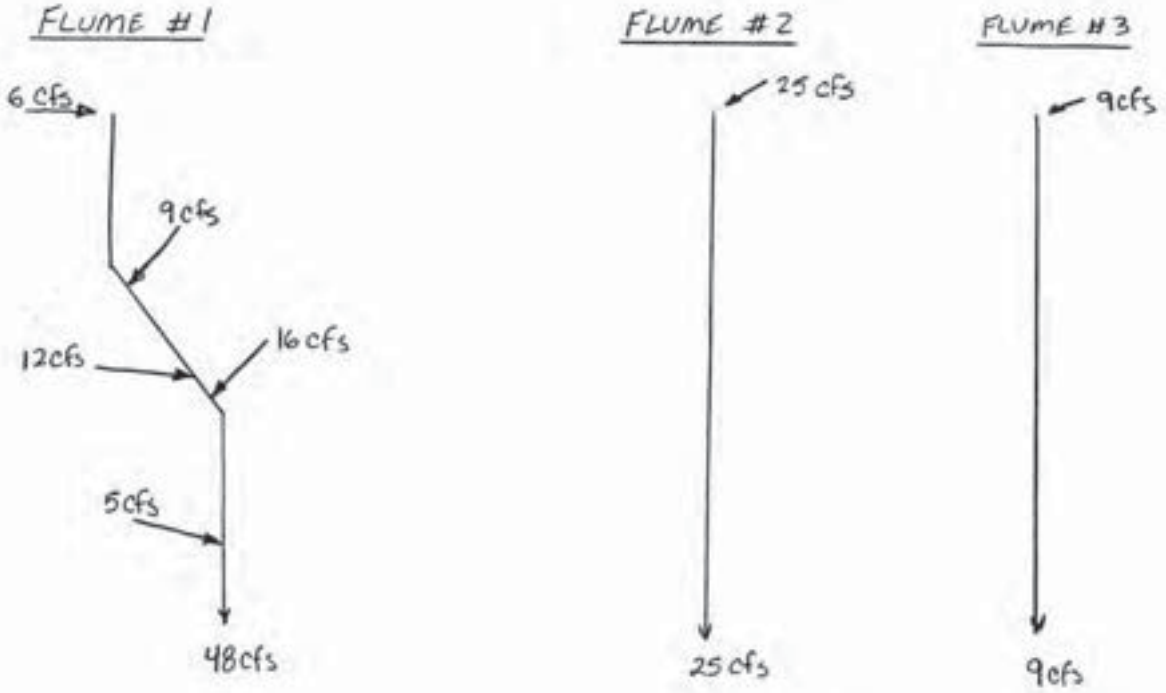
RMT
744 Heartland Trail
Madison, WI 53717-1934
Tel. (608) 831-4444 • Fax (608) 831-3334

SHEET ____ OF ____

| | | |
|---|---|---|
| PROJECT / PROPOSAL NAME / LOCATION: DAIRYLAND POWER – POO | | PROJECT / PROPOSAL NO. 3081.40 |
| SUBJECT: FLUME SIZING | | |
| PREPARED BY: B.J.K | DATE: 9/00 | FINAL ☐ |
| CHECKED BY: | DATE: | REVISION ☐ |

# DOWNSLOPE FLUME SIZING

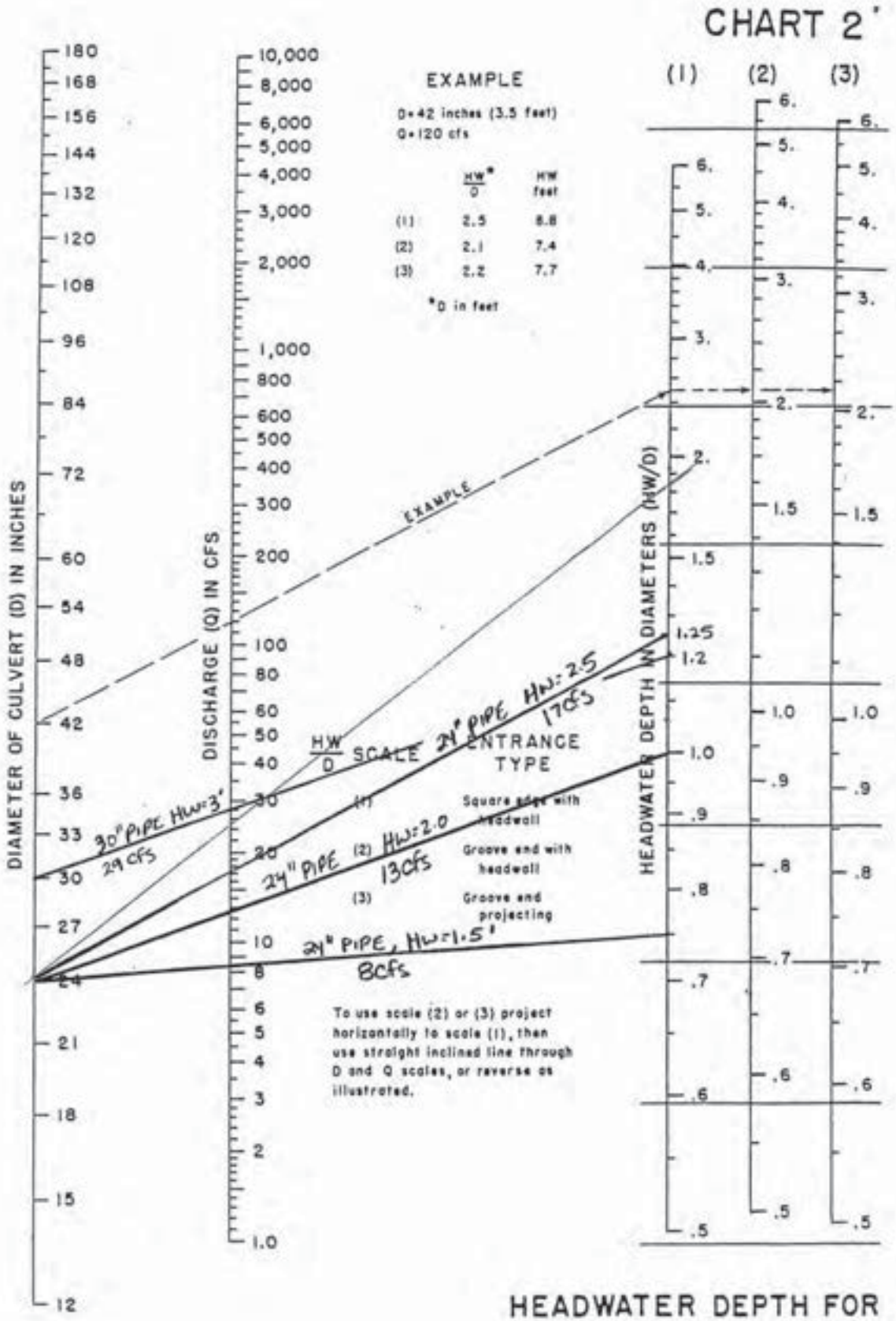
1. SIZE INLET PIPES




NOTE: PEAK FLOWS OBTAINED FROM RUNOFF CALCULATIONS
PEAK FLOWS ADDED TO OBTAIN TOTALS (CONSERVATIVE)

ESTABLISH INLET PIPE SIZES AND BERM HEIGHTS USING INLET CONTROL NOMOGRAPHS:

| FLOW RANGE | INLET PIPE SIZE | HW | REQ'D BERM HEIGHT |
|---|---|---|---|
| 0-8 cfs | 24" | 1.5' | 2.5' |
| 9-13 cfs | 24" | 2.0' | 2.5' |
| 14-17 cfs | 24" | 2.5' | 3.0' |
| 18-29 cfs | 30" | 3.0' | 3.5' |




HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

RMT
744 Heartland Trail
Madison, WI 53717-1934
Tel: (608) 831-4444 • Fax (608) 831-3334

SHEET ____ OF ____

| PROJECT / PROPOSAL NAME / LOCATION: DAIRYLAND POWER - POO | | PROJECT / PROPOSAL NO. |
|---|---|---|
| SUBJECT: FLUME SIZING | | 3081 40 |
| PREPARED BY: BJK | DATE: 9/00 | FINAL ☐ |
| CHECKED BY: | DATE: | REVISION ☐ |

CHECK STRAIGHT PIPE FLUME SIZING

WORST-CASE FLOW - FLUME #1

SLOPE = 20% (AT RIDGE)
PIPE DIA = 1.5'
MAX FLOW = 48 cfs

FULL PIPE FLOW:

$$Q = \frac{1.49}{n} R^{2/3} S^{1/2} A$$

$n = 0.010$ for HDPE PIPE
$R = D/4 = 1.5/4 = 0.375$
$S = 0.20$ ft/ft
$A = \pi D^2/4 = \pi (1.5)^2/4 = 1.77 \text{ ft}^2$

$$Q_{FULL} = \frac{1.49}{0.01} (0.375)^{2/3} (0.20)^{1/2} (1.77)$$

$= 61$ cfs $> 48$ cfs OK ✓

A WATER RESOURCES TECHNICAL PUBLICATION

Engineering Monograph No. 25

# Hydraulic Design of Stilling Basins and Energy Dissipators

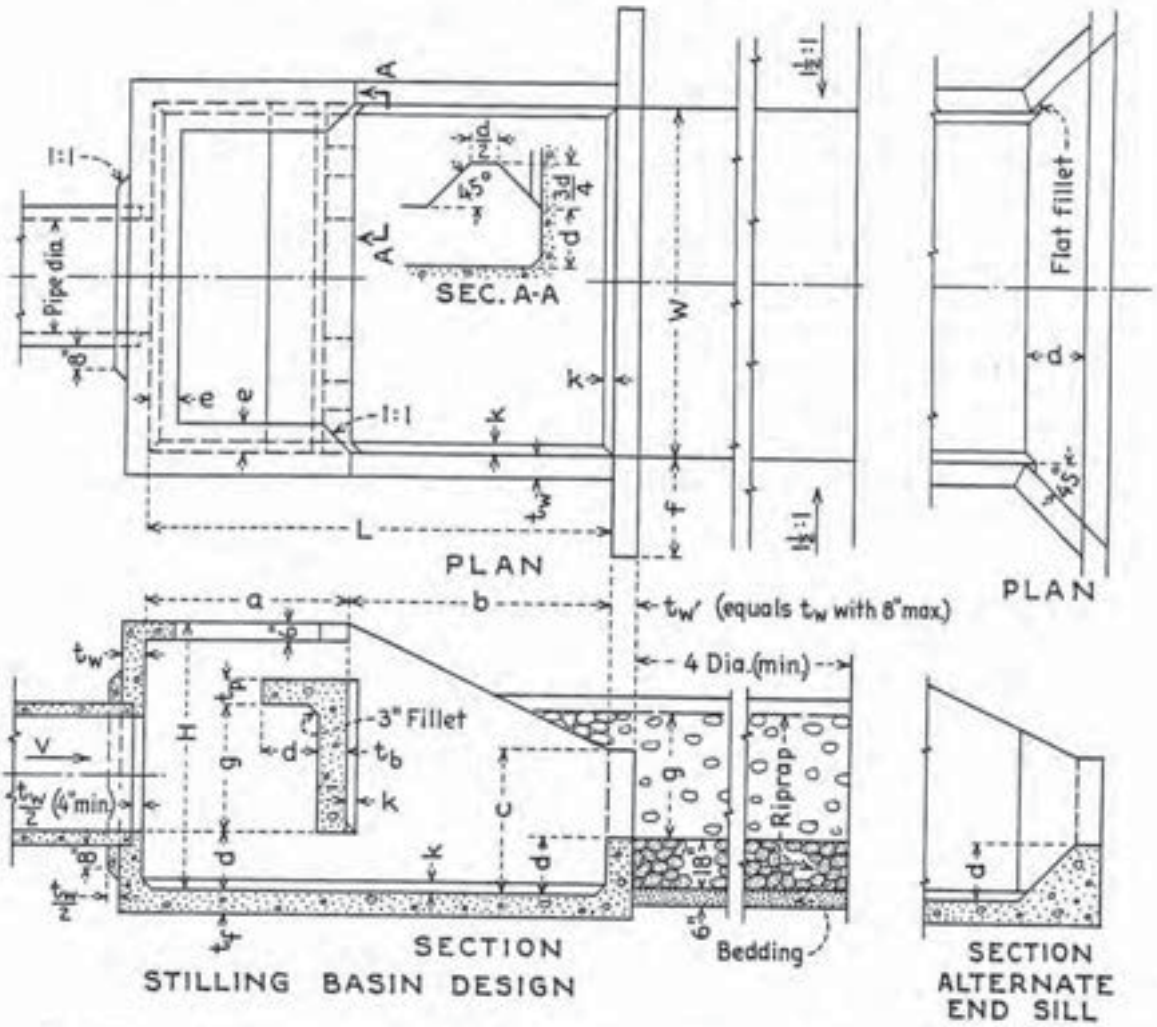
By A. J. PETERKA

Denver, Colorado

United States Department of the Interior

BUREAU OF RECLAMATION

RMT
LIBRARY
NOV 22 1999



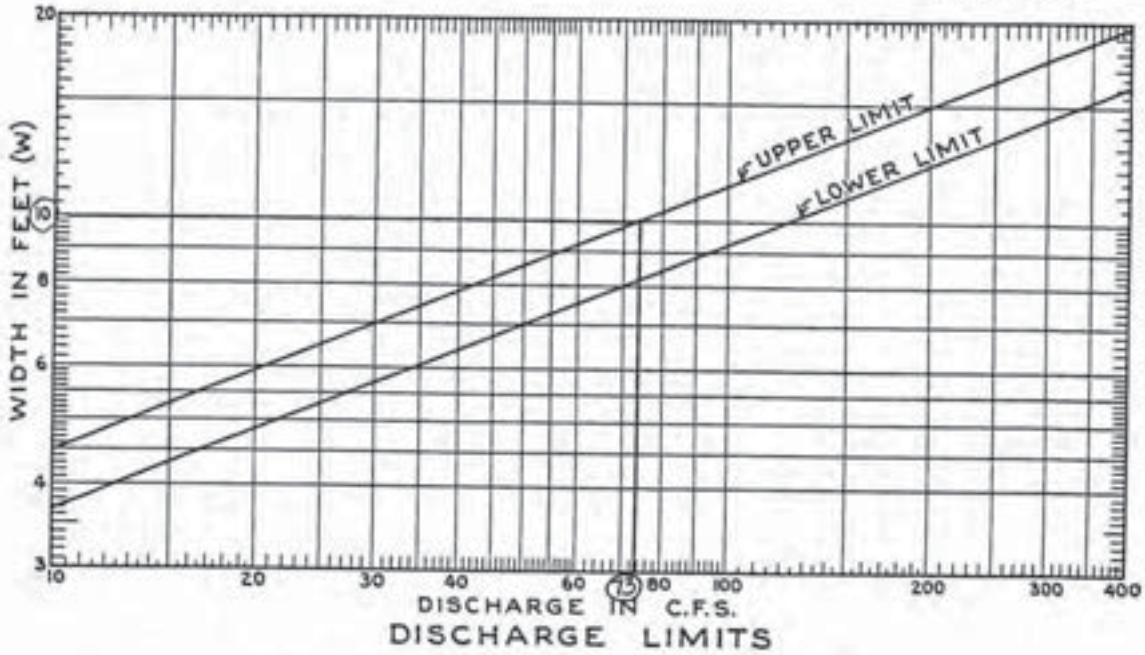




FIGURE 42.—*Impact-type energy dissipator (Basin VI).*

TABLE 11.—*Stilling basin dimensions (Basin VI). Impact-type energy dissipator.*

| Suggested pipe size [1] | | Max discharge Q | Feet and inches | | | | | | | | | | Inches | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dia in. | Area (sq ft) | | W | H | L | s | b | c | d | e | f | g | $t_w$ | $t_f$ | $t_s$ | $t_p$ | K | Suggested riprap size |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) | (18) | (19) [3] |
| 18 | 1.77 | [2] 21 | 5-6 | 4-3 | 7-4 | 3-3 | 4-1 | 2-4 | 0-11 | 0-6 | 1-6 | 2-1 | 6 | 6½ | 6 | 6 | 3 | 4.0 |
| 24 | 3.14 | 38 | 6-9 | 5-3 | 9-0 | 3-11 | 5-1 | 2-10 | 1-2 | 0-6 | 2-0 | 2-6 | 6 | 6½ | 6 | 6 | 3 | 7.0 |
| 30 | 4.91 | 59 | 8-0 | 6-3 | 10-8 | 4-7 | 6-1 | 3-4 | 1-4 | 0-8 | 2-6 | 3-0 | 6 | 6½ | 7 | 7 | 3 | 8.5 |
| 73cfs → 36 | 7.07 | 85 | 9-3 | 7-3 | 12-4 | 5-3 | 7-1 | 3-10 | 1-7 | 0-8 | 3-0 | 3-6 | 7 | 7½ | 8 | 8 | 3 | 9.0 |
| 42 | 9.62 | 115 | 10-6 | 8-0 | 14-0 | 6-0 | 8-0 | 4-5 | 1-9 | 0-10 | 3-0 | 3-11 | 8 | 8½ | 9 | 8 | 4 | 9.5 |
| 48 | 12.57 | 151 | 11-9 | 9-0 | 15-8 | 6-9 | 8-11 | 4-11 | 2-0 | 0-10 | 3-0 | 4-5 | 9 | 9½ | 10 | 8 | 4 | 10.5 |
| 54 | 15.90 | 191 | 13-0 | 9-9 | 17-4 | 7-4 | 10-0 | 5-5 | 2-2 | 1-0 | 3-0 | 4-11 | 10 | 10½ | 10 | 8 | 4 | 12.0 |
| 60 | 19.63 | 236 | 14-3 | 10-9 | 19-0 | 8-0 | 11-0 | 5-11 | 2-5 | 1-0 | 3-0 | 5-4 | 11 | 11½ | 11 | 8 | 6 | 13.0 |
| 72 | 28.27 | 339 | 16-6 | 12-3 | 22-0 | 9-3 | 12-9 | 6-11 | 2-9 | 1-3 | 3-0 | 6-2 | 12 | 12½ | 12 | 8 | 6 | 14.0 |

[1] Suggested pipe will run full when velocity is 12 feet per second or half full when velocity is 24 feet per second. Size may be modified for other velocities by Q=AV, but relation between Q and basin dimensions shown must be maintained.

[2] For discharges less than 21 second-feet, obtain basin width from curve of Fig. 42. Other dimensions proportional to W; $H=\frac{3W}{4}$, $L=\frac{4W}{3}$, $d=\frac{W}{6}$, etc.

[3] Determination of riprap size explained in Sec. 10.

# Calculations – Temporary Culverts, Operational Conditions

# COMPUTATION SHEET

RMT INC.

SHEET ____ OF ____

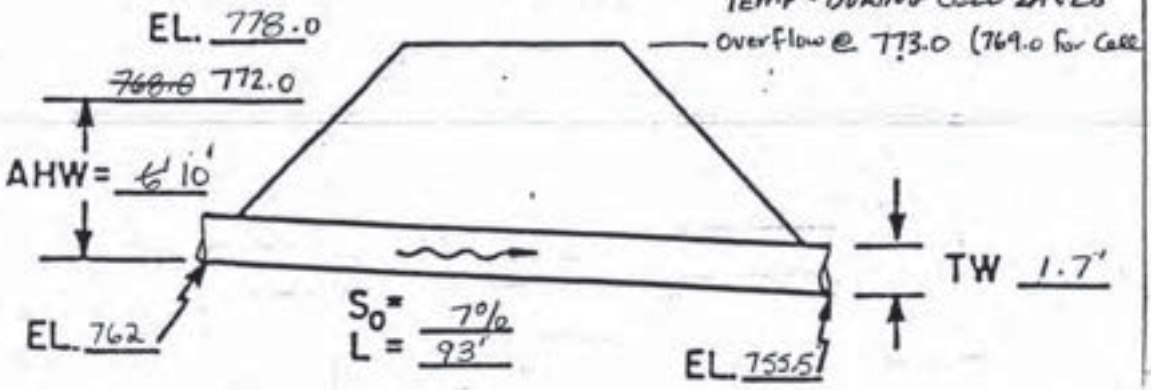
744 Heartland Trail P.O. Box 8923 Madison, WI 53708-8923 (608) 831-4444 FAX: (608) 831-3334

| PROJECT / PROPOSAL NAME | PREPARED By: BJK Date: 9/10 | CHECKED By: Date: | PROJECT/PROPOSAL NO. |
|---|---|---|---|
| DPC - PLAN OF OPERATION | | | 3081.40 |

REV BJK 7/03

## SKETCH

STATION: CULVERT #1
TEMP - DURING CELL 2A & 2B




MAX. STREAM FLOW= ~~323 cfs~~ 355 cfs (25 yr)
561 cfs (100 yr)

Flows for Areas North + West - See Pages 92 & 96 from AEO Apx K

# Culvert Calculator Report
## Culvert 1 - Operational (25-Year)

Solve For: Headwater Elevation

| Culvert Summary | | | |
|---|---|---|---|
| Allowable HW Elevation | 773.00 ft | Headwater Depth/ Height | 1.94 |
| Computed Headwater Elevation | 769.75 ft | Discharge | 355.00 cfs |
| Inlet Control HW Elev | 769.18 ft | Tailwater Elevation | 757.20 ft |
| Outlet Control HW Elev | 769.75 ft | Control Type | Entrance Control |

| Grades | | | |
|---|---|---|---|
| Upstream Invert | 762.00 ft | Downstream Invert | 755.50 ft |
| Length | 93.00 ft | Constructed Slope | 0.069892 ft/ft |

| Hydraulic Profile | | | |
|---|---|---|---|
| Profile | S2 | Depth, Downstream | 2.10 ft |
| Slope Type | Steep | Normal Depth | 1.58 ft |
| Flow Regime | Supercritical | Critical Depth | 4.00 ft |
| Velocity Downstream | 24.17 ft/s | Critical Slope | 0.008921 ft/ft |

| Section | | | |
|---|---|---|---|
| Section Shape | Box | Mannings Coefficient | 0.013 |
| Section Material | Concrete | Span | 7.00 ft |
| Section Size | 7 x 4 ft | Rise | 4.00 ft |
| Number Sections | 1 | | |

| Outlet Control Properties | | | |
|---|---|---|---|
| Outlet Control HW Elev | 769.75 ft | Upstream Velocity Head | 2.50 ft |
| Ke | 0.50 | Entrance Loss | 1.25 ft |

| Inlet Control Properties | | | |
|---|---|---|---|
| Inlet Control HW Elev | 769.18 ft | Flow Control | Submerged |
| Inlet Type | 18 to 33.7 ° wingwall flare, d=0.0830 | Area Full | 28.0 ft² |
| K | 0.48600 | HDS 5 Chart | 9 |
| M | 0.66700 | HDS 5 Scale | 2 |
| C | 0.02490 | Equation Form | 2 |
| Y | 0.83000 | | |

# Culvert Calculator Report
## Culvert 1 - Operational (100-Year)

Solve For: Headwater Elevation

| Culvert Summary | | | |
|---|---|---|---|
| Allowable HW Elevation | 773.00 ft | Headwater Depth/ Height | 3.34 |
| Computed Headwater Elevation | 775.36 ft | Discharge | 561.00 cfs |
| Inlet Control HW Elev | 775.18 ft | Tailwater Elevation | 757.20 ft |
| Outlet Control HW Elev | 775.36 ft | Control Type | Entrance Control |

| Grades | | | |
|---|---|---|---|
| Upstream Invert | 762.00 ft | Downstream Invert | 755.50 ft |
| Length | 93.00 ft | Constructed Slope | 0.069892 ft/ft |

| Hydraulic Profile | | | |
|---|---|---|---|
| Profile | S2 | Depth, Downstream | 2.93 ft |
| Slope Type | Steep | Normal Depth | 2.18 ft |
| Flow Regime | Supercritical | Critical Depth | 4.00 ft |
| Velocity Downstream | 27.37 ft/s | Critical Slope | 0.022277 ft/ft |

| Section | | | |
|---|---|---|---|
| Section Shape | Box | Mannings Coefficient | 0.013 |
| Section Material | Concrete | Span | 7.00 ft |
| Section Size | 7 x 4 ft | Rise | 4.00 ft |
| Number Sections | 1 | | |

| Outlet Control Properties | | | |
|---|---|---|---|
| Outlet Control HW Elev | 775.36 ft | Upstream Velocity Head | 6.24 ft |
| Ke | 0.50 | Entrance Loss | 3.12 ft |

| Inlet Control Properties | | | |
|---|---|---|---|
| Inlet Control HW Elev | 775.18 ft | Flow Control | Submerged |
| Inlet Type | 18 to 33.7 ° wingwall flare, d=0.0830 | Area Full | 28.0 ft² |
| K | 0.48600 | HDS 5 Chart | 9 |
| M | 0.66700 | HDS 5 Scale | 2 |
| C | 0.02490 | Equation Form | 2 |
| Y | 0.83000 | | |

# COMPUTATION SHEET

RMT INC.

SHEET ____ OF ____

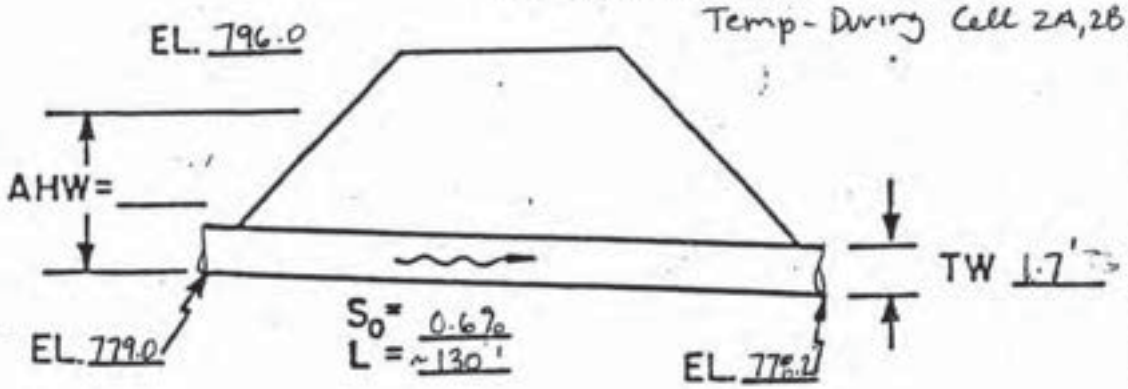
744 Heartland Trail P.O. Box 8923 Madison, WI 53708-8923 (608) 831-4444 FAX: (608) 831-3334

| PROJECT / PROPOSAL NAME | PREPARED By: | Date: | CHECKED By: | Date: | PROJECT/PROPOSAL NO. |
|---|---|---|---|---|---|
| Dairyland Power - Phase IV | BJT | 7/03 | | | 3061.56 |

## SKETCH

STATION: Culvert #2

Temp - During Cell 2A, 2B

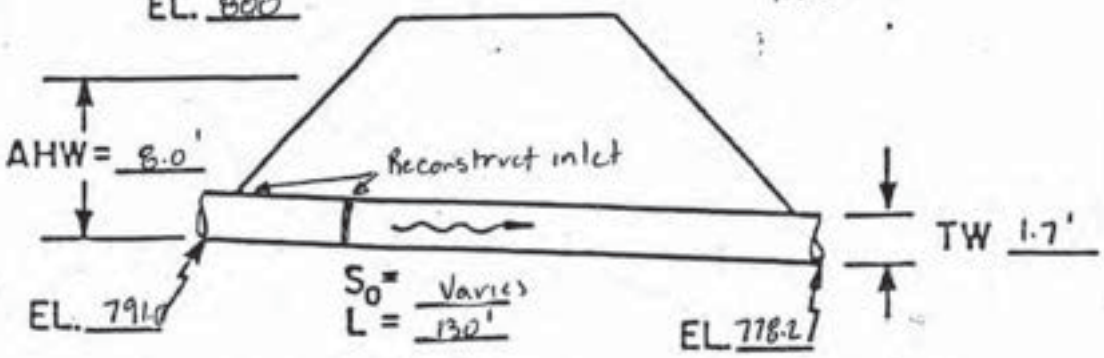



MAX. STREAM FLOW= 561 ~~323~~ cfs

## SKETCH

STATION: Culvert #2

Final




MAX. STREAM FLOW= 323 cfs

# Culvert Calculator Report
## Culvert 2 - Operational

Solve For: Headwater Elevation

| Culvert Summary | | | |
|---|---|---|---|
| Allowable HW Elevation | 796.00 ft | Headwater Depth/ Height | 3.86 |
| Computed Headwater Elevation | 794.45 ft | Discharge | 561.00 cfs |
| Inlet Control HW Elev | 792.30 ft | Tailwater Elevation | 779.90 ft |
| Outlet Control HW Elev | 794.45 ft | Control Type | Outlet Control |

| Grades | | | |
|---|---|---|---|
| Upstream Invert | 779.00 ft | Downstream Invert | 778.20 ft |
| Length | 130.00 ft | Constructed Slope | 0.006154 ft/ft |

| Hydraulic Profile | | | |
|---|---|---|---|
| Profile | Pressure | Depth, Downstream | 4.00 ft |
| Slope Type | N/A | Normal Depth | N/A ft |
| Flow Regime | N/A | Critical Depth | 4.00 ft |
| Velocity Downstream | 20.04 ft/s | Critical Slope | 0.022277 ft/ft |

| Section | | | |
|---|---|---|---|
| Section Shape | Box | Mannings Coefficient | 0.013 |
| Section Material | Concrete | Span | 7.00 ft |
| Section Size | 7 x 4 ft | Rise | 4.00 ft |
| Number Sections | 1 | | |

| Outlet Control Properties | | | |
|---|---|---|---|
| Outlet Control HW Elev | 794.45 ft | Upstream Velocity Head | 6.24 ft |
| Ke | 0.50 | Entrance Loss | 3.12 ft |

| Inlet Control Properties | | | |
|---|---|---|---|
| Inlet Control HW Elev | 792.30 ft | Flow Control | Submerged |
| Inlet Type | 18 to 33.7 " wingwall flare, d=0.0830 | Area Full | 28.0 ft² |
| K | 0.48600 | HDS 5 Chart | 9 |
| M | 0.66700 | HDS 5 Scale | 2 |
| C | 0.02490 | Equation Form | 2 |
| Y | 0.83000 | | |

# Culvert Calculator Report
## Culvert 2 - Final

Solve For: Headwater Elevation

| Culvert Summary | | | |
|---|---|---|---|
| Allowable HW Elevation | 799.00 ft | Headwater Depth/ Height | 1.78 |
| Computed Headwater Elevation | 798.10 ft | Discharge | 323.00 cfs |
| Inlet Control HW Elev | 797.44 ft | Tailwater Elevation | 779.90 ft |
| Outlet Control HW Elev | 798.10 ft | Control Type | Entrance Control |

| Grades | | | |
|---|---|---|---|
| Upstream Invert | 791.00 ft | Downstream Invert | 778.20 ft |
| Length | 130.00 ft | Constructed Slope | 0.098462 ft/ft |

| Hydraulic Profile | | | |
|---|---|---|---|
| Profile | S2 | Depth, Downstream | 1.60 ft |
| Slope Type | Steep | Normal Depth | 1.32 ft |
| Flow Regime | Supercritical | Critical Depth | 4.00 ft |
| Velocity Downstream | 28.87 ft/s | Critical Slope | 0.007385 ft/ft |

| Section | | | |
|---|---|---|---|
| Section Shape | Box | Mannings Coefficient | 0.013 |
| Section Material | Concrete | Span | 7.00 ft |
| Section Size | 7 x 4 ft | Rise | 4.00 ft |
| Number Sections | 1 | | |

| Outlet Control Properties | | | |
|---|---|---|---|
| Outlet Control HW Elev | 798.10 ft | Upstream Velocity Head | 2.07 ft |
| Ke | 0.50 | Entrance Loss | 1.03 ft |

| Inlet Control Properties | | | |
|---|---|---|---|
| Inlet Control HW Elev | 797.44 ft | Flow Control | Submerged |
| Inlet Type | 18 to 33.7 " wingwall flare, d=0.0830 | Area Full | 28.0 ft² |
| K | 0.48600 | HDS 5 Chart | 9 |
| M | 0.66700 | HDS 5 Scale | 2 |
| C | 0.02490 | Equation Form | 2 |
| Y | 0.83000 | | |

# COMPUTATION SHEET

RMT INC.
744 Heartland Trail P.O. Box 8923 Madison, WI 53708-8923 (608) 831-4444 FAX: (608) 831-3334

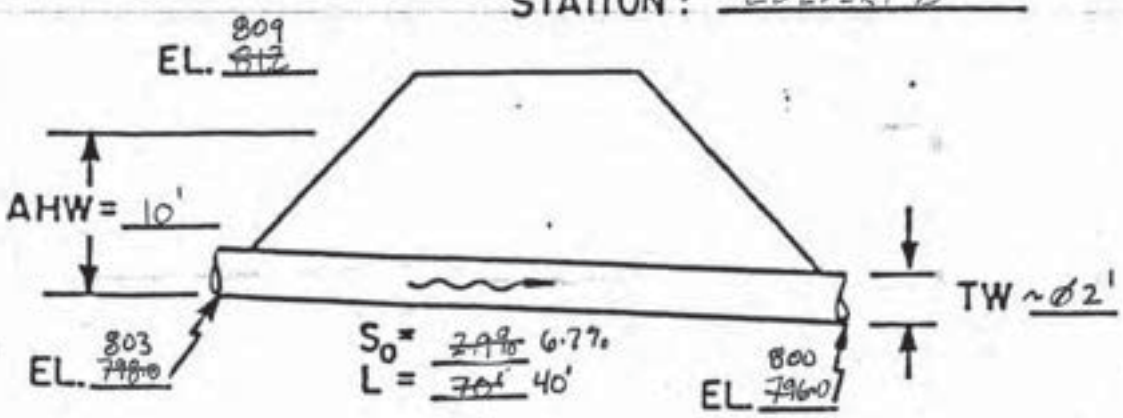
SHEET _____ OF _____

| PROJECT / PROPOSAL NAME | PREPARED By: | Date: | CHECKED By: | Date: | PROJECT/PROPOSAL NO. |
|---|---|---|---|---|---|
| DPC-PLAN OF OPERATION | AAA | 9/27/00 | | | 3081.4C |

RCV BJK 8/03

## SKETCH

STATION: CULVERT D




MAX. STREAM FLOW= ~~583 cfs~~ 228 CFS (25-YR) 360 CFS (100-YR)

# Culvert Calculator Report
## Culvert D - 25 Year

Solve For: Headwater Elevation

| Culvert Summary | | | |
|---|---|---|---|
| Allowable HW Elevation | 809.00 ft | Headwater Depth/ Height | 1.40 |
| Computed Headwater Elevation | 808.61 ft | Discharge | 228.00 cfs |
| Inlet Control HW Elev | 807.84 ft | Tailwater Elevation | 802.00 ft |
| Outlet Control HW Elev | 808.61 ft | Control Type | Entrance Control |

| Grades | | | |
|---|---|---|---|
| Upstream Invert | 803.00 ft | Downstream Invert | 800.00 ft |
| Length | 45.00 ft | Constructed Slope | 0.066667 ft/ft |

| Hydraulic Profile | | | |
|---|---|---|---|
| Profile | S2 | Depth, Downstream | 1.74 ft |
| Slope Type | Steep | Normal Depth | 1.19 ft |
| Flow Regime | Supercritical | Critical Depth | 3.21 ft |
| Velocity Downstream | 18.70 ft/s | Critical Slope | 0.003975 ft/ft |

| Section | | | |
|---|---|---|---|
| Section Shape | Box | Mannings Coefficient | 0.013 |
| Section Material | Concrete | Span | 7.00 ft |
| Section Size | 7 x 4 ft | Rise | 4.00 ft |
| Number Sections | 1 | | |

| Outlet Control Properties | | | |
|---|---|---|---|
| Outlet Control HW Elev | 808.61 ft | Upstream Velocity Head | 1.60 ft |
| Ke | 0.50 | Entrance Loss | 0.80 ft |

| Inlet Control Properties | | | |
|---|---|---|---|
| Inlet Control HW Elev | 807.84 ft | Flow Control | Submerged |
| Inlet Type | 18 to 33.7 ° wingwall flare, d=0.0830 | Area Full | 28.0 ft² |
| K | 0.48600 | HDS 5 Chart | 9 |
| M | 0.66700 | HDS 5 Scale | 2 |
| C | 0.02490 | Equation Form | 2 |
| Y | 0.83000 | | |

# Culvert Calculator Report
## Culvert D - 100 Year

Solve For: Headwater Elevation

| Culvert Summary | | | |
|---|---|---|---|
| Allowable HW Elevation | 809.00 ft | Headwater Depth/ Height | 1.96 |
| Computed Headwater Elevation | 810.85 ft | Discharge | 360.00 cfs |
| Inlet Control HW Elev | 810.30 ft | Tailwater Elevation | 802.00 ft |
| Outlet Control HW Elev | 810.85 ft | Control Type | Entrance Control |

| Grades | | | |
|---|---|---|---|
| Upstream Invert | 803.00 ft | Downstream Invert | 800.00 ft |
| Length | 45.00 ft | Constructed Slope | 0.066667 ft/ft |

| Hydraulic Profile | | | |
|---|---|---|---|
| Profile | S2 | Depth, Downstream | 2.52 ft |
| Slope Type | Steep | Normal Depth | 1.63 ft |
| Flow Regime | Supercritical | Critical Depth | 4.00 ft |
| Velocity Downstream | 20.38 ft/s | Critical Slope | 0.009174 ft/ft |

| Section | | | |
|---|---|---|---|
| Section Shape | Box | Mannings Coefficient | 0.013 |
| Section Material | Concrete | Span | 7.00 ft |
| Section Size | 7 x 4 ft | Rise | 4.00 ft |
| Number Sections | 1 | | |

| Outlet Control Properties | | | |
|---|---|---|---|
| Outlet Control HW Elev | 810.85 ft | Upstream Velocity Head | 2.57 ft |
| Ke | 0.50 | Entrance Loss | 1.28 ft |

| Inlet Control Properties | | | |
|---|---|---|---|
| Inlet Control HW Elev | 810.30 ft | Flow Control | Submerged |
| Inlet Type | 18 to 33.7 " wingwall flare, d=0.0830 | Area Full | 28.0 ft² |
| K | 0.48600 | HDS 5 Chart | 9 |
| M | 0.66700 | HDS 5 Scale | 2 |
| C | 0.02490 | Equation Form | 2 |
| Y | 0.83000 | | |

# Culvert Calculator Report
## Flume MH

Solve For: Headwater Elevation

| Culvert Summary | | | | | |
|---|---|---|---|---|---|
| | | → 827.5, adjacent pipe inlet | | | |
| Allowable HW Elevation | 8.00 | ft | Headwater Depth/ Height | 1.98 | |
| Computed Headwater Elevation | 825.18 | ft | Discharge | 73.00 | cfs |
| Inlet Control HW Elev | 825.18 | ft | Tailwater Elevation | 780.67 | ft |
| Outlet Control HW Elev | 824.72 | ft | Control Type | Inlet Control | |

| Grades | | | | | |
|---|---|---|---|---|---|
| Upstream Invert | 819.25 | ft | Downstream Invert | 779.00 | ft |
| Length | 185.00 | ft | Constructed Slope | 0.217568 | ft/ft |

| Hydraulic Profile | | | | | |
|---|---|---|---|---|---|
| Profile | S2 | | Depth, Downstream | 0.91 | ft |
| Slope Type | Steep | | Normal Depth | 0.86 | ft |
| Flow Regime | Supercritical | | Critical Depth | 2.70 | ft |
| Velocity Downstream | 40.57 | ft/s | Critical Slope | 0.006248 | ft/ft |

| Section | | | | | |
|---|---|---|---|---|---|
| Section Shape | Circular | | Mannings Coefficient | 0.010 | |
| Section Material | PVC | | Span | 3.00 | ft |
| Section Size | 36 inch | | Rise | 3.00 | ft |
| Number Sections | 1 | | | | |

| Outlet Control Properties | | | | | |
|---|---|---|---|---|---|
| Outlet Control HW Elev | 824.72 | ft | Upstream Velocity Head | 1.85 | ft |
| Ke | 0.50 | | Entrance Loss | 0.92 | ft |

| Inlet Control Properties | | | | | |
|---|---|---|---|---|---|
| Inlet Control HW Elev | 825.18 | ft | Flow Control | Submerged | |
| Inlet Type | Square edge w/headwall | | Area Full | 7.1 | $ft^2$ |
| K | 0.00980 | | HDS 5 Chart | 1 | |
| M | 2.00000 | | HDS 5 Scale | 1 | |
| C | 0.03980 | | Equation Form | 1 | |
| Y | 0.67000 | | | | |



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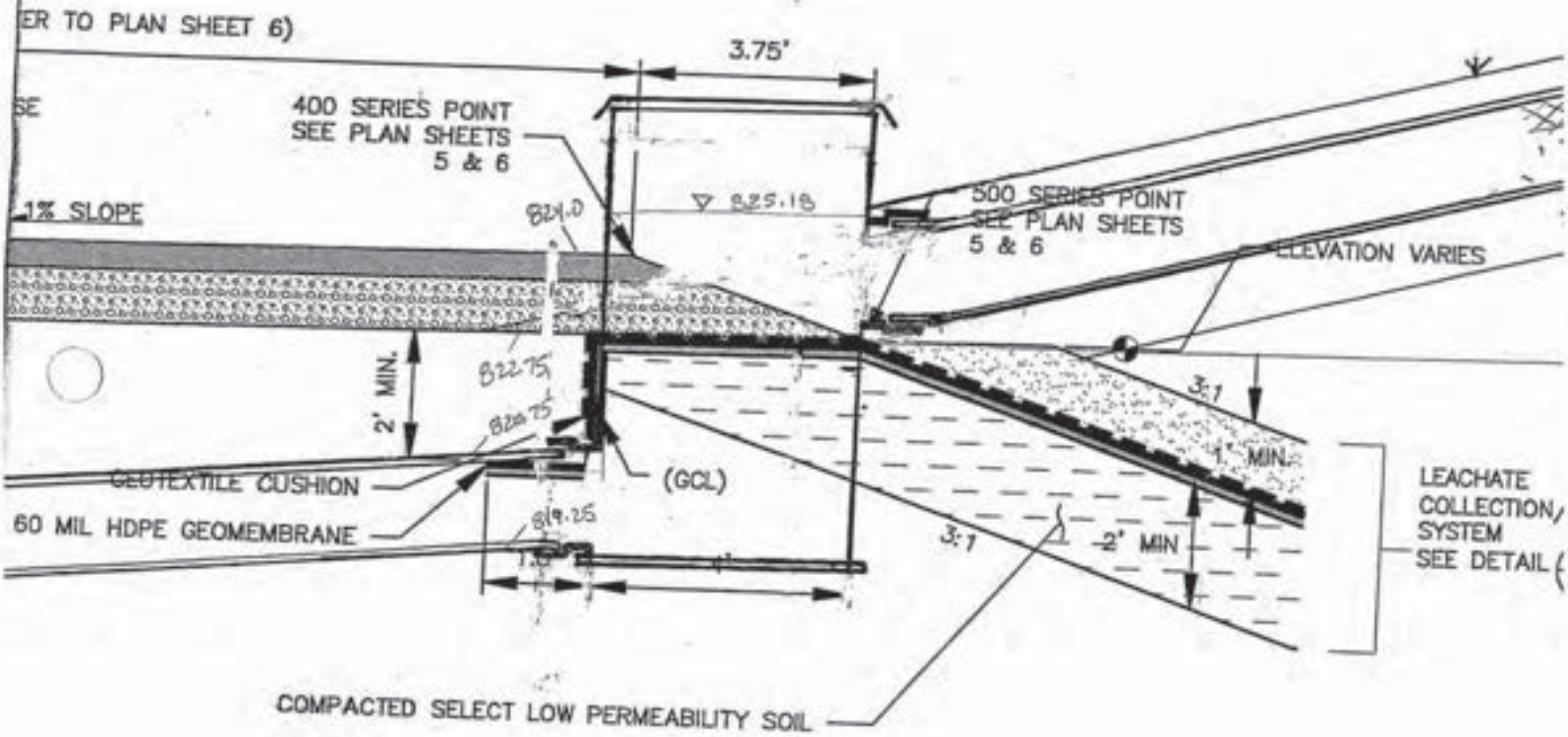
TURKEN SUPPLY
LARRY WOOD
262-255-3030
5/27/03

$65/ft × 7 VF BARREL
PLATE 1"

2,200 - 2,500 (incl. $500 for lid)

d flange
lid add $500



# COMPUTATION SHEET

RMT INC.

SHEET ____ OF ____

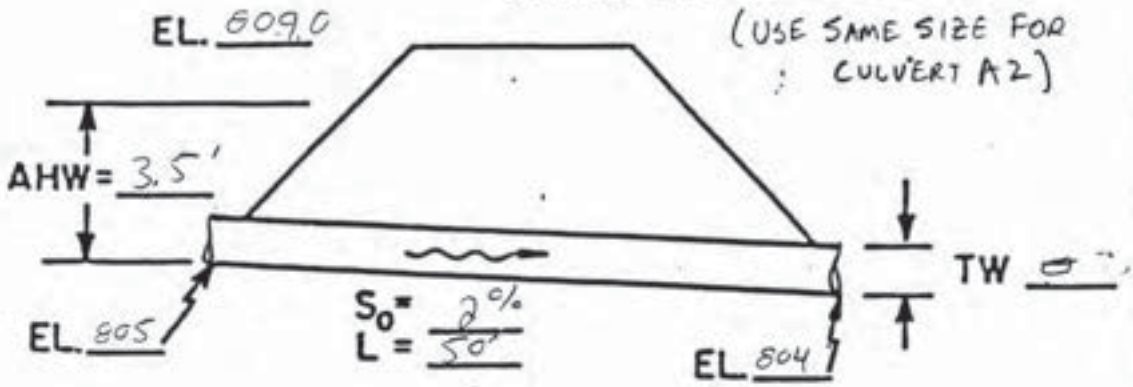
744 Heartland Trail P.O. Box 8923 Madison, WI 53708-8923 (608) 831-4444 FAX: (608) 831-3334

| PROJECT / PROPOSAL NAME | PREPARED By: SAA Date: 9/8/00 | CHECKED By: BJK Date: | PROJECT/PROPOSAL NO. |
|---|---|---|---|
| DPC - PLAN OF OPERATION | | | 3CE1.40 |

## SKETCH

STATION : CULVERT A1/A2

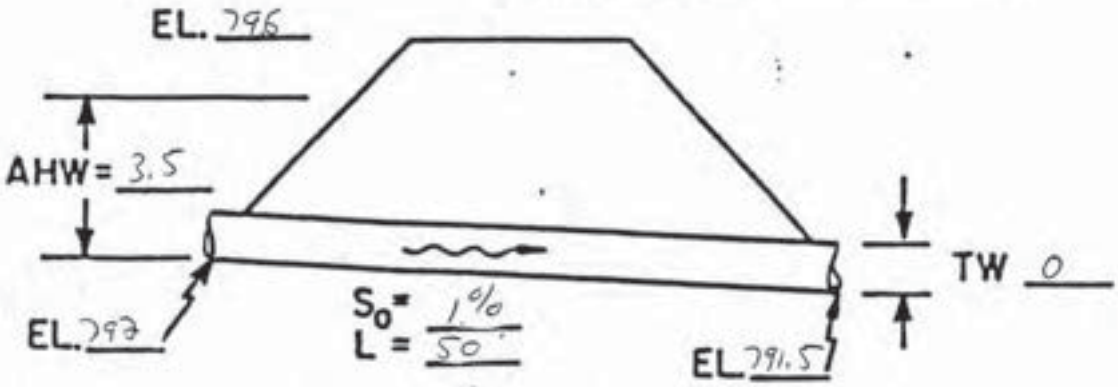
(USE SAME SIZE FOR CULVERT A2)




MAX. STREAM FLOW= 14 cfs.

## SKETCH

STATION : CULVERT B




MAX. STREAM FLOW= 11 cfs

# COMPUTATION SHEET

RMT INC.

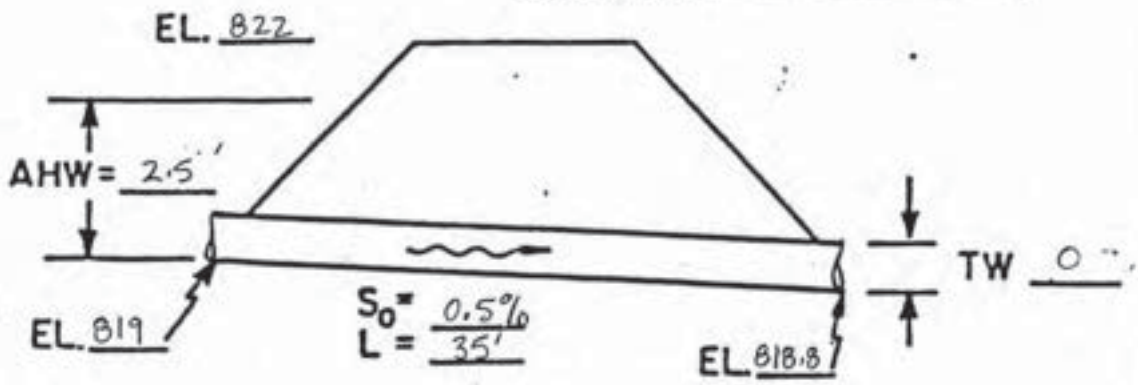
SHEET ____ OF ____

744 Heartland Trail P.O. Box 8923 Madison, WI 53708-8923 (608) 831-4444 FAX: (608) 831-3334

| PROJECT / PROPOSAL NAME | PREPARED By: | Date: | CHECKED By: | Date: | PROJECT/PROPOSAL NO. |
|---|---|---|---|---|---|
| DPC-PLAN OF OPERATION | JAA | 9/27/06 | | | 30E).4C |

## SKETCH

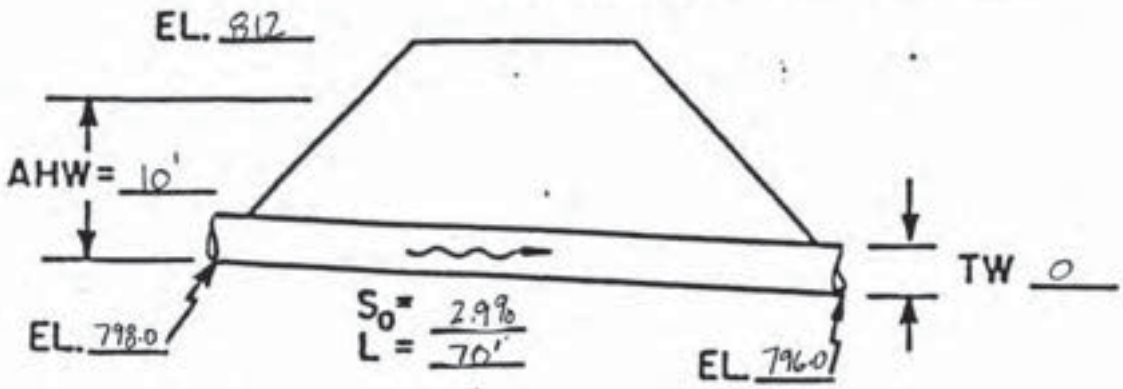
STATION : CULVERT C




MAX. STREAM FLOW= 6 cfs

## SKETCH

STATION : CULVERT D




MAX. STREAM FLOW= 583 cfs

# COMPUTATION SHEET

RMT INC.

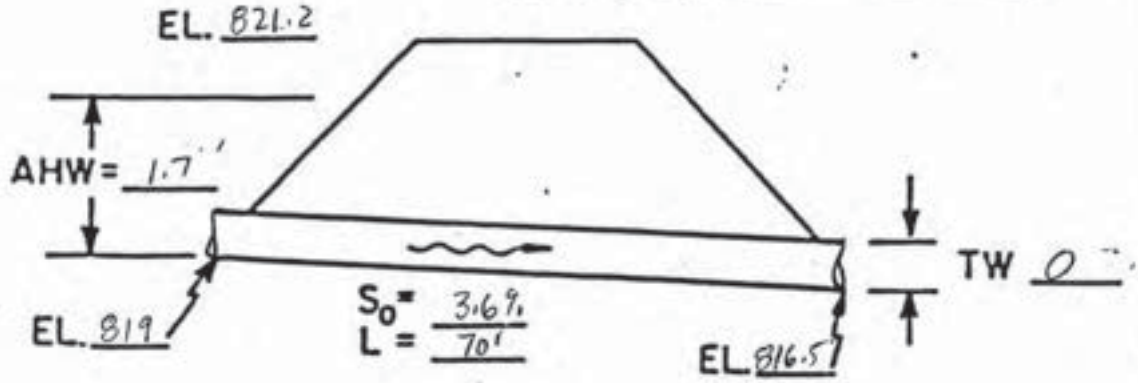
SHEET ____ OF ____

744 Heartland Trail P.O. Box 8923 Madison, WI 53708-8923 (608) 831-4444 FAX: (608) 831-3334

| PROJECT / PROPOSAL NAME | PREPARED By: | Date: | CHECKED By: | Date: | PROJECT/PROPOSAL NO. |
|---|---|---|---|---|---|
| DPC - PLAN OF OPERATION | [illegible] | 7/29/02 | | | 3C81.4C |

## SKETCH

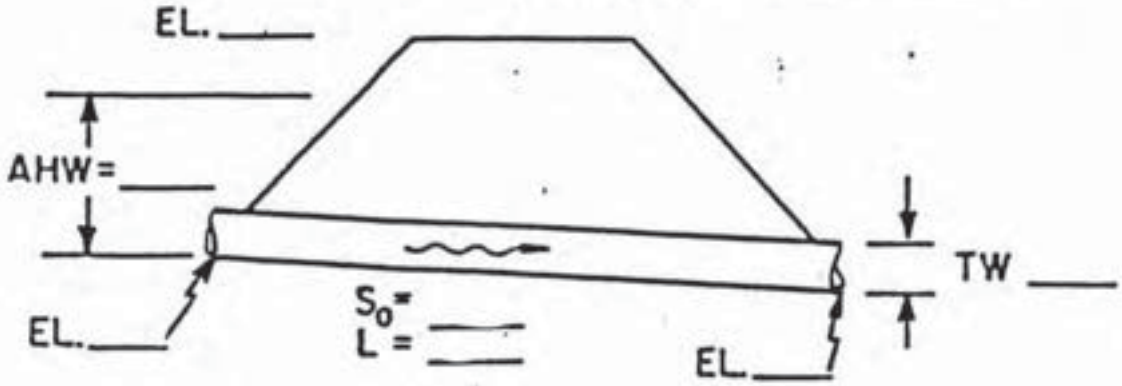
STATION : CULVERT E




MAX. STREAM FLOW= 7 cfs

## SKETCH

STATION : ____




MAX. STREAM FLOW= ____

PROJECT: DPC PCO

DESIGNER: BAA

DATE: 9/28/00

## HYDROLOGIC AND CHANNEL INFORMATION

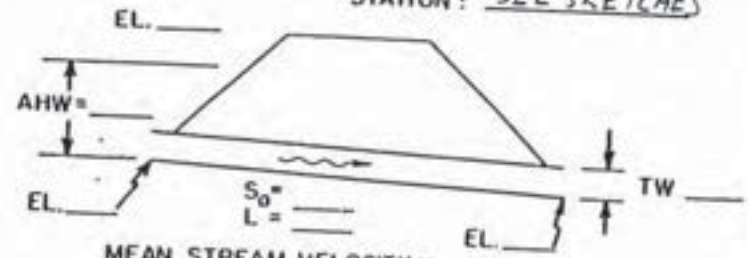
$Q_1$ = SEE SKETCHES  $TW_1$ = _____

$Q_2$ = _____  $TW_2$ = _____

( $Q_1$ = DESIGN DISCHARGE, SAY $Q_{25}$
$Q_2$ = CHECK DISCHARGE, SAY $Q_{50}$ OR $Q_{100}$ )

## SKETCH

STATION: SEE SKETCHES




MEAN STREAM VELOCITY = _____

MAX. STREAM VELOCITY = _____

| CULVERT DESCRIPTION (ENTRANCE TYPE) | Q | SIZE | HEADWATER COMPUTATION: INLET CONT. HW/D | INLET CONT. HW | OUTLET CONTROL HW=H+$h_o$−$LS_o$: $K_e$ | H | $d_c$ | $\frac{d_c+D}{2}$ | TW | $h_o$ | $LS_o$ | HW | CONTROLLING HW | OUTLET VELOCITY | COST | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CULVERT A CMP-PROJECTING | 14 | 24" | 1.15 | 2.3 | 0.9 | 1.3 | 1.4 | 1.7 | | 1.7 | 1 | 2 | 2.3 | | | OK |
| CULVERT A CONCRETE | 14 | 18" | 2 | 3 | 0.2 | 2.1 | 1.4 | 1.45 | | 1.45 | 1 | 2.55 | | | | OK |
| CULVERT B CMP | 11 | 24" | 1.0 | 2.0 | 0.9 | 0.8 | 1.2 | 1.6 | 0 | 1.6 | 1.0 | 1.4 | | | | RECOMMENDED |
| CULVERT C | 6 | 24" | .65 | 1.3 | 0.9 | 0.4 | 0.8 | 1.4 | 0 | 1.4 | 0.2 | 1.6 | | | | OK |

SUMMARY & RECOMMENDATIONS:

Figure 7

PROJECT: DPC POO

DESIGNER: BAA

DATE: 9/29/00

## HYDROLOGIC AND CHANNEL INFORMATION

$Q_1$ = SEE SKETCHES  $TW_1$ = _____

$Q_2$ = _____  $TW_2$ = _____

( $Q_1$ = DESIGN DISCHARGE, SAY $Q_{25}$
$Q_2$ = CHECK DISCHARGE, SAY $Q_{50}$ OR $Q_{100}$ )

## SKETCH

STATION: SEE SKETCHES

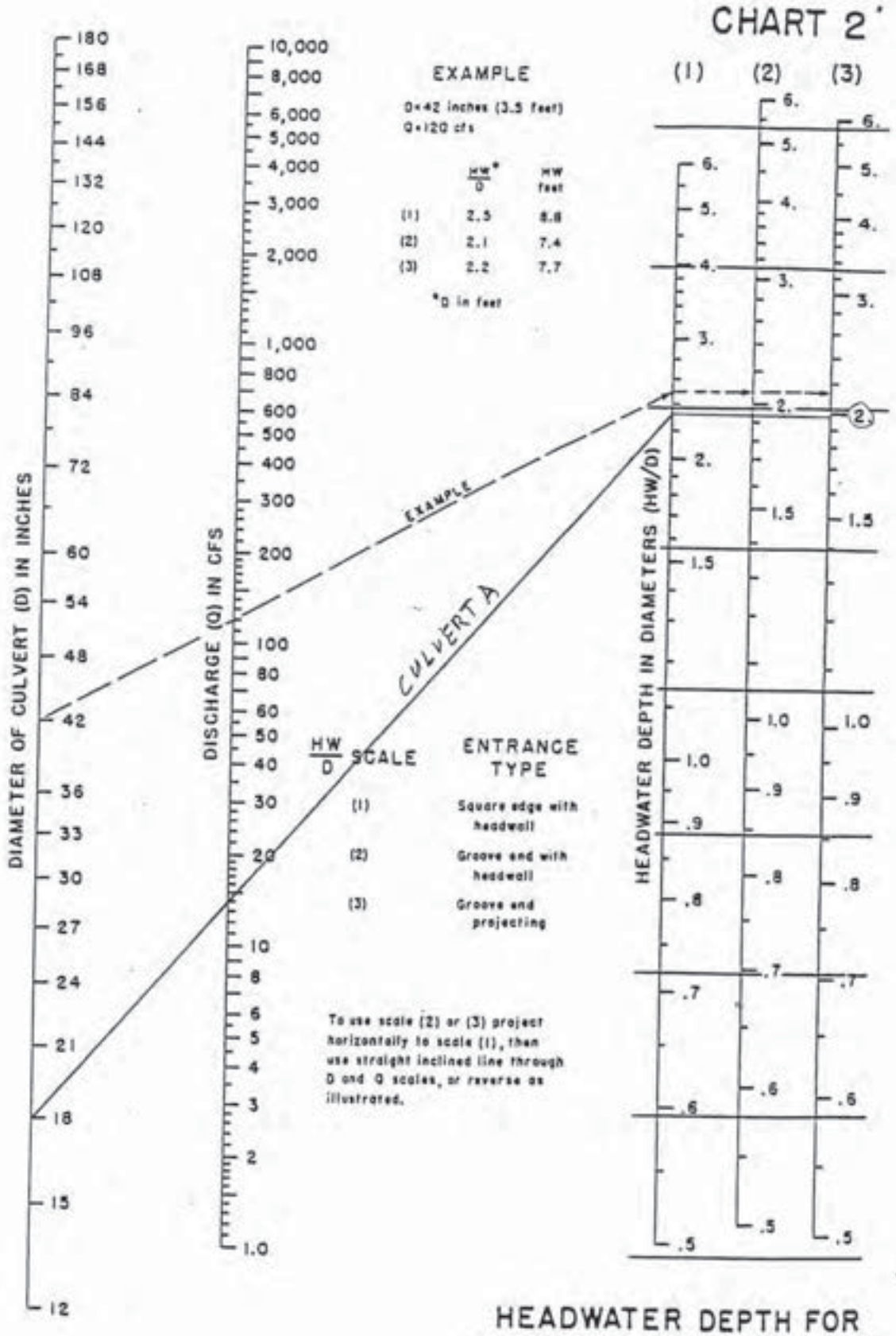
MEAN STREAM VELOCITY = _____

MAX. STREAM VELOCITY = _____

| CULVERT DESCRIPTION (ENTRANCE TYPE) | Q | SIZE | HEADWATER COMPUTATION: INLET CONT. $\frac{HW}{D}$ | HW | OUTLET CONTROL $HW = H + h_o - LS_o$: $K_e$ | H | $d_c$ | $\frac{d_c+D}{2}$ | TW | $h_o$ | $LS_o$ | HW | CONTROLLING HW | OUTLET VELOCITY | COST | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CULVERT E CMP-PROJECTING | 7 | 24" | 0.7 | 1.4 | 0.9 | 0.4 | 0.8 | 1.4 | 0 | 1.4 | 2.5 | — | 1.4 | | | OK |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| CULVERT D 7'X4' BOX | 583 | SAME FLOW AS PERMANENT CULVERTS 1, 2, and 5. | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |

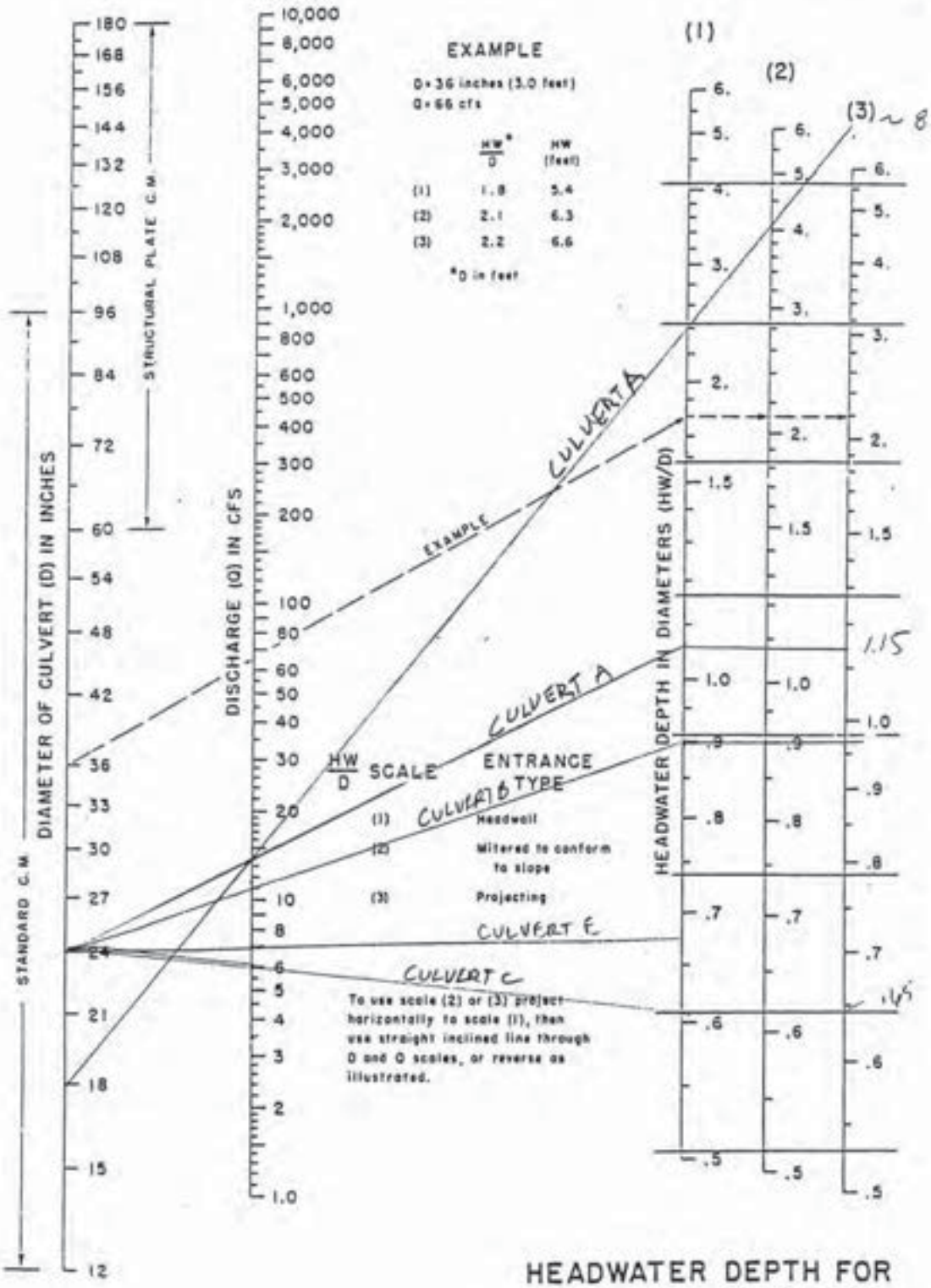
SUMMARY & RECOMMENDATIONS:

Figure 7



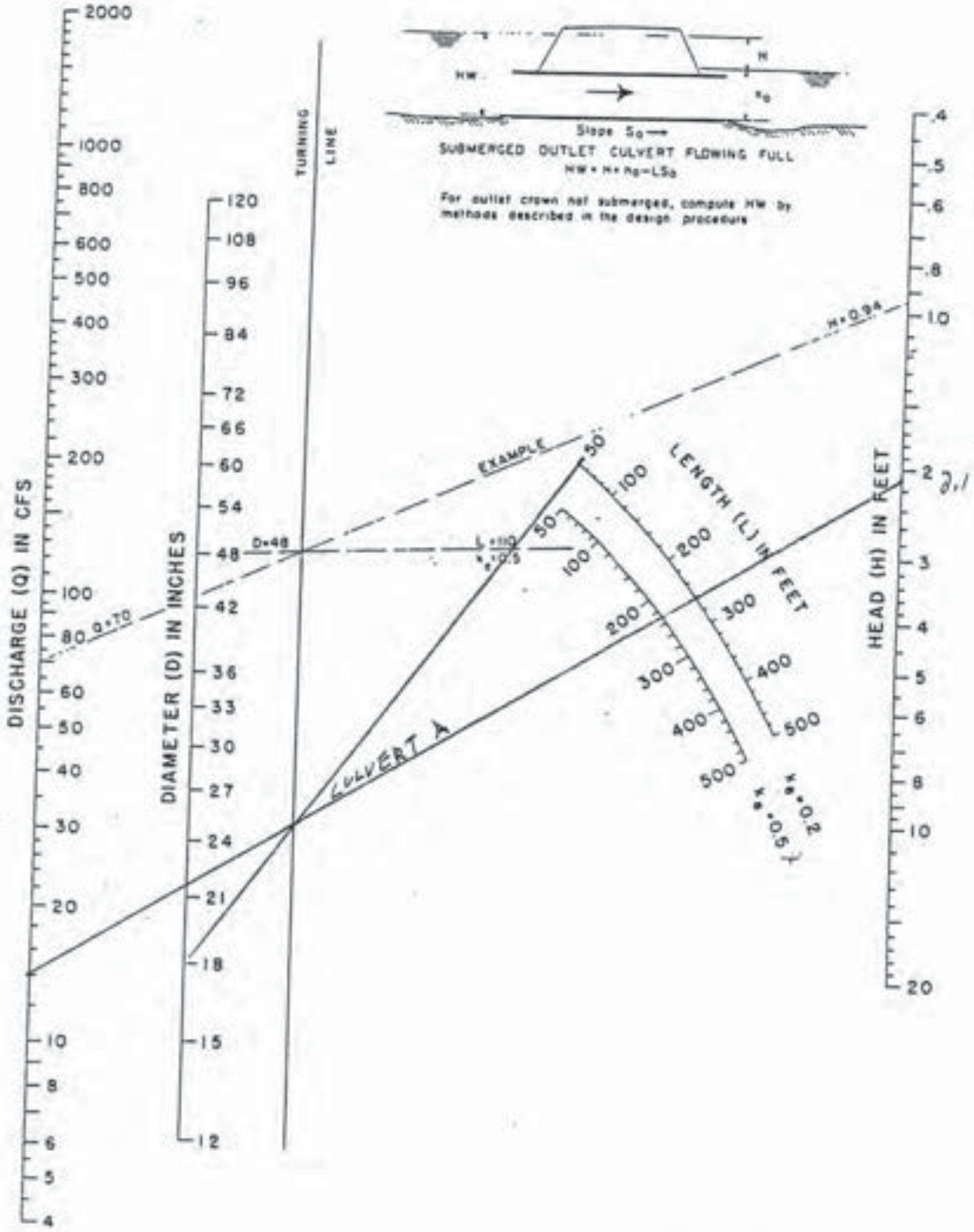

HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

# CHART 5



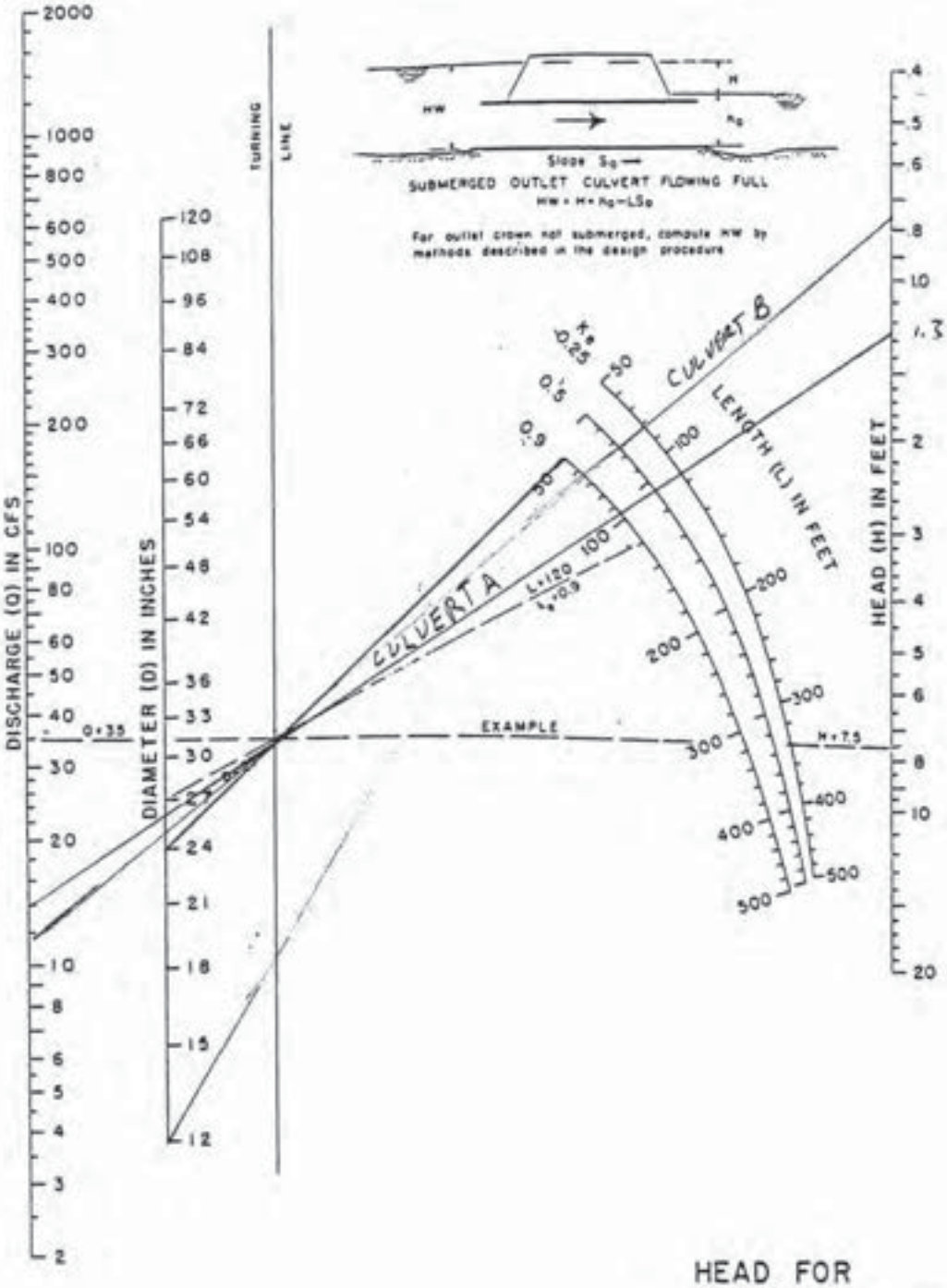

HEADWATER DEPTH FOR
C. M. PIPE CULVERTS
WITH INLET CONTROL

CHART 9



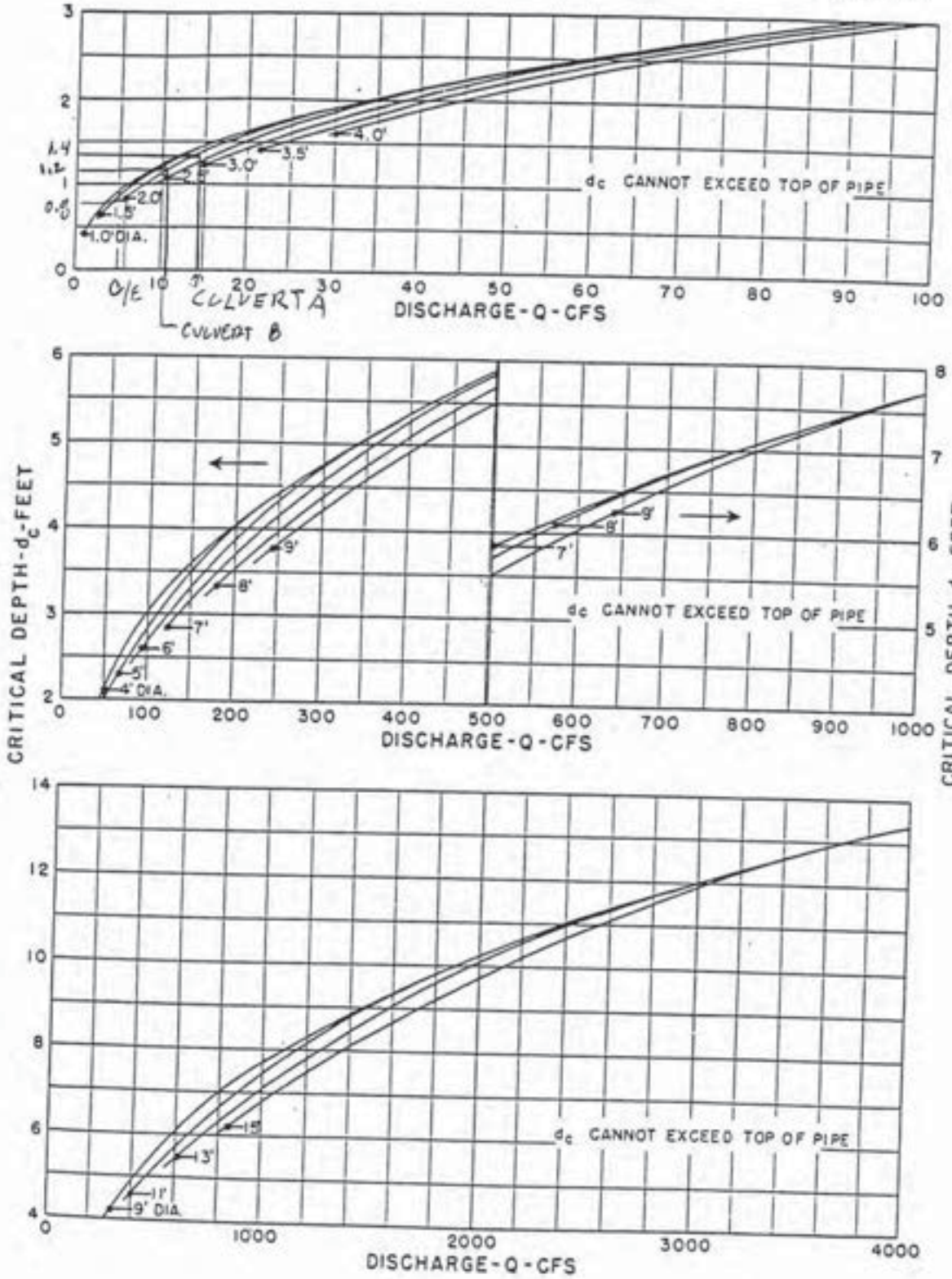

HEAD FOR
CONCRETE PIPE CULVERTS
FLOWING FULL
n = 0.012

# CHART 11




HEAD FOR
STANDARD
C. M. PIPE CULVERTS
FLOWING FULL
n = 0.024

CHART 16




# CRITICAL DEPTH
## CIRCULAR PIPE

## TABLE 1 - ENTRANCE LOSS COEFFICIENTS

Outlet Control, Full or Partly Full

Entrance head loss $H_e = k_e \frac{V^2}{2g}$

| Type of Structure and Design of Entrance | Coefficient $k_e$ |
|---|---|
| **Pipe, Concrete** | |
| Projecting from fill, socket end (groove-end) . . . | 0.2 |
| Projecting from fill, sq. cut end . . . . . | 0.5 |
| Headwall or headwall and wingwalls | |
| Socket end of pipe (groove-end) . . . . . | 0.2 |
| Square-edge . . . . . | 0.5 |
| Rounded (radius = 1/12D) . . . . . | 0.2 |
| Mitered to conform to fill slope . . . . . | 0.7 |
| *End-Section conforming to fill slope . . . . . | 0.5 |
| Beveled edges, 33.7° or 45° bevels . . . . . | 0.2 |
| Side-or slope-tapered inlet . . . . . | 0.2 |
| **Pipe, or Pipe-Arch, Corrugated Metal** | |
| Projecting from fill (no headwall) . . . . . | 0.9 |
| Headwall or headwall and wingwalls square-edge . . | 0.5 |
| Mitered to conform to fill slope, paved or unpaved slope . . . . . | 0.7 |
| *End-Section conforming to fill slope . . . . . | 0.5 |
| Beveled edges, 33.7° or 45° bevels . . . . . | 0.2 |
| Side-or slope-tapered inlet . . . . . | 0.2 |
| **Box, Reinforced Concrete** | |
| Headwall parallel to embankment (no wingwalls) | |
| Square-edged on 3 edges . . . . . | 0.5 |
| Rounded on 3 edges to radius of 1/12 barrel dimension, or beveled edges on 3 sides . . . | 0.2 |
| Wingwalls at 30° to 75° to barrel | |
| Square-edged at crown . . . . . | 0.4 |
| Crown edge rounded to radius of 1/12 barrel dimension, or beveled top edge . . . . . | 0.2 |
| Wingwall at 10° to 25° to barrel | |
| Square-edged at crown . . . . . | 0.5 |
| Wingwalls parallel (extension of sides) | |
| Square-edged at crown . . . . . | 0.7 |
| Side-or slope-tapered inlet . . . . . | 0.2 |

*Note: "End Section conforming to fill slope," made of either metal or concrete, are the sections commonly available from manufacturers. From limited hydraulic tests they are equivalent in operation to a headwall in both inlet and outlet control. Some end sections, incorporating a closed taper in their design have a superior hydraulic performance. These latter sections can be designed using the information given for the beveled inlet, p. 5-13.

# Vegetation Information

✓BLG 10/6/98

**********

NORTH AMERICAN GREEN - ECMDS VER.IV - SLOPE PROTECTION - ENGLISH
USER SPECIFIED - PERMANENT PROTECTION RESULTS

**********

PROJECT NAME: Dairyland Power Coop. PROJECT NO.: 3081.33
COMPUTED BY: BJK DATE: 10-06-1998
SLOPE DESCRIPTION: 2:1 Slopes

---

Slope Gradient: 2.00:1 ✓ Slope Length: 50 feet ✓
Soil Type: Clay Loam (K= 0.21) ✓ Annual R Factor: 125.0 ✓

| Slope Reach feet | Material | Type | Density | LS | C |
|---|---|---|---|---|---|
| 0 - 30 | Est. Veg. | Mix | 75-95% | 4.10 | .020 |
| 30 - 50 | P300 | Mix | 75-95% | 7.35 | .002 |

| Slope Reach feet | Material | Type | Density | ASLbare inch | ASLmat inch | SLT inch | Sf | Recommend |
|---|---|---|---|---|---|---|---|---|
| 0 - 30 | Est. Veg. | Mix | 75-95% | 0.641 | 0.013 | 0.03 | 2.3 | STABLE |
| 30 - 50 | P300 | Mix | 75-95% | 1.149 | 0.002 | 0.03 | 13.1 | STABLE |
| 0 - 50 | Composite | | | 0.844 | 0.009 | | | |

← For Slope's 0'-30' use Mix No. 20 Vegetation

For slopes >30', use permanant erosion matting on bottom portion of slope (below 30') And No. 20 Vegetation on upper portion

Vegetation Density=Percentage of soil coverage provided by vegetation
C=Cover material performance factor (Fraction of soil loss of unprotected)
ASLbare=Average Soil Loss potential of unprotected soil (uniform inches)
ASLmat=Average Soil Loss potential w/material (uniform inches)
SLT=Soil Loss Tolerance for slope segment (uniform inches)
Sf=Safety Factor
Composite=Average soil loss from total slope length (uniform inches)

---

- See Attached For Vegetation Types

| Species Common Name | Species Botanical Name | Acceptable Varieties |
|---|---|---|
| Kentucky Bluegrass | Poa pratensis | |
| Red Fescue | Festuca rubra | Creeping |
| Hard Fescue | Festuca ovina var. duriuscula | Improved |
| Tall Fescue | Festuca arundinacea | Improved turf type |
| Salt Grass | Puccinella distans | Fult's |
| Redtop | Agrostis alba | |
| Timothy | Phleum pratense | |
| Little Bluestem* | Andropogon scoparius | |
| Sideoats Grama* | Bouteloua curtipendula | |
| Canada Wild Rye* | Elymus canadensis | |
| Perennial Ryegrass | Lolium perenne | |
| Perennial Ryegrass | Lolium perenne | Improved Fine |
| Annual Ryegrass | Lolium multiflorum | |
| Alsike Clover | Trifolium hybridum | |
| Red Clover | Trifolium pratense | |
| White Clover | Trifolium repens | |
| Birdsfoot Trefoil | Lotus corniculatus | Empire |
| Japanese Millet | Echinochola crusgalli var. frumentacea | |
| Annual Oats | Avena sativa | |
| Alfalfa | Medicago sativa | |
| Bromegrass | Bromus inermis | |
| Orchardgrass | Dactylis glomerata | |
| Ladino Clover | Trifolium repens var. latum | Ladino |
| Agricultural Rye | Secale cereale | |
| Winter Wheat | Triticum aestivum | |

*Pure Live Seed



| Species | Purity Min. % | Germination min. % | Mixture Proportions, Percent | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Ditches No. 10 | Slopes No. 20 | No. 30 | No. 40 | No. 50 | No. 60 | No. 70 |
| Kentucky Bluegrass | 85 | 80 | 40 | 6 | 10 | 35 | | | |
| Red Fescue | 97 | 85 | 25 | | 30 | 20 | | | |
| Hard Fescue | 97 | 85 | | 24 | 25 | 20 | | | 10 |
| Tall Fescue | 98 | 85 | | 40 | | | | | 25 |
| Salt Grass | 98 | 85 | | | 10 | | | | |
| Redtop | 92 | 85 | 5 | | | | | | |
| Timothy | 98 | 90 | | | | | | 12 | |
| Little Bluestem | | PLS* | | | | | | | 15 |
| Sideoats Grama | | PLS* | | | | | | | 15 |
| Canada Wild Rye | | PLS* | | | | | | 12 | 5 |
| Perennial Ryegrass | 97 | 90 | 20 | 30 | | | | | 30 |
| Improved Fine Perennial Ryegrass | 96 | 85 | | | 15 | 25 | | | |
| Annual Ryegrass | 97 | 90 | | | | | | 35 | |
| Alsike Clover | 97 | 90 | | | | | | 4 | |
| Red Clover | 98 | 90 | | | | | | 4 | |
| White Clover | 95 | 90 | 10 | | | | | | |
| Birdsfoot Trefoil | 95 | 80 | | | 10 | | 100 | | |
| Japenese Millet | 97 | 85 | | | | | | 8 | |
| Annual Oats* | 98 | 90 | | | | | | 25 | |

* Substitute winter wheat for annual oats in fall plantings started after September 1.

**630.2.1.5.1.1.2 Mixture to be Used.** The selection of the seed mixture or mixtures for use on the project shall meet with the approval of the engineer, and unless otherwise provided in the contract, shall be in accordance with the following:

Seed Mixture No. 10 is intended for use on projects where average loam, heavy clay or moist soils predominate.

Seed Mixture No. 20 is intended for use on projects where light, dry, well-drained, sandy or gravelly soils predominate and shall be used for all high cut and fill slopes (generally exceeding 1.8 to 2.4 m), except where No. 70 is used.

STATE OF WISCONSIN
DEPARTMENT OF TRANSPORTATION

# STANDARD SPECIFICATIONS

FOR

# HIGHWAY AND STRUCTURE CONSTRUCTION

1996 EDITION

RMT
LIBRARY
86-00019-23
FEB 0 3 1997

```
****************************************
*****     VEGETATION SELECTION     *****
*****     North American Green     *****
****************************************
```

Region Number: 1

Predominant Soil Type: Clay - Clay Loam

Moisture Regime Conditions: Normal Moisture

Planned Maintenance: Medium - High Maintenance

| | Longevity | Growth Habit | Seed Rate lb/ac | kg/ha | |
|---|---|---|---|---|---|
| **Grasses** | | | | | |
| Tall Fescue (Festuca arundinacea) | P | B | 200 | 224 | (No. 20) |
| Chewings Fescue (Festuca rubra, commutata) | P | B | 120 | 134 | (No. 10) |
| Kentucky Bluegrass (Poa pratensis) | P | S | 80 | 90 | (No 10, No. 20) |
| Perennial Ryegrass (Lolium perenne) | P | B | 160 | 179 | (No. 10, No 20) |
| Annual Ryegrass (Lolium multiflorum) | A | B | 160 | 179 | |
| Orchardgrass (Dactylis glomerata) | P | B | 40 | 45 | |
| Timothy (Phleum pratense) | P | B | 80 | 90 | |
| Creeping Red Fescue (Festuca rubra) | P | S | 120 | 134 | |
| **Legumes** | | | | | |
| Alsike Clover (Trifolium hybridum) | P | | 15 | 17 | |
| White Dutch Clover (Trifolium repens) | P | | 5 | 6 | |
| White Sweet Clover (Melilotus alba) | P | | 15 | 17 | |

# Appendix B: Surface Water Run-Off Control System Calculations

- Leachate Storage Capacity for the 25-Year 24-Hour Storm Event
- References

# Leachate Storage Capacity for the 25-Year 24-Hour Storm Event

| PROJECT / LOCATION: DPC: Alma Offsite Disposal Facility, Phase IV Landfill | | PROJECT / PROPOSAL NO. |
|---|---|---|
| SUBJECT: Active Area Leachate Disposal Capacity | | 421717.0000 |
| PREPARED BY: B. Kahnk | DATE: 4/27/2021 | FINAL X |
| CHECKED BY: J. Hotstream | DATE: 4/29/2021 | REVISION X |

Purpose: Determine the leachate storage capacity from a 25 year, 24-hour storm event during the critical leachate generation scenario.

Assumptions:
1. Critical leachate generation scenario occurs during the current condition with approximately 12.7 acres are operational (Portions of Cell 2 and the entirety of Cell 3) and approximately 7.6 acres have final cover. (See Figure 1 for this scenario).

2. The 25 year, 24-hour storm event is 5.40 inches (refer to attached sheet).

3. No portion of the leachate drainage layer within the open area is saturated.

4. The leachate drainage sand has a porosity of 30 percent. The bottom ash has a porosity of 25 percent.

5. The minimum thickness of the drainage layer is 1.0 foot.

6. A minimum of 1 foot of bottom ash was installed above the drainage layer in Cell 2A over an area of approximately 2.3 acres.

7.A minimum of 4 feet of bottom ash was installed above the drainage layer during the Cell 3A construction. Using a maximum elevation of 820 feet, this bottom ash covers an area of approximately 2.75 acres.

Method:
1. Determine the volume of rain collected in the open areas during the critical condition from a 25 year, 24-hour storm event.

2. Calculate the available storage volume for leachate in the drainage layer. Due to the slope of the landfill perimeter berm, the capacity of the drainage layer is based on the area of the drainage layer at or below an elevation of 820 feet. Elevation 820 represents the lowest top of berm base grade elevation documented during construction of Cell 3A (refer to attached base grades sheet).

3. The available storage volume within the pipe trenches, transfer piping, and leachate collection tank is ignored.

4. Calculate the available storage volume for leachate in the 4 feet of bottom ash placed above the drainage layer during Cell 3A construction and 1 foot of bottom ash placed above the drainage layer during Cell 2A construction.

5. Calculate the volume of storage required for the 25 year, 24-hour storm event.

| | | |
|---|---|---|
| PROJECT / LOCATION: DPC: Alma Offsite Disposal Facility, Phase IV Landfill | | PROJECT / PROPOSAL NO. |
| SUBJECT: Active Area Leachate Disposal Capacity | | 421717.0000 |
| PREPARED BY: B. Kahnk | DATE: 4/27/2021 | FINAL X |
| CHECKED BY: J. Hotstream | DATE: 4/29/2021 | REVISION |

Step 1. Determine volume of run-off collected during the 25 year, 24-hour storm event

Area: 12.7 acres - Area open (portions of Cell 2 and the entirety of Cell 3)

Rain Event: 5.43 inches

$$Runoff\ Volume(ft^3): Rain\ Event\ (inches) \times \frac{1ft}{12\ inches} \times Area\ (acres) \times \frac{43{,}560\ ft^2}{1\ acre}$$

Runoff Volume: 250,328 cubic feet

Step 2. Calculate the available storage volume for leachate in the drainage layer.

Area: 9.2 acres - see attached base grades plan
Thickness: 1 foot
Porosity: 0.3

$$Storage\ Capacity(ft^3): Area\ (acres) \times \frac{43{,}560\ ft^2}{1\ acre} \times Thickness\ (foot) \times Porosity$$

Storage Capacity: 120,226 cubic feet

Step 3. Ignore storage in pipe trenches, transfer piping and leachate collection tank

Step 4. Calculate the available storage volume in the bottom ash placed above the drainage layer

| Cell 2A: | | Cell 3A: | |
|---|---|---|---|
| Area: | 2.3 acre(s) | Area: | 2.75 acre(s) |
| Thickness: | 1 feet | Thickness: | 4 feet |
| Porosity: | 0.25 | Porosity: | 0.25 |

$$Storage\ Capacity(ft^3): Area\ (acres) \times \frac{43{,}560\ ft^2}{1\ acre} \times Thickness\ (foot) \times Porosity$$

| Cell 2A: | | Cell 3A: | |
|---|---|---|---|
| Storage Capacity: | 25,047 cubic feet | Storage Capacity: | 119,790 cubic feet |

Total Storage Capacity (Cell 2A + Cell 3A): 144,837 cubic feet

| | | |
|---|---|---|
| PROJECT / LOCATION: DPC: Alma Offsite Disposal Facility, Phase IV Landfill | | PROJECT / PROPOSAL NO. |
| SUBJECT: Active Area Leachate Disposal Capacity | | 421717.0000 |
| PREPARED BY: B. Kahnk | DATE: 4/27/2021 | FINAL X |
| CHECKED BY: J. Hotstream | DATE: 4/29/2021 | REVISION |

Step 5. Calculate the storage required for the 25 year, 24-hour storm event.

Required Storage:

$$Required\ Storage = Run\ Off\ Volume - Drainage\ Layer\ Capacity\ - Bottom\ Ash\ Capacity$$

| | | |
|---|---|---|
| Run-Off Volume: | 250,328 | cubic feet from Step 1 |
| Drainage Layer: | 120,226 | cubic feet, from Step 2 |
| Bottom Ash: | 144,837 | cubic feet from Step 4 |
| Required Storage: | -14,734 | cubic feet |

The negative required storage calculated above indicates that there is sufficient storage capacity in the leachate collection drainage layer and the bottom ash that was placed in the cells above the drainage layer to contain the runoff from a 25 year, 24-hour storm event.

# References

**NOAA Atlas 14, Volume 8, Version 2**
**Location name: Alma, Wisconsin, US***
**Latitude: 44.3657°, Longitude: -91.9171°**
**Elevation: 1074 ft***
* source: Google Maps

## POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffery Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

### PF tabular

**PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]**

| Duration | Average recurrence interval (years) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 5 | 10 | 25 | 50 | 100 | 200 | 500 | 1000 |
| 5-min | 0.366 (0.300-0.455) | 0.436 (0.357-0.543) | 0.555 (0.453-0.692) | 0.657 (0.532-0.822) | 0.801 (0.626-1.03) | 0.915 (0.697-1.20) | 1.03 (0.757-1.38) | 1.16 (0.809-1.58) | 1.32 (0.887-1.85) | 1.45 (0.946-2.06) |
| 10-min | 0.536 (0.439-0.666) | 0.639 (0.523-0.795) | 0.813 (0.663-1.01) | 0.962 (0.779-1.20) | 1.17 (0.917-1.52) | 1.34 (1.02-1.75) | 1.51 (1.11-2.02) | 1.69 (1.19-2.31) | 1.94 (1.30-2.71) | 2.13 (1.39-3.02) |
| 15-min | 0.653 (0.535-0.812) | 0.779 (0.638-0.969) | 0.991 (0.809-1.24) | 1.17 (0.950-1.47) | 1.43 (1.12-1.85) | 1.64 (1.25-2.14) | 1.84 (1.35-2.46) | 2.06 (1.45-2.82) | 2.36 (1.58-3.31) | 2.59 (1.69-3.68) |
| 30-min | 0.908 (0.744-1.13) | 1.09 (0.894-1.36) | 1.40 (1.14-1.74) | 1.66 (1.34-2.08) | 2.03 (1.58-2.62) | 2.32 (1.76-3.03) | 2.62 (1.92-3.49) | 2.92 (2.05-4.00) | 3.34 (2.24-4.68) | 3.66 (2.39-5.19) |
| 60-min | 1.19 (0.978-1.48) | 1.42 (1.16-1.77) | 1.82 (1.48-2.27) | 2.17 (1.76-2.72) | 2.69 (2.12-3.51) | 3.13 (2.39-4.11) | 3.58 (2.63-4.81) | 4.07 (2.86-5.60) | 4.76 (3.20-6.70) | 5.31 (3.46-7.53) |
| 2-hr | 1.48 (1.22-1.82) | 1.75 (1.44-2.15) | 2.23 (1.84-2.76) | 2.68 (2.19-3.33) | 3.36 (2.67-4.37) | 3.94 (3.04-5.15) | 4.55 (3.38-6.09) | 5.22 (3.70-7.15) | 6.18 (4.20-8.66) | 6.96 (4.57-9.80) |
| 3-hr | 1.67 (1.38-2.04) | 1.95 (1.62-2.39) | 2.48 (2.05-3.05) | 2.99 (2.46-3.69) | 3.79 (3.04-4.93) | 4.48 (3.48-5.86) | 5.24 (3.92-7.00) | 6.07 (4.33-8.31) | 7.28 (4.97-10.2) | 8.28 (5.46-11.6) |
| 6-hr | 1.96 (1.64-2.38) | 2.28 (1.91-2.77) | 2.90 (2.41-3.53) | 3.50 (2.90-4.28) | 4.47 (3.63-5.79) | 5.32 (4.18-6.93) | 6.27 (4.73-8.33) | 7.32 (5.27-9.96) | 8.86 (6.11-12.3) | 10.1 (6.74-14.1) |
| 12-hr | 2.23 (1.88-2.68) | 2.59 (2.18-3.12) | 3.29 (2.76-3.96) | 3.96 (3.30-4.79) | 5.02 (4.10-6.43) | 5.96 (4.71-7.68) | 6.99 (5.31-9.21) | 8.13 (5.90-11.0) | 9.80 (6.81-13.5) | 11.2 (7.49-15.5) |
| 24-hr | 2.53 (2.15-3.01) | 2.91 (2.47-3.46) | 3.63 (3.07-4.33) | 4.33 (3.64-5.19) | 5.43 (4.47-6.89) | 6.40 (5.10-8.17) | 7.46 (5.72-9.75) | 8.65 (6.33-11.6) | 10.4 (7.26-14.2) | 11.8 (7.97-16.2) |
| 2-day | 2.94 (2.52-3.46) | 3.29 (2.81-3.87) | 3.97 (3.39-4.69) | 4.65 (3.94-5.53) | 5.76 (4.79-7.25) | 6.75 (5.44-8.56) | 7.86 (6.08-10.2) | 9.10 (6.72-12.1) | 10.9 (7.72-14.9) | 12.5 (8.48-17.0) |
| 3-day | 3.23 (2.79-3.79) | 3.58 (3.08-4.19) | 4.26 (3.65-5.01) | 4.95 (4.21-5.84) | 6.07 (5.07-7.59) | 7.07 (5.72-8.91) | 8.19 (6.37-10.6) | 9.45 (7.01-12.5) | 11.3 (8.02-15.3) | 12.8 (8.79-17.5) |
| 4-day | 3.48 (3.00-4.05) | 3.85 (3.32-4.49) | 4.57 (3.93-5.35) | 5.28 (4.51-6.21) | 6.42 (5.37-7.98) | 7.43 (6.03-9.31) | 8.55 (6.67-11.0) | 9.81 (7.30-12.9) | 11.6 (8.29-15.7) | 13.2 (9.04-17.9) |
| 7-day | 4.09 (3.56-4.73) | 4.59 (3.99-5.31) | 5.48 (4.75-6.37) | 6.30 (5.42-7.35) | 7.54 (6.31-9.20) | 8.58 (6.97-10.6) | 9.70 (7.58-12.3) | 10.9 (8.15-14.2) | 12.6 (9.03-16.9) | 14.0 (9.70-19.0) |
| 10-day | 4.64 (4.05-5.34) | 5.24 (4.57-6.03) | 6.27 (5.45-7.24) | 7.17 (6.20-8.32) | 8.50 (7.11-10.3) | 9.58 (7.80-11.7) | 10.7 (8.39-13.4) | 11.9 (8.91-15.4) | 13.6 (9.73-18.1) | 14.9 (10.4-20.1) |
| 20-day | 6.27 (5.53-7.14) | 7.04 (6.19-8.02) | 8.32 (7.29-9.51) | 9.40 (8.19-10.8) | 10.9 (9.19-13.0) | 12.1 (9.95-14.7) | 13.4 (10.6-16.6) | 14.7 (11.0-18.7) | 16.4 (11.8-21.6) | 17.7 (12.4-23.7) |
| 30-day | 7.70 (6.82-8.72) | 8.60 (7.61-9.75) | 10.1 (8.89-11.5) | 11.3 (9.91-12.9) | 13.0 (11.0-15.3) | 14.3 (11.8-17.2) | 15.7 (12.4-19.3) | 17.0 (12.9-21.6) | 18.8 (13.6-24.6) | 20.2 (14.2-26.9) |
| 45-day | 9.58 (8.53-10.8) | 10.7 (9.51-12.1) | 12.5 (11.1-14.1) | 13.9 (12.3-15.8) | 15.9 (13.4-18.5) | 17.3 (14.3-20.6) | 18.8 (14.9-22.9) | 20.2 (15.3-25.3) | 21.9 (15.9-28.5) | 23.3 (16.4-30.8) |
| 60-day | 11.2 (10.0-12.6) | 12.6 (11.2-14.1) | 14.7 (13.0-16.5) | 16.3 (14.4-18.5) | 18.5 (15.7-21.4) | 20.1 (16.6-23.7) | 21.5 (17.1-26.1) | 22.9 (17.4-28.7) | 24.7 (18.0-31.8) | 25.9 (18.4-34.2) |

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Back to Top

| | | |
|---|---|---|
| PROJECT / LOCATION: DPC: Alma Offsite Disposal Facility, Phase IV Landfill | | PROJECT / PROPOSAL NO. |
| SUBJECT: Active Area Leachate Disposal Capacity | | 243332.0002 |
| PREPARED BY: J. Hotstream | DATE: 8/31/2016 | FINAL ☐ |
| CHECKED BY: | DATE: | REVISION ☐ |

# Volume Relationships of Sand

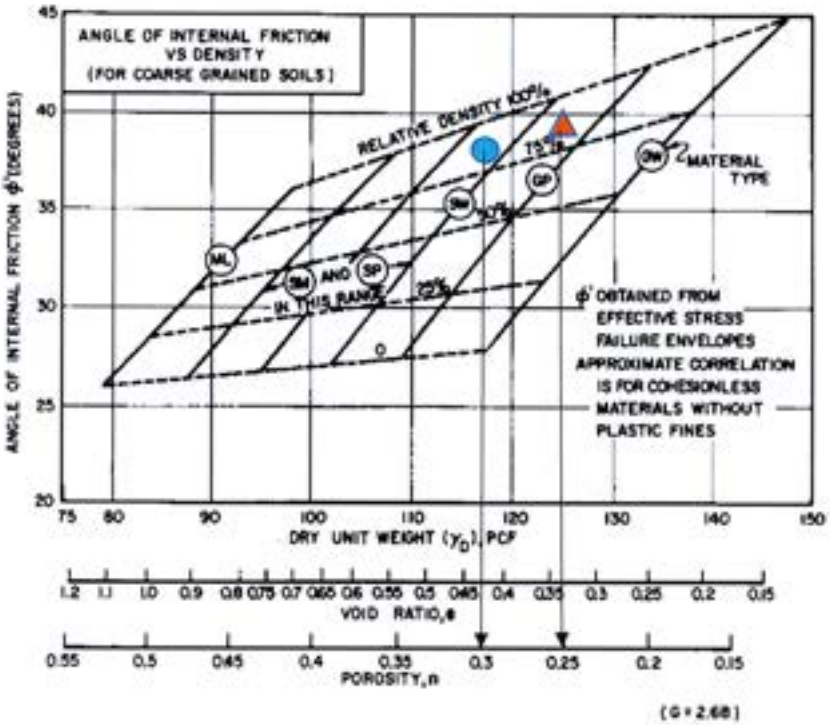
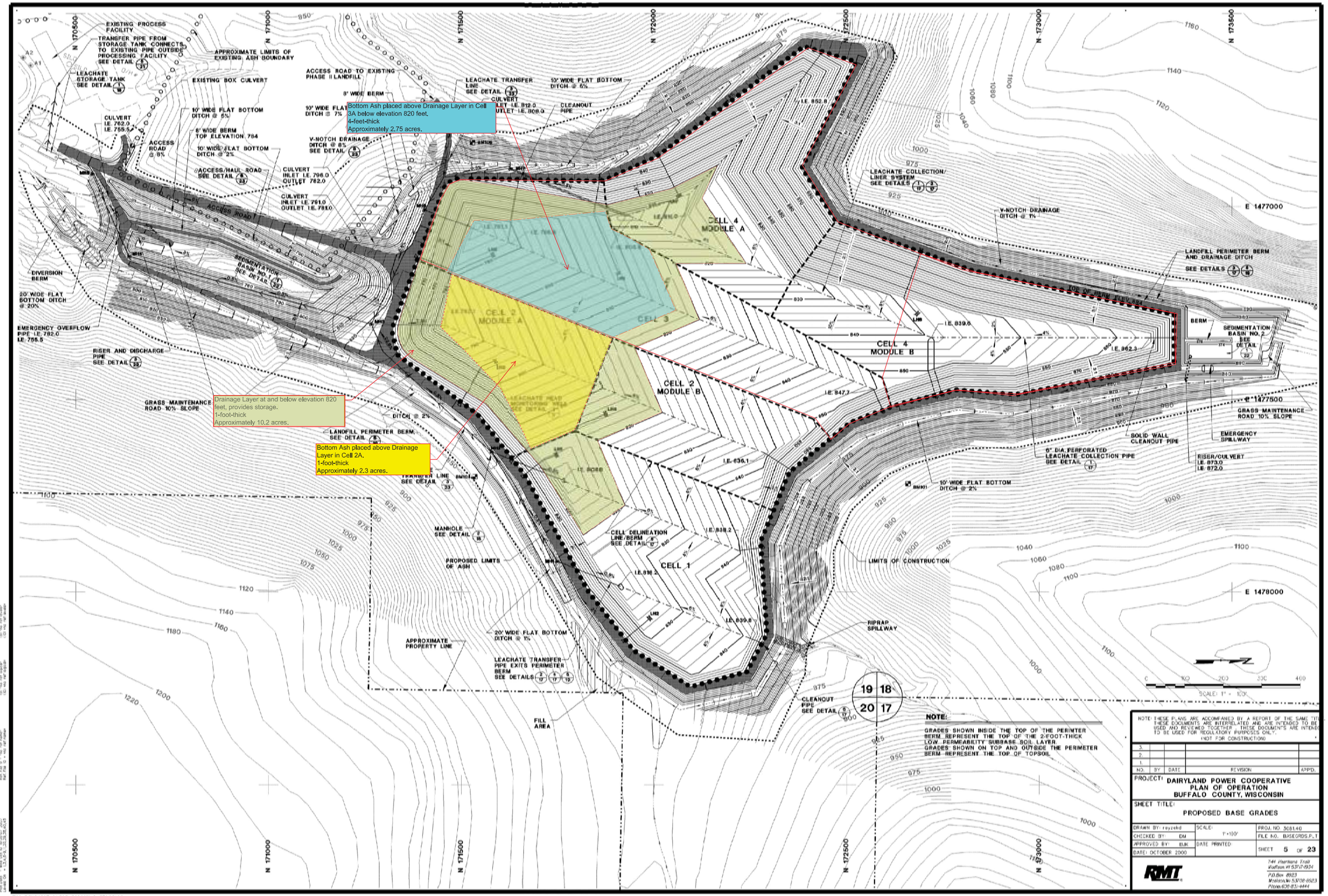
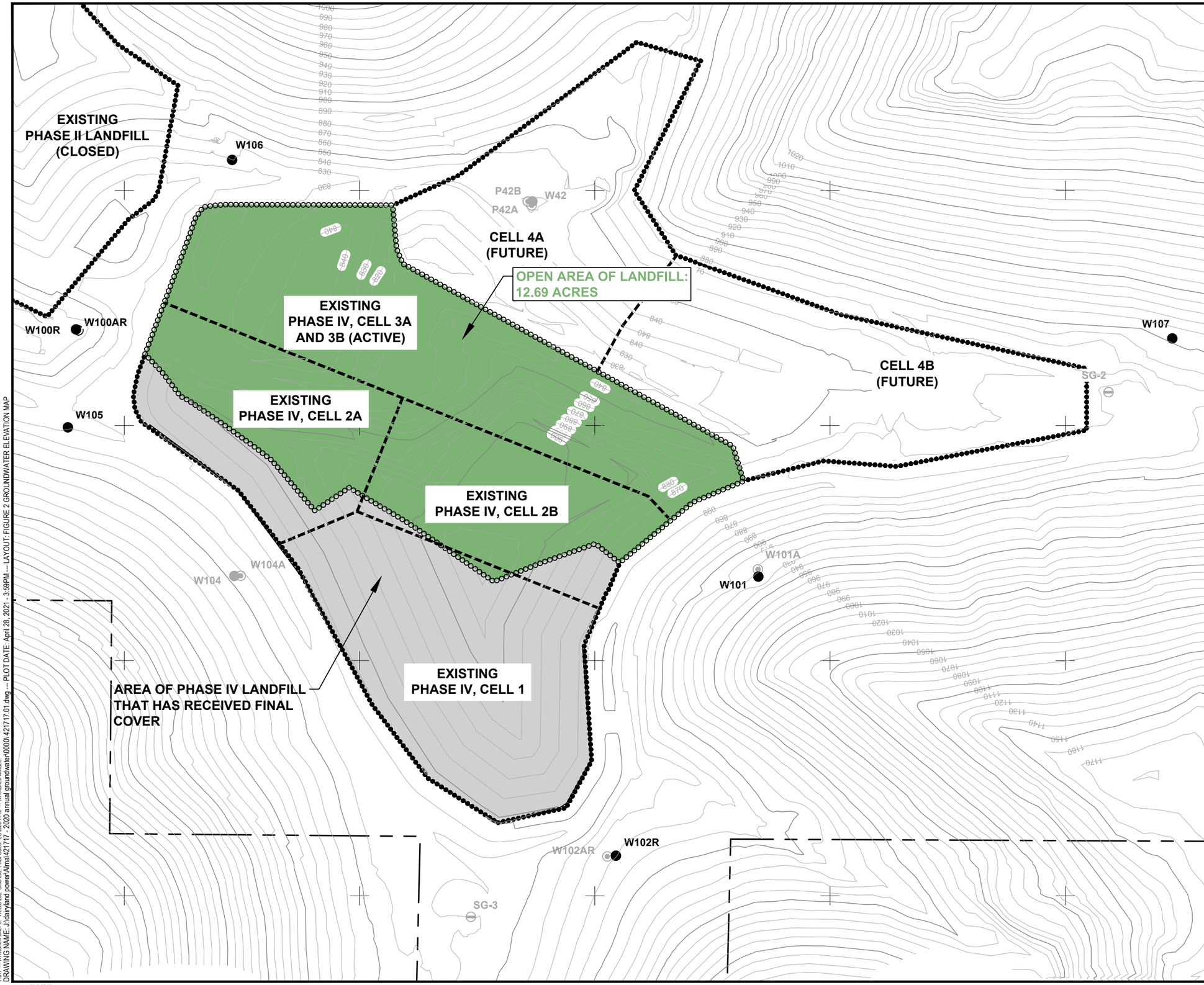



Figure from NavFac DM 7.1 (1986)

● Drainage Layer Sand - Poorly Graded Sand (SP)

▲ Bottom Ash - Poorly Graded Sand (SP) to Poorly Graded Gravel (GP)


Bottom Ash placed above Drainage Layer in Cell 3A below elevation 820 feet.
4-feet-thick
Approximately 2.75 acres.
Drainage Layer at and below elevation 820 feet, provides storage.
1-foot-thick
Approximately 10.2 acres.
Bottom Ash placed above Drainage Layer in Cell 2A.
1-foot-thick
Approximately 2.3 acres.
CELL 1
CELL 2 MODULE A
CELL 2 MODULE B
CELL 3
CELL 4 MODULE A
CELL 4 MODULE B
EXISTING PROCESS FACILITY
TRANSFER PIPE FROM STORAGE TANK CONNECTS TO EXISTING PIPE OUTSIDE PROCESSING FACILITY SEE DETAIL
APPROXIMATE LIMITS OF EXISTING ASH BOUNDARY
LEACHATE STORAGE TANK SEE DETAIL
EXISTING BOX CULVERT
ACCESS ROAD TO EXISTING PHASE II LANDFILL
8' WIDE BERM
10' WIDE FLAT BOTTOM DITCH @ 6%
LEACHATE TRANSFER LINE SEE DETAIL
CULVERT INLET I.E. 812.0 OUTLET I.E. 808.0
CLEANOUT PIPE
10' WIDE FLAT BOTTOM DITCH @ 5%
CULVERT I.E. 762.0 I.E. 755.5
8' WIDE BERM TOP ELEVATION 784
10' WIDE FLAT BOTTOM DITCH @ 2%
ACCESS ROAD @ 8%
V-NOTCH DRAINAGE DITCH @ 8% SEE DETAIL
ACCESS/HAUL ROAD SEE DETAIL
CULVERT INLET I.E. 796.0 OUTLET 782.0
CULVERT INLET I.E. 791.0 OUTLET I.E. 781.0
ACCESS ROAD
SEDIMENTATION BASIN NO. 1 SEE DETAIL
DIVERSION BERM
20' WIDE FLAT BOTTOM DITCH @ 20%
EMERGENCY OVERFLOW PIPE I.E. 782.0 I.E. 755.5
RISER AND DISCHARGE PIPE SEE DETAIL
GRASS MAINTENANCE ROAD 10% SLOPE
DITCH @ 2%
LANDFILL PERIMETER BERM SEE DETAIL
TRANSFER LINE SEE DETAIL
MANHOLE SEE DETAIL
PROPOSED LIMITS OF ASH
CELL DELINEATION LINE/BERM SEE DETAIL
APPROXIMATE PROPERTY LINE
20' WIDE FLAT BOTTOM DITCH @ 1%
LEACHATE TRANSFER PIPE EXITS PERIMETER BERM SEE DETAILS
FILL AREA
CLEANOUT PIPE SEE DETAIL
LEACHATE COLLECTION/ LINER SYSTEM SEE DETAILS
V-NOTCH DRAINAGE DITCH @ 1%
LANDFILL PERIMETER BERM AND DRAINAGE DITCH SEE DETAILS
TOE OF BERM ELEV. 884
BERM
SEDIMENTATION BASIN NO. 2 SEE DETAIL
GRASS MAINTENANCE ROAD 10% SLOPE
EMERGENCY SPILLWAY
SOLID WALL CLEANOUT PIPE
6" DIA. PERFORATED LEACHATE COLLECTION PIPE SEE DETAIL
RISER/CULVERT I.E. 873.0 I.E. 872.0
10' WIDE FLAT BOTTOM DITCH @ 2%
LIMITS OF CONSTRUCTION
RIPRAP SPILLWAY
E 1477000
E 1477500
E 1478000
N 170500
N 171000
N 171500
N 172000
N 172500
N 173000
N 173500
19 18
20 17
SCALE: 1" = 100'
NOTE:
GRADES SHOWN INSIDE THE TOP OF THE PERIMTER BERM REPRESENT THE TOP OF THE 2-FOOT-THICK LOW PERMEABILITY SUBBASE SOIL LAYER.
GRADES SHOWN ON TOP AND OUTSIDE THE PERIMETER BERM REPRESENT THE TOP OF TOPSOIL.
NOTE: THESE PLANS ARE ACCOMPANIED BY A REPORT OF THE SAME TITLE. THESE DOCUMENTS ARE INTERRELATED AND ARE INTENDED TO BE USED AND REVIEWED TOGETHER. THESE DOCUMENTS ARE INTENDED TO BE USED FOR REGULATORY PURPOSES ONLY.
(NOT FOR CONSTRUCTION)
NO. BY DATE REVISION APPD.
PROJECT: DAIRYLAND POWER COOPERATIVE
PLAN OF OPERATION
BUFFALO COUNTY, WISCONSIN
SHEET TITLE: PROPOSED BASE GRADES
DRAWN BY: reyzekd
CHECKED BY: DM
APPROVED BY: BJK
DATE: OCTOBER 2000
SCALE: 1"=100'
DATE PRINTED:
PROJ. NO. 3081.40
FILE NO. BASEGRDS.P_T
SHEET 5 OF 23
RMT
744 Heartland Trail
Madison WI 53717-1934
P.O. Box 8923
Madison, WI 53708-8923
Phone 608-831-4444
RMT COMPUTER AIDED DESIGN & DRAFTING




## LEGEND

| | |
|---|---|
| | APPROXIMATE PROPERTY BOUNDARY |
| | GRID LOCATION |
| 890 | EXISTING 10' CONTOUR |
| x 895.7 | EXISTING SPOT ELEVATION |
| | LIMITS OF PERMITTED LANDFILL |
| | LIMITS OF CCR DISPOSAL (ACTIVE LANDFILL) |
| | PHASE LINE |
| W42 | MONITORING WELL (NOT INCLUDED IN FEDERAL GWMP) |
| W42B | PIEZOMETER (NOT INCLUDED IN FEDERAL GWMP) |
| W101 | MONITORING WELL LOCATION |
| W101A | PIEZOMETER LOCATION |

## NOTES

1. THE BASE MAP WAS COMPILED FROM THE CELL 3B LINER CONSTRUCTION DOCUMENTATION REPORT (OCTOBER, 2016) AND THE NOVEMBER 12, 2020 ANNUAL AIR SPACE SURVEY BY EXETER DESIGN, INC.
2. THE HORIZONTAL DATUM IS REFERENCED TO THE WISCONSIN STATE PLANE COORDINATE SYSTEM, CENTRAL ZONE, NORTH AMERICAN DATUM 1983, US SURVEY FEET.
3. VERTICAL DATUM IS NORTH AMERICAN VERTICAL DATUM 1988. CONTOUR INTERVAL IS 10 FEET.

0 200 400

SCALE IN FEET

PROJECT: DAIRYLAND POWER COOPERATIVE
RUN-ON AND RUN-OFF CONTROL SYSTEMS PLAN
ALMA OFF-SITE PHASE IV LANDFILL
BUFFALO COUNTY, WISCONSIN

TITLE: EXISTING CONDITIONS

WORKING COPY

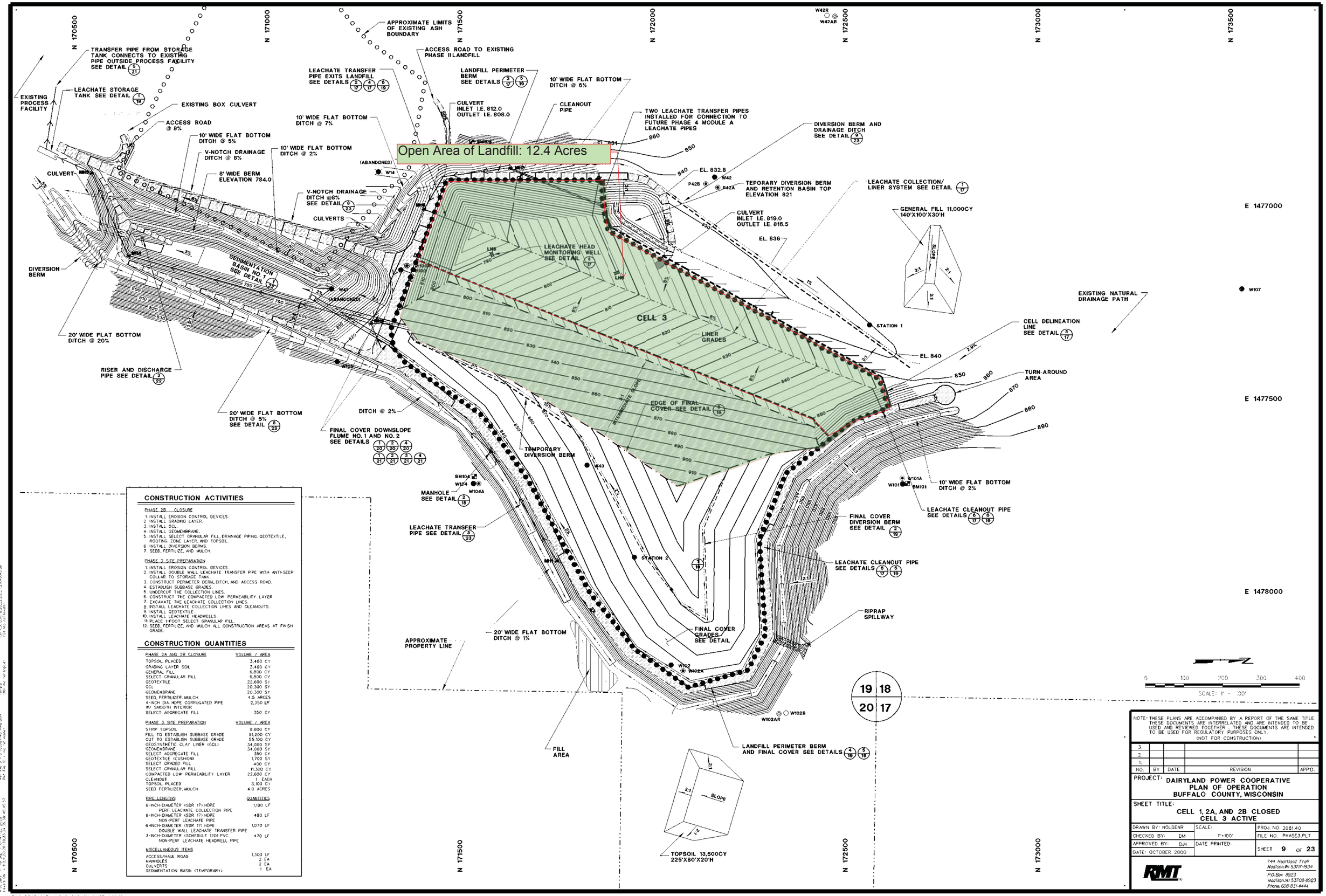
| | | | |
|---|---|---|---|
| DRAWN BY: | S. HAMWAY | PROJ NO.: | 421717 |
| CHECKED BY: | B. KAHNK | FIGURE 1 | |
| APPROVED BY: | | | |
| DATE: | OCTOBER 2021 | | |


TRC
708 Heartland Trail
Suite 3000
Madison, WI 53717
Phone: 608.826.3600


FILE NO.: 421717.01.dwg

11x17 --- ATTACHED XREFS: WELLS 200, GRID 200, PROPOSED, EG 2020-11-12 --- ATTACHED IMAGES:
DRAWING NAME: J:\dairyland power\Alma\421717 - 2020 annual groundwater\0000\421717.01.dwg --- PLOT DATE: April 28, 2021 - 3:59PM --- LAYOUT: FIGURE 2 GROUNDWATER ELEVATION MAP

Version: 2017-03-03




## CONSTRUCTION ACTIVITIES

PHASE 2B CLOSURE

1. INSTALL EROSION CONTROL DEVICES.
2. INSTALL GRADING LAYER.
3. INSTALL GCL.
4. INSTALL GEOMEMBRANE.
5. INSTALL SELECT GRANULAR FILL, DRAINAGE PIPING, GEOTEXTILE, ROOTING ZONE LAYER, AND TOPSOIL.
6. INSTALL DIVERSION BERMS.
7. SEED, FERTILIZE, AND MULCH.

PHASE 3 SITE PREPARATION

1. INSTALL EROSION CONTROL DEVICES.
2. INSTALL DOUBLE WALL LEACHATE TRANSFER PIPE WITH ANTI-SEEP COLLAR TO STORAGE TANK.
3. CONSTRUCT PERIMETER BERM, DITCH, AND ACCESS ROAD.
4. ESTABLISH SUBBASE GRADES.
5. UNDERCUT THE COLLECTION LINES.
6. CONSTRUCT THE COMPACTED LOW PERMEABILITY LAYER
7. EXCAVATE THE LEACHATE COLLECTION LINES.
8. INSTALL LEACHATE COLLECTION LINES AND CLEANOUTS.
9. INSTALL GEOTEXTILE.
10. INSTALL LEACHATE HEADWELLS.
11. PLACE 1-FOOT SELECT GRANULAR FILL.
12. SEED, FERTILIZE, AND MULCH ALL CONSTRUCTION AREAS AT FINISH GRADE.

## CONSTRUCTION QUANTITIES

| PHASE 2A AND 2B CLOSURE | VOLUME / AREA |
|---|---|
| TOPSOIL PLACED | 3,400 CY |
| GRADING LAYER SOIL | 3,400 CY |
| GENERAL FILL | 6,800 CY |
| SELECT GRANULAR FILL | 6,800 CY |
| GEOTEXTILE | 22,600 SY |
| GCL | 20,300 SY |
| GEOMEMBRANE | 20,300 SY |
| SEED, FERTILIZER, MULCH | 4.5 ARCES |
| 4-INCH DIA. HDPE CORRUGATED PIPE W/ SMOOTH INTERIOR | 2,350 LF |
| SELECT AGGREGATE FILL | 350 CY |

| PHASE 3 SITE PREPARATION | VOLUME / AREA |
|---|---|
| STRIP TOPSOIL | 8,800 CY |
| FILL TO ESTABLISH SUBBASE GRADE | 91,200 CY |
| CUT TO ESTABLISH SUBBASE GRADE | 55,100 CY |
| GEOSYNTHETIC CLAY LINER (GCL) | 34,000 SY |
| GEOMEMBRANE | 34,000 SY |
| SELECT AGGREGATE FILL | 350 CY |
| GEOTEXTILE (CUSHION) | 1,700 SY |
| SELECT GRADED FILL | 400 CY |
| SELECT GRANULAR FILL | 11,300 CY |
| COMPACTED LOW PERMEABILITY LAYER | 22,600 CY |
| CLEANOUT | 1 EACH |
| TOPSOIL PLACED | 3,100 CY |
| SEED FERTILIZER, MULCH | 4.0 ACRES |

| PIPE LENGTHS | QUANTITIES |
|---|---|
| 6-INCH-DIAMETER (SDR 17) HDPE PERF LEACHATE COLLECTION PIPE | 1,100 LF |
| 6-INCH-DIAMETER (SDR 17) HDPE NON-PERF LEACHATE PIPE | 480 LF |
| 6-INCH-DIAMETER (SDR 17) HDPE DOUBLE WALL LEACHATE TRANSFER PIPE | 1,070 LF |
| 3-INCH-DIAMETER (SCHEDULE 120) PVC NON-PERF LEACHATE HEADWELL PIPE | 470 LF |

| MISCELLANEOUS ITEMS | |
|---|---|
| ACCESS/HAUL ROAD | 1,300 LF |
| MANHOLES | 2 EA |
| CULVERTS | 2 EA |
| SEDIMENTATION BASIN (TEMPORARY) | 1 EA |

NOTE: THESE PLANS ARE ACCOMPANIED BY A REPORT OF THE SAME TITLE. THESE DOCUMENTS ARE INTERRELATED AND ARE INTENDED TO BE USED AND REVIEWED TOGETHER. THESE DOCUMENTS ARE INTENDED TO BE USED FOR REGULATORY PURPOSES ONLY.
(NOT FOR CONSTRUCTION)

| NO. | BY | DATE | REVISION | APPD. |
|---|---|---|---|---|
| 3. | | | | |
| 2. | | | | |
| 1. | | | | |

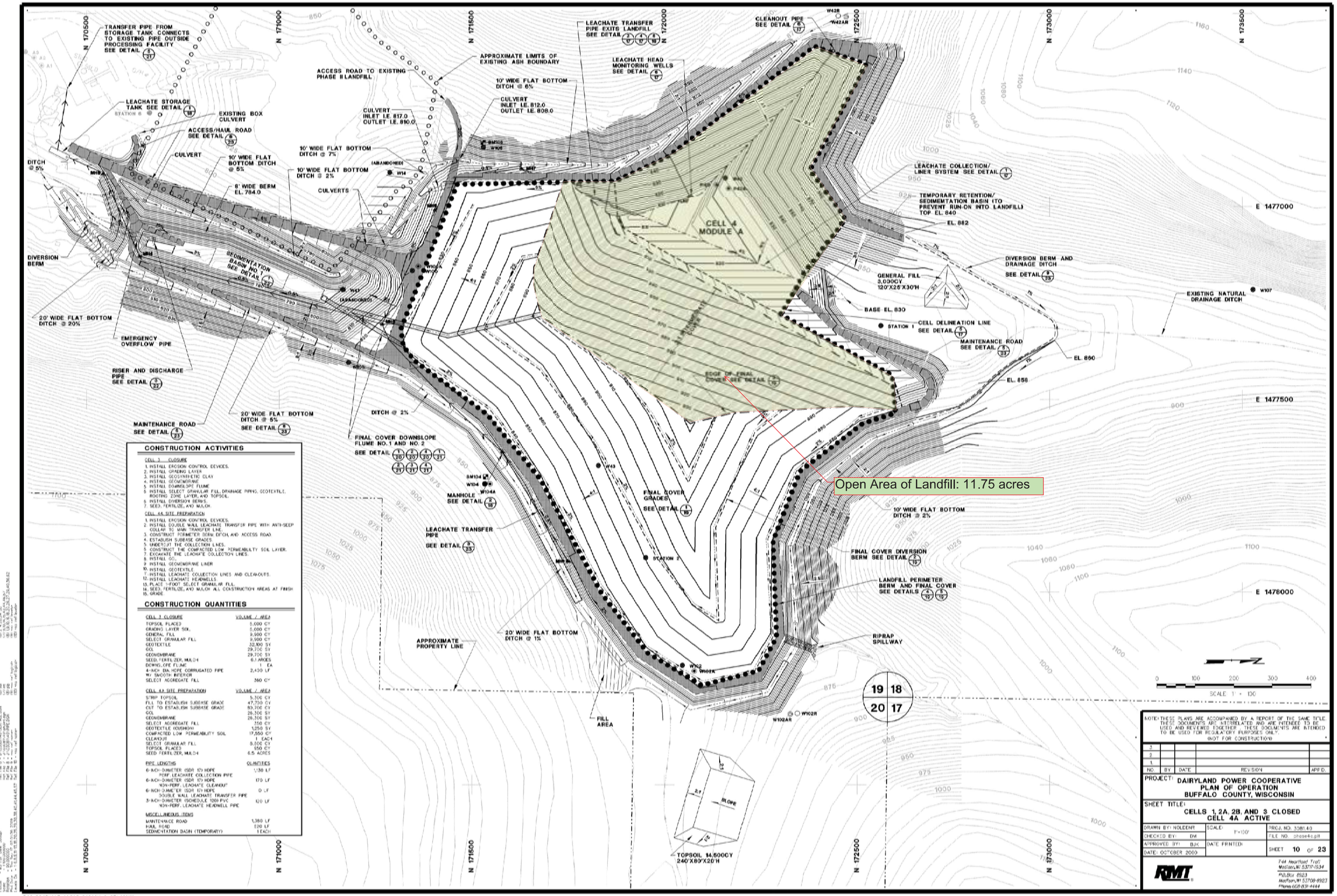
PROJECT: DAIRYLAND POWER COOPERATIVE
PLAN OF OPERATION
BUFFALO COUNTY, WISCONSIN

SHEET TITLE:
CELL 1, 2A, AND 2B CLOSED
CELL 3 ACTIVE

| | | |
|---|---|---|
| DRAWN BY: NOLDENR | SCALE: 1"=100' | PROJ. NO. 3081.40 |
| CHECKED BY: DM | | FILE NO. PHASE3.PLT |
| APPROVED BY: BJK | DATE PRINTED: | SHEET 9 OF 23 |
| DATE: OCTOBER 2000 | | |

RMT
744 Heartland Trail
Madison, WI 53717-1934
P.O. Box 8923
Madison, WI 53708-8923
Phone 608-831-4444

RMT COMPUTER AIDED DESIGN & DRAFTING




## CONSTRUCTION ACTIVITIES

CELL 3 CLOSURE

1. INSTALL EROSION CONTROL DEVICES.
2. INSTALL GRADING LAYER
3. INSTALL GEOSYNTHETIC CLAY
4. INSTALL GEOMEMBRANE
5. INSTALL DOWNSLOPE FLUME
6. INSTALL SELECT GRANULAR FILL, DRAINAGE PIPING, GEOTEXTILE, ROOTING ZONE LAYER, AND TOPSOIL.
6. INSTALL DIVERSION BERMS.
7. SEED, FERTILIZE, AND MULCH.

CELL 4A SITE PREPARATION

1. INSTALL EROSION CONTROL DEVICES.
2. INSTALL DOUBLE WALL LEACHATE TRANSFER PIPE WITH ANTI-SEEP COLLAR TO MAIN TRANSFER LINE.
3. CONSTRUCT PERIMETER BERM DITCH, AND ACCESS ROAD.
4. ESTABLISH SUBBASE GRADES.
5. UNDERCUT THE COLLECTION LINES.
5. CONSTRUCT THE COMPACTED LOW PERMEABILITY SOIL LAYER.
7. EXCAVATE THE LEACHATE COLLECTION LINES.
8. INSTALL GCL.
9. INSTALL GEOMEMBRANE LINER
10. INSTALL GEOTEXTILE.
11. INSTALL LEACHATE COLLECTION LINES AND CLEANOUTS.
12. INSTALL LEACHATE HEADWELLS.
13. PLACE 1-FOOT SELECT GRANULAR FILL.
14. SEED, FERTILIZE, AND MULCH ALL CONSTRUCTION AREAS AT FINISH GRADE.

## CONSTRUCTION QUANTITIES

| CELL 3 CLOSURE | VOLUME / AREA |
|---|---|
| TOPSOIL PLACED | 5,000 CY |
| GRADING LAYER SOIL | 5,000 CY |
| GENERAL FILL | 9,900 CY |
| SELECT GRANULAR FILL | 9,900 CY |
| GEOTEXTILE | 32,100 SY |
| GCL | 29,700 SY |
| GEOMEMBRANE | 29,700 SY |
| SEED, FERTILIZER, MULCH | 6.1 ARCES |
| DOWNSLOPE FLUME | 1 EA |
| 4-INCH DIA. HDPE CORRUGATED PIPE W/ SMOOTH INTERIOR | 2,430 LF |
| SELECT AGGREGATE FILL | 360 CY |

| CELL 4A SITE PREPARATION | VOLUME / AREA |
|---|---|
| STRIP TOPSOIL | 5,300 CY |
| FILL TO ESTABLISH SUBBASE GRADE | 47,700 CY |
| CUT TO ESTABLISH SUBBASE GRADE | 80,700 CY |
| GCL | 26,300 SY |
| GEOMEMBRANE | 26,300 SY |
| SELECT AGGREGATE FILL | 350 CY |
| GEOTEXTILE (CUSHION) | 3,250 SY |
| COMPACTED LOW PERMEABILITY SOIL | 17,550 CY |
| CLEANOUT | 1 EACH |
| SELECT GRANULAR FILL | 8,500 CY |
| TOPSOIL PLACED | 950 CY |
| SEED, FERTILIZER, MULCH | 6.5 ACRES |

| PIPE LENGTHS | QUANTITIES |
|---|---|
| 6-INCH-DIAMETER (SDR 17) HDPE PERF. LEACHATE COLLECTION PIPE | 1,130 LF |
| 6-INCH-DIAMETER (SDR 17) HDPE NON-PERF. LEACHATE CLEANOUT | 170 LF |
| 6-INCH-DIAMETER (SDR 17) HDPE DOUBLE WALL LEACHATE TRANSFER PIPE | 0 LF |
| 3-INCH-DIAMETER (SCHEDULE 1200) PVC NON-PERF. LEACHATE HEADWELL PIPE | 120 LF |

| MISCELLANEOUS ITEMS | |
|---|---|
| MAINTENANCE ROAD | 1,380 LF |
| HAUL ROAD | 520 LF |
| SEDIMENTATION BASIN (TEMPORARY) | 1 EACH |

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| NO. | BY | DATE | REVISION | APP'D. |
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PROJECT: DAIRYLAND POWER COOPERATIVE
PLAN OF OPERATION
BUFFALO COUNTY, WISCONSIN

SHEET TITLE: CELLS 1, 2A, 2B, AND 3 CLOSED
CELL 4A ACTIVE

| | | |
|---|---|---|
| DRAWN BY: NOLDEN® | SCALE: 1"=100' | PROJ. NO. 3081.40 |
| CHECKED BY: DM | | FILE NO. phase4c.plt |
| APPROVED BY: BJK | DATE PRINTED: | SHEET 10 OF 23 |
| DATE: OCTOBER 2000 | | |

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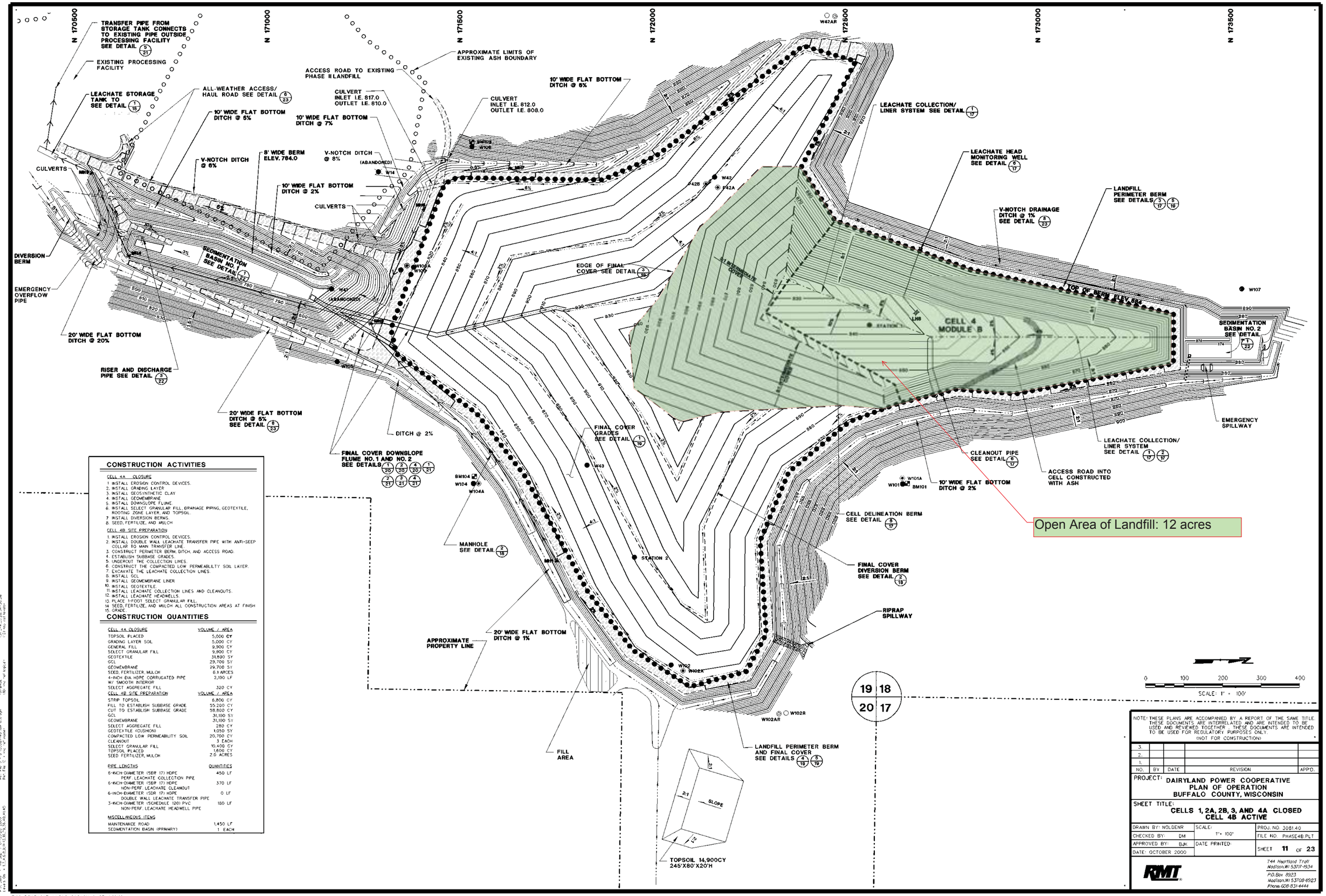
RMT COMPUTER AIDED DESIGN & DRAFTING




## CONSTRUCTION ACTIVITIES

CELL 4A CLOSURE

1. INSTALL EROSION CONTROL DEVICES.
2. INSTALL GRADING LAYER
3. INSTALL GEOSYNTHETIC CLAY
4. INSTALL GEOMEMBRANE
5. INSTALL DOWNSLOPE FLUME.
6. INSTALL SELECT GRANULAR FILL, DRAINAGE PIPING, GEOTEXTILE, ROOTING ZONE LAYER, AND TOPSOIL.
7. INSTALL DIVERSION BERMS.
8. SEED, FERTILIZE, AND MULCH

CELL 4B SITE PREPARATION

1. INSTALL EROSION CONTROL DEVICES.
2. INSTALL DOUBLE WALL LEACHATE TRANSFER PIPE WITH ANTI-SEEP COLLAR TO MAIN TRANSFER LINE.
3. CONSTRUCT PERIMETER BERM, DITCH, AND ACCESS ROAD.
4. ESTABLISH SUBBASE GRADES.
5. UNDERCUT THE COLLECTION LINES.
6. CONSTRUCT THE COMPACTED LOW PERMEABILITY SOIL LAYER.
7. EXCAVATE THE LEACHATE COLLECTION LINES.
8. INSTALL GCL.
9. INSTALL GEOMEMBRANE LINER
10. INSTALL GEOTEXTILE.
11. INSTALL LEACHATE COLLECTION LINES AND CLEANOUTS.
12. INSTALL LEACHATE HEADWELLS.
13. PLACE 1-FOOT SELECT GRANULAR FILL.
14. SEED, FERTILIZE, AND MULCH ALL CONSTRUCTION AREAS AT FINISH
15. GRADE.

## CONSTRUCTION QUANTITIES

| CELL 4A CLOSURE | VOLUME / AREA |
|---|---|
| TOPSOIL PLACED | 5,000 CY |
| GRADING LAYER SOIL | 5,000 CY |
| GENERAL FILL | 9,900 CY |
| SELECT GRANULAR FILL | 9,900 CY |
| GEOTEXTILE | 31,800 SY |
| GCL | 29,700 SY |
| GEOMEMBRANE | 29,700 SY |
| SEED, FERTILIZER, MULCH | 6.1 ARCES |
| 4-INCH DIA. HDPE CORRUGATED PIPE W/ SMOOTH INTERIOR | 2,100 LF |
| SELECT AGGREGATE FILL | 320 CY |

| CELL 4B SITE PREPARATION | VOLUME / AREA |
|---|---|
| STRIP TOPSOIL | 6,800 CY |
| FILL TO ESTABLISH SUBBASE GRADE | 55,200 CY |
| CUT TO ESTABLISH SUBBASE GRADE | 58,800 CY |
| GCL | 31,100 SY |
| GEOMEMBRANE | 31,100 SY |
| SELECT AGGREGATE FILL | 280 CY |
| GEOTEXTILE (CUSHION) | 1,050 SY |
| COMPACTED LOW PERMEABILITY SOIL | 20,700 CY |
| CLEANOUT | 3 EACH |
| SELECT GRANULAR FILL | 10,400 CY |
| TOPSOIL PLACED | 1,600 CY |
| SEED FERTILIZER, MULCH | 2.0 ACRES |

| PIPE LENGTHS | QUANTITIES |
|---|---|
| 6-INCH-DIAMETER (SDR 17) HDPE PERF. LEACHATE COLLECTION PIPE | 450 LF |
| 6-INCH-DIAMETER (SDR 17) HDPE NON-PERF. LEACHATE CLEANOUT | 370 LF |
| 6-INCH-DIAMETER (SDR 17) HDPE DOUBLE WALL LEACHATE TRANSFER PIPE | 0 LF |
| 3-INCH-DIAMETER (SCHEDULE 120) PVC NON-PERF. LEACHATE HEADWELL PIPE | 180 LF |

| MISCELLANEOUS ITEMS | |
|---|---|
| MAINTENANCE ROAD | 1,450 LF |
| SEDIMENTATION BASIN (PRIMARY) | 1 EACH |

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|---|---|---|---|---|
| 3. | | | | |
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PROJECT: DAIRYLAND POWER COOPERATIVE
PLAN OF OPERATION
BUFFALO COUNTY, WISCONSIN

SHEET TITLE: CELLS 1, 2A, 2B, 3, AND 4A CLOSED
CELL 4B ACTIVE

| | | |
|---|---|---|
| DRAWN BY: NOLDENR | SCALE: 1" = 100' | PROJ. NO. 3081.40 |
| CHECKED BY: DM | | FILE NO. PHASE4B.PLT |
| APPROVED BY: BJK | DATE PRINTED: | SHEET 11 OF 23 |
| DATE: OCTOBER 2000 | | |

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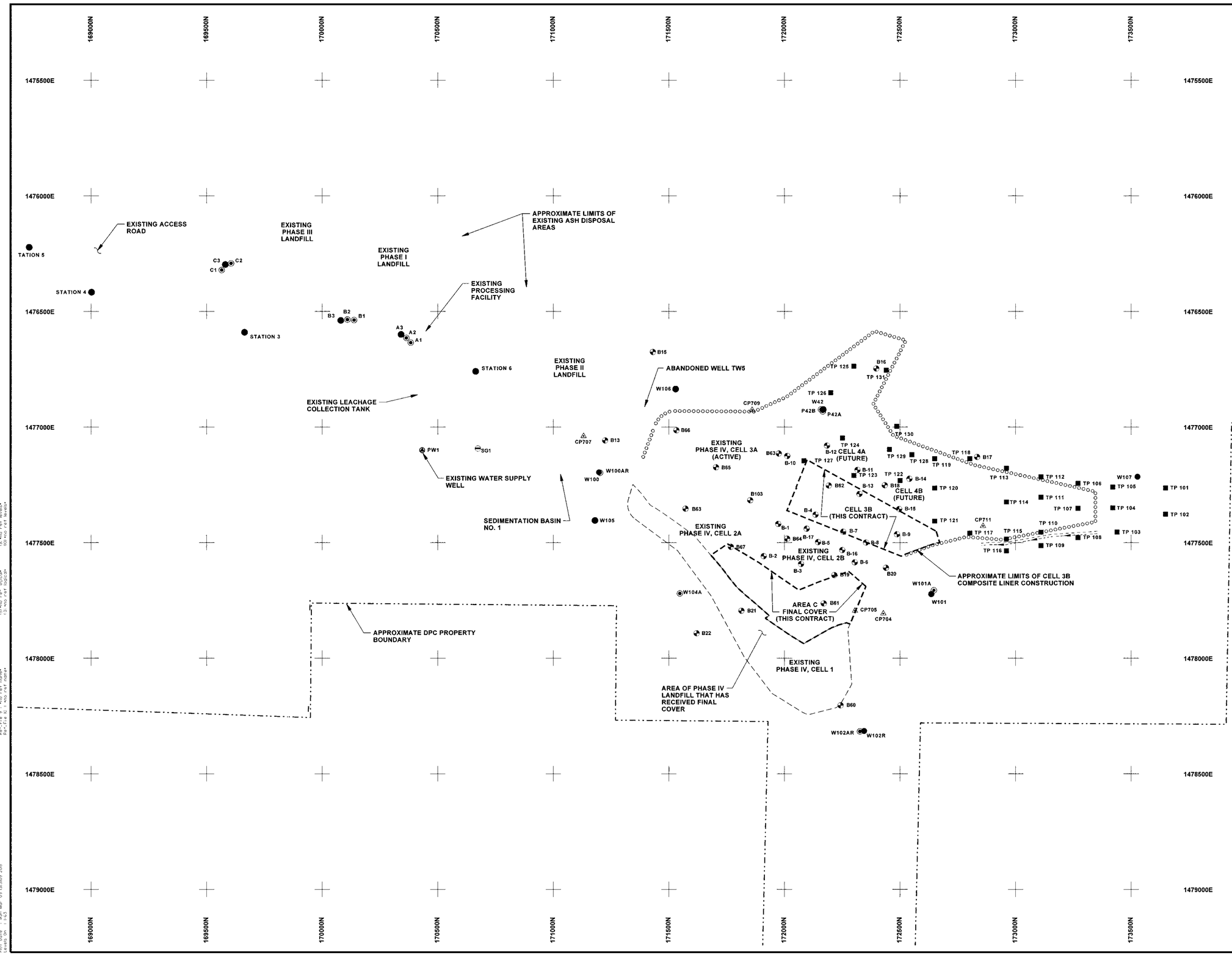
# Appendix C: Relevant October 2002 POO Plan Sheets

- Sheet 3 Existing Conditions Map – Phase IV, Cell 3B Liner & Area C (Over Cells 1 & 2) Final Cover Construction
- Sheet 5 Proposed Base Grades
- Sheet 9 Phasing Plan – Cell 1, 2A, and 2B Closed; Cell 3 Active
- Sheet 11 Phasing Plan – Cell 1, 2A, 2B, 3, and 4A Closed; Cell 4B Active
- Sheet 12 Proposed Final Grades
- Sheet 17 Details – Liner and Collection Pipes
- Sheet 19 Details – Final Cover
- Sheet 22 Details – Sedimentation Basins
- Sheet 23 Details - Miscellaneous

## NOTES

1. REFER TO PLAN SHEET 2 FOR STANDARD LEGEND, NOTES, AND BENCHMARK LOCATIONS.




0 200 400 600 800

SCALE IN FEET

NOTE: THE CONTRACTOR SHALL NOTIFY ALL AREA UTILITY COMPANIES PRIOR TO COMMENCING WORK ON THIS CONTRACT, IN ACCORDANCE WITH STATE AND LOCAL REQUIREMENTS.

NOTE: THESE PLANS ARE ACCOMPANIED BY A PROJECT MANUAL OF THE SAME TITLE. THESE DOCUMENTS ARE INTERRELATED AND ARE INTENDED TO BE USED TOGETHER.

| NO. | BY | DATE | REVISION | APP'D. |
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PROJECT:
**DAIRYLAND POWER COOPERATIVE**
**PHASE IV, CELL 3B LINER & AREA C (OVER CELLS 1 & 2)**
**FINAL COVER CONSTRUCTION**
**BUFFALO COUNTY, WISCONSIN**

SHEET TITLE:
**EXISTING CONDITIONS MAP**

| | | | |
|---|---|---|---|
| DRAWN BY: lstormer | SCALE: | PROJ. NO. | 216851.0004 |
| CHECKED BY: DM | AS SHOWN | FILE NO. | 215851.0004.SHT03-EC.PLT |
| APPROVED BY: TWM | DATE PRINTED: | SHEET 3 OF 13 | |
| DATE: MARCH 2015 | | | |


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Madison, WI 53717
Phone: 608.826.3600


Plot Data
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Plot Time : MS_DEFAULT
Scale : 1.000000000
Position : 0.000,0.000
Plot Date : Mon Mar 09 15:30:09 2015
Device : KIP 7170
Dgns On : ref

Reference Files
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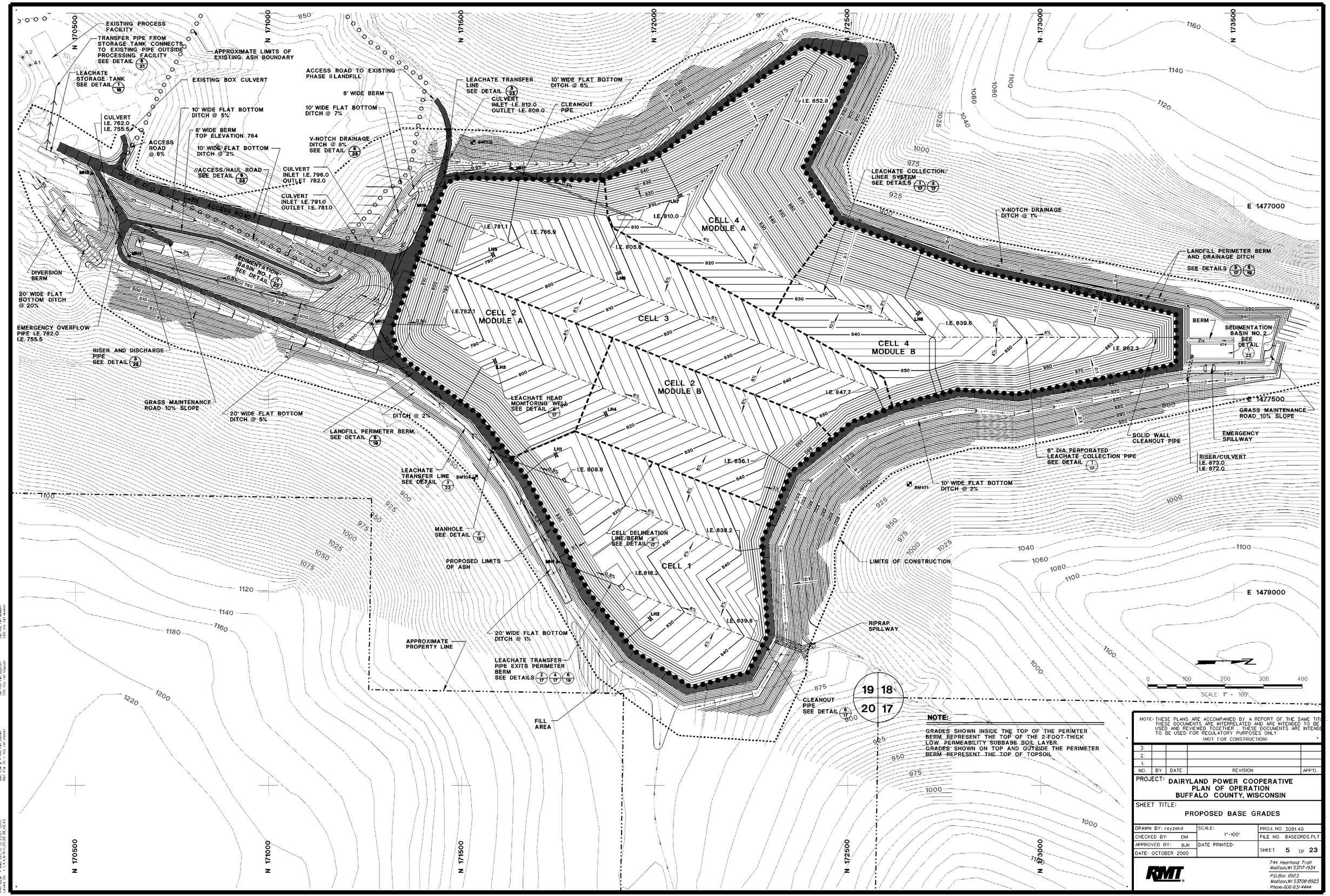
Re-File 2 : J:\Dairyland Power\Alma\216851\004\Base Files\VREF-Topo 2006.dgn
Re-File 3 : J:\Dairyland Power\Alma\216851\004\Base Files\VREF-Topo 2009.dgn
Re-File 4 : J:\Dairyland Power\Alma\216851\004\Base Files\VREF-Topo 2012.dgn
Re-File 5 : J:\Dairyland Power\Alma\216851\004\Base Files\VREF-Topo 2013.dgn
Re-File 6 : J:\Dairyland Power\Alma\216851\004\Base Files\VREF-2012-Rec-CCEI.dgn
Re-File 7 : J:\Dairyland Power\Alma\216851\004\Base Files\VREF-2012-Rec-CCEI-Hs3.dgn
Re-File 8 : J:\Dairyland Power\Alma\216851\004\Base Files\VREF-Cell 3B Proposed Grading Plan.dgn
Re-File 9 : J:\Dairyland Power\Alma\216851\004\Base Files\VREF-Cell 3B Proposed Grading Plan (Hs3).dgn
Re-File 10 : Hs3 ref Topo*
Re-File 11 : Hs3 ref Topo*
Re-File 12 : Hs3 ref Topo*
Re-File 13 : Hs3 ref Topo*

Logical Names
Re-File 1 : Topo 2004*
Re-File 2 : Topo 2006*
Re-File 3 : Topo 2009*
Re-File 4 : Topo 2012*
Re-File 5 : Topo 2013*
Re-File 6 : Rec-CCEI*
Re-File 7 : Rec-CCEI-Hs3*
Re-File 8 : Cell 3B Proposed Grading Plan*
Re-File 9 : Cell 3B Proposed Grading Plan (Hs3)*
Re-File 10 : Hs3 ref Topo*
Re-File 11 : Hs3 ref Topo*
Re-File 12 : Hs3 ref Topo*
Re-File 13 : Hs3 ref Topo*

Levels
Re-File 1 : 1,2,3,4,5,6,7,8,9,10,11,12,14,15,16,18,19,20,25,27-40,61-63
Re-File 2 : 1,2,3,4,5,6,7,8,9,10,11,12,14,15,16,18,19,20,25,27-40,61-63
Re-File 3 : 1,2,3,4,5,6,7,8,9,10,11,12,14,15,16,18,19,20,25,27-40,61-63
Re-File 4 : 1,2,3,4,5,6,7,8,9,10,11,12,14,15,16,18,19,20,25,27-40,61-63
Re-File 5 : 1,2,3,4,5,6,7,8,9,10,11,12,14,15,16,18,19,20,25,27-40,61-63
Re-File 6 : 1,2,3,4,5,6,7,8,9,10,11,12,14,15,16,18,19,20,25,27-40,61-63
Re-File 7 : 1,2,3,4,5,6,7,8,9,10,11,12,14,15,16,18,19,20,25,27-40,61-63
Re-File 8 : 1,2,3,4,5,6,7,8,9,10,11,12,14,15,16,18,19,20,25,27-40,61-63
Re-File 9 : 1,2,3,4,5,6,7,8,9,10,11,12,14,15,16,18,19,20,25,27-40,61-63
Re-File 10 : Hs3 ref Topo*
Re-File 11 : Hs3 ref Topo*
Re-File 12 : Hs3 ref Topo*
Re-File 13 : Hs3 ref Topo*




**NOTE:**

GRADES SHOWN INSIDE THE TOP OF THE PERIMTER BERM REPRESENT THE TOP OF THE 2-FOOT-THICK LOW PERMEABILITY SUBBASE SOIL LAYER. GRADES SHOWN ON TOP AND OUTSIDE THE PERIMETER BERM REPRESENT THE TOP OF TOPSOIL

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(NOT FOR CONSTRUCTION)

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| 3. | | | | |
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PROJECT: DAIRYLAND POWER COOPERATIVE
PLAN OF OPERATION
BUFFALO COUNTY, WISCONSIN

SHEET TITLE:
PROPOSED BASE GRADES

| | | |
|---|---|---|
| DRAWN BY: reyzekd | SCALE: 1"=100' | PROJ. NO. 3081.40 |
| CHECKED BY: DM | | FILE NO. BASEGRDS.PLT |
| APPROVED BY: BJK | DATE PRINTED: | SHEET 5 OF 23 |
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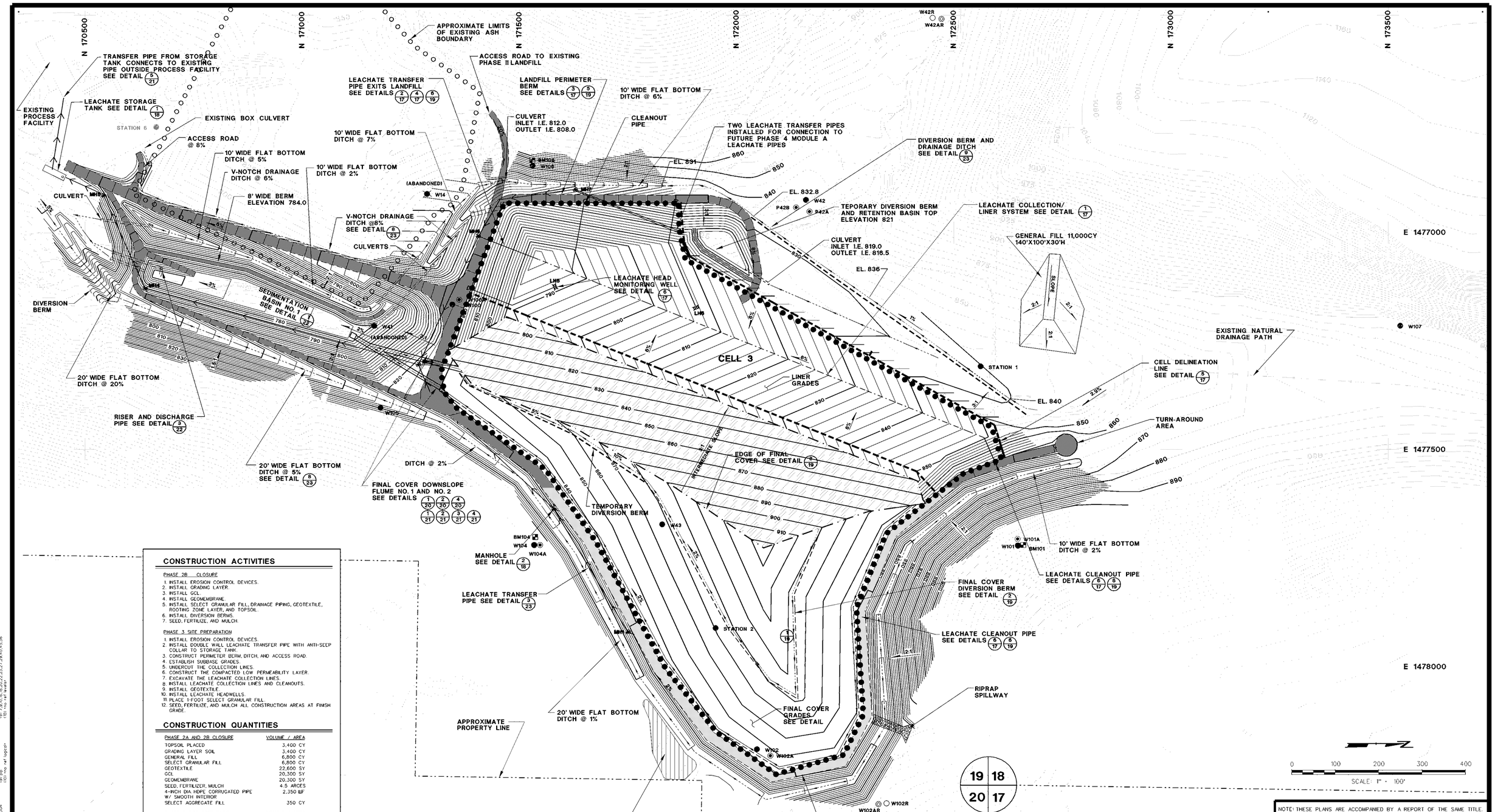


## CONSTRUCTION ACTIVITIES

PHASE 2B CLOSURE

1. INSTALL EROSION CONTROL DEVICES.
2. INSTALL GRADING LAYER.
3. INSTALL GCL.
4. INSTALL GEOMEMBRANE.
5. INSTALL SELECT GRANULAR FILL, DRAINAGE PIPING, GEOTEXTILE, ROOTING ZONE LAYER, AND TOPSOIL.
6. INSTALL DIVERSION BERMS.
7. SEED, FERTILIZE, AND MULCH.

PHASE 3 SITE PREPARATION

1. INSTALL EROSION CONTROL DEVICES.
2. INSTALL DOUBLE WALL LEACHATE TRANSFER PIPE WITH ANTI-SEEP COLLAR TO STORAGE TANK.
3. CONSTRUCT PERIMETER BERM, DITCH, AND ACCESS ROAD.
4. ESTABLISH SUBBASE GRADES.
5. UNDERCUT THE COLLECTION LINES.
6. CONSTRUCT THE COMPACTED LOW PERMEABILITY LAYER.
7. EXCAVATE THE LEACHATE COLLECTION LINES.
8. INSTALL LEACHATE COLLECTION LINES AND CLEANOUTS.
9. INSTALL GEOTEXTILE.
10. INSTALL LEACHATE HEADWELLS.
11. PLACE 1-FOOT SELECT GRANULAR FILL.
12. SEED, FERTILIZE, AND MULCH ALL CONSTRUCTION AREAS AT FINISH GRADE.

## CONSTRUCTION QUANTITIES

| PHASE 2A AND 2B CLOSURE | VOLUME / AREA |
|---|---|
| TOPSOIL PLACED | 3,400 CY |
| GRADING LAYER SOIL | 3,400 CY |
| GENERAL FILL | 6,800 CY |
| SELECT GRANULAR FILL | 6,800 CY |
| GEOTEXTILE | 22,600 SY |
| GCL | 20,300 SY |
| GEOMEMBRANE | 20,300 SY |
| SEED, FERTILIZER, MULCH | 4.5 ACRES |
| 4-INCH DIA. HDPE CORRUGATED PIPE W/ SMOOTH INTERIOR | 2,350 LF |
| SELECT AGGREGATE FILL | 350 CY |

| PHASE 3 SITE PREPARATION | VOLUME / AREA |
|---|---|
| STRIP TOPSOIL | 8,800 CY |
| FILL TO ESTABLISH SUBBASE GRADE | 91,200 CY |
| CUT TO ESTABLISH SUBBASE GRADE | 55,100 CY |
| GEOSYNTHETIC CLAY LINER (GCL) | 34,000 SY |
| GEOMEMBRANE | 34,000 SY |
| SELECT AGGREGATE FILL | 350 CY |
| GEOTEXTILE (CUSHION) | 1,700 SY |
| SELECT GRADED FILL | 400 CY |
| SELECT GRANULAR FILL | 11,300 CY |
| COMPACTED LOW PERMEABILITY LAYER | 22,600 CY |
| CLEANOUT | 1 EACH |
| TOPSOIL PLACED | 3,100 CY |
| SEED FERTILIZER, MULCH | 4.0 ACRES |

| PIPE LENGTHS | QUANTITIES |
|---|---|
| 6-INCH-DIAMETER (SDR 17) HDPE PERF. LEACHATE COLLECTION PIPE | 1,100 LF |
| 6-INCH-DIAMETER (SDR 17) HDPE NON-PERF. LEACHATE PIPE | 480 LF |
| 6-INCH-DIAMETER (SDR 17) HDPE DOUBLE WALL LEACHATE TRANSFER PIPE | 1,070 LF |
| 3-INCH-DIAMETER (SCHEDULE 120) PVC NON-PERF. LEACHATE HEADWELL PIPE | 470 LF |

| MISCELLANEOUS ITEMS | |
|---|---|
| ACCESS/HAUL ROAD | 1,300 LF |
| MANHOLES | 2 EA |
| CULVERTS | 2 EA |
| SEDIMENTATION BASIN (TEMPORARY) | 1 EA |

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| 3. | | | | |
| 2. | | | | |
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PROJECT: DAIRYLAND POWER COOPERATIVE
PLAN OF OPERATION
BUFFALO COUNTY, WISCONSIN

SHEET TITLE: CELL 1, 2A, AND 2B CLOSED
CELL 3 ACTIVE

| | | |
|---|---|---|
| DRAWN BY: NOLDENR | SCALE: 1"=100' | PROJ. NO. 3081.40 |
| CHECKED BY: DM | | FILE NO. PHASE3.PLT |
| APPROVED BY: BJK | DATE PRINTED: | SHEET 9 OF 23 |
| DATE: OCTOBER 2000 | | |

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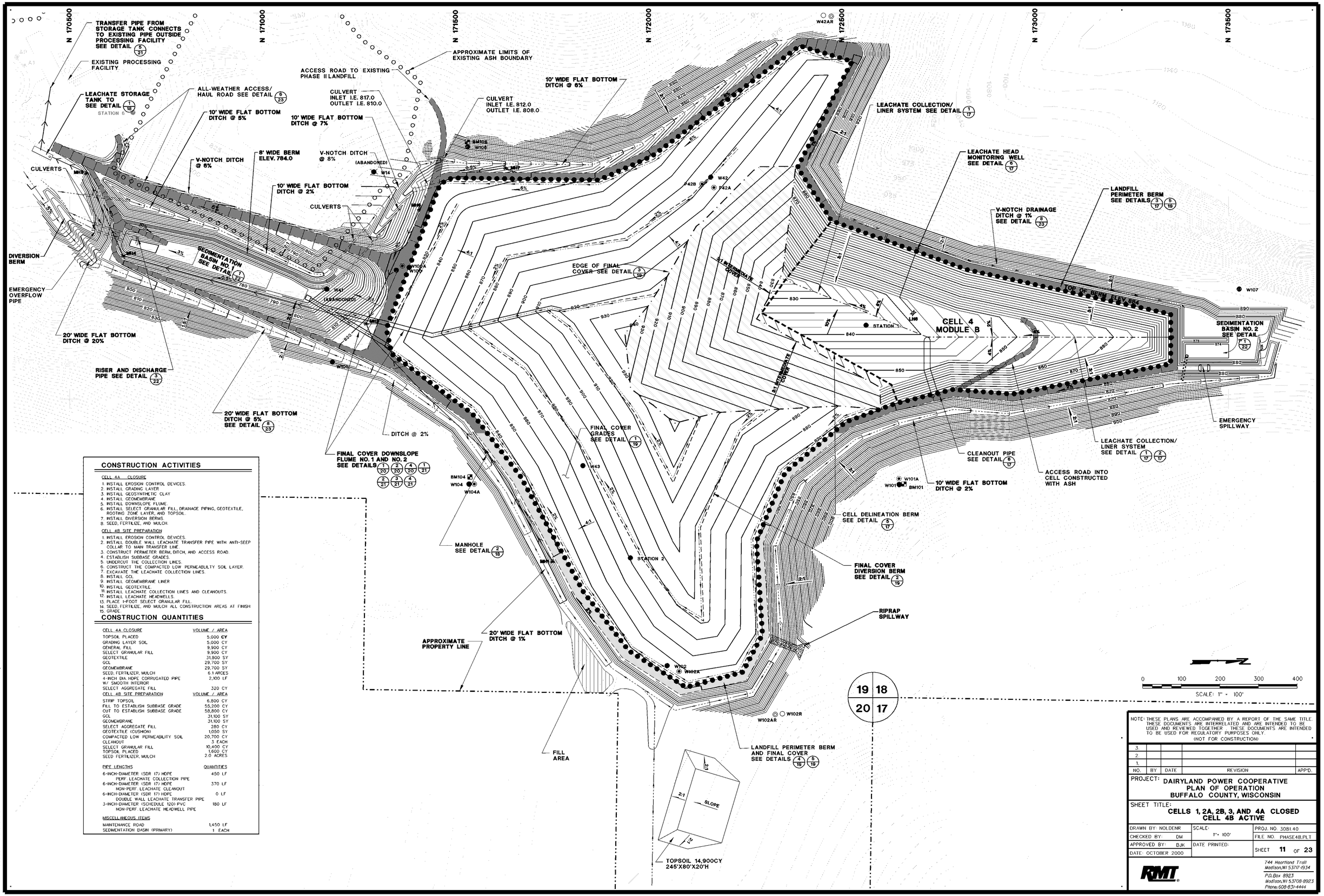


## CONSTRUCTION ACTIVITIES

CELL 4A CLOSURE

1. INSTALL EROSION CONTROL DEVICES.
2. INSTALL GRADING LAYER.
3. INSTALL GEOSYNTHETIC CLAY.
4. INSTALL GEOMEMBRANE.
5. INSTALL DOWNSLOPE FLUME.
6. INSTALL SELECT GRANULAR FILL, DRAINAGE PIPING, GEOTEXTILE, ROOTING ZONE LAYER, AND TOPSOIL.
7. INSTALL DIVERSION BERMS.
8. SEED, FERTILIZE, AND MULCH.

CELL 4B SITE PREPARATION

1. INSTALL EROSION CONTROL DEVICES.
2. INSTALL DOUBLE WALL LEACHATE TRANSFER PIPE WITH ANTI-SEEP COLLAR TO MAIN TRANSFER LINE.
3. CONSTRUCT PERIMETER BERM, DITCH, AND ACCESS ROAD.
4. ESTABLISH SUBBASE GRADES.
5. UNDERCUT THE COLLECTION LINES.
6. CONSTRUCT THE COMPACTED LOW PERMEABILITY SOIL LAYER.
7. EXCAVATE THE LEACHATE COLLECTION LINES.
8. INSTALL GCL.
9. INSTALL GEOMEMBRANE LINER.
10. INSTALL GEOTEXTILE.
11. INSTALL LEACHATE COLLECTION LINES AND CLEANOUTS.
12. INSTALL LEACHATE HEADWELLS.
13. PLACE 1-FOOT SELECT GRANULAR FILL.
14. SEED, FERTILIZE, AND MULCH ALL CONSTRUCTION AREAS AT FINISH.
15. GRADE.

## CONSTRUCTION QUANTITIES

| CELL 4A CLOSURE | VOLUME / AREA |
|---|---|
| TOPSOIL PLACED | 5,000 CY |
| GRADING LAYER SOIL | 5,000 CY |
| GENERAL FILL | 9,900 CY |
| SELECT GRANULAR FILL | 9,900 CY |
| GEOTEXTILE | 31,800 SY |
| GCL | 29,700 SY |
| GEOMEMBRANE | 29,700 SY |
| SEED, FERTILIZER, MULCH | 6.1 ARCES |
| 4-INCH DIA. HDPE CORRUGATED PIPE W/ SMOOTH INTERIOR | 2,100 LF |
| SELECT AGGREGATE FILL | 320 CY |
| **CELL 4B SITE PREPARATION** | **VOLUME / AREA** |
| STRIP TOPSOIL | 6,800 CY |
| FILL TO ESTABLISH SUBBASE GRADE | 55,200 CY |
| CUT TO ESTABLISH SUBBASE GRADE | 58,800 CY |
| GCL | 31,100 SY |
| GEOMEMBRANE | 31,100 SY |
| SELECT AGGREGATE FILL | 280 CY |
| GEOTEXTILE (CUSHION) | 1,050 SY |
| COMPACTED LOW PERMEABILITY SOIL | 20,700 CY |
| CLEANOUT | 3 EACH |
| SELECT GRANULAR FILL | 10,400 CY |
| TOPSOIL PLACED | 1,600 CY |
| SEED FERTILIZER, MULCH | 2.0 ACRES |
| **PIPE LENGTHS** | **QUANTITIES** |
| 6-INCH-DIAMETER (SDR 17) HDPE PERF. LEACHATE COLLECTION PIPE | 450 LF |
| 6-INCH-DIAMETER (SDR 17) HDPE NON-PERF. LEACHATE CLEANOUT | 370 LF |
| 6-INCH-DIAMETER (SDR 17) HDPE DOUBLE WALL LEACHATE TRANSFER PIPE | 0 LF |
| 3-INCH-DIAMETER (SCHEDULE 120) PVC NON-PERF. LEACHATE HEADWELL PIPE | 180 LF |
| **MISCELLANEOUS ITEMS** | |
| MAINTENANCE ROAD | 1,450 LF |
| SEDIMENTATION BASIN (PRIMARY) | 1 EACH |

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| NO. | BY | DATE | REVISION | APP'D. |
|---|---|---|---|---|
| 3. | | | | |
| 2. | | | | |
| 1. | | | | |

PROJECT: DAIRYLAND POWER COOPERATIVE
PLAN OF OPERATION
BUFFALO COUNTY, WISCONSIN

SHEET TITLE:
**CELLS 1, 2A, 2B, 3, AND 4A CLOSED**
**CELL 4B ACTIVE**

| | | |
|---|---|---|
| DRAWN BY: NOLDENR | SCALE: 1" = 100' | PROJ. NO. 3081.40 |
| CHECKED BY: DM | | FILE NO. PHASE4B.PLT |
| APPROVED BY: BJK | DATE PRINTED: | SHEET 11 OF 23 |
| DATE: OCTOBER 2000 | | |

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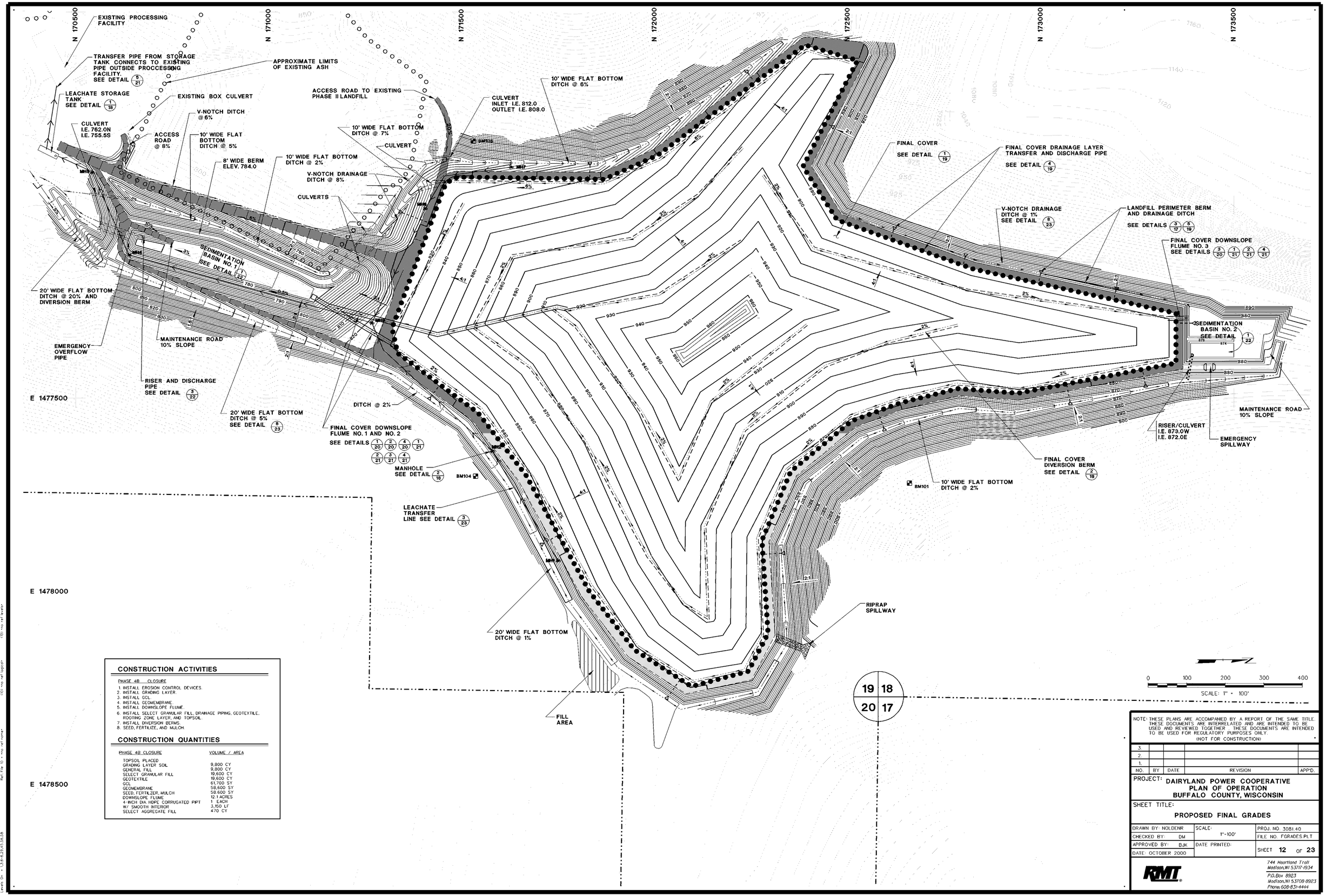
RMT COMPUTER AIDED DESIGN & DRAFTING




## CONSTRUCTION ACTIVITIES

PHASE 4B CLOSURE

1. INSTALL EROSION CONTROL DEVICES.
2. INSTALL GRADING LAYER.
3. INSTALL GCL.
4. INSTALL GEOMEMBRANE.
5. INSTALL DOWNSLOPE FLUME.
6. INSTALL SELECT GRANULAR FILL, DRAINAGE PIPING, GEOTEXTILE, ROOTING ZONE LAYER, AND TOPSOIL.
7. INSTALL DIVERSION BERMS.
8. SEED, FERTILIZE, AND MULCH.

## CONSTRUCTION QUANTITIES

| PHASE 4B CLOSURE | VOLUME / AREA |
|---|---|
| TOPSOIL PLACED | |
| GRADING LAYER SOIL | 9,800 CY |
| GENERAL FILL | 9,800 CY |
| SELECT GRANULAR FILL | 19,600 CY |
| GEOTEXTILE | 19,600 CY |
| GCL | 61,700 SY |
| GEOMEMBRANE | 58,600 SY |
| SEED, FERTILIZER, MULCH | 58,600 SY |
| DOWNSLOPE FLUME | 12.1 ACRES |
| 4-INCH DIA HDPE CORRUGATED PIPT W/ SMOOTH INTERIOR | 1 EACH |
| | 3,150 LF |
| SELECT AGGREGATE FILL | 470 CY |

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| 3. | | | | |
| 2. | | | | |
| 1. | | | | |

PROJECT: DAIRYLAND POWER COOPERATIVE
PLAN OF OPERATION
BUFFALO COUNTY, WISCONSIN

SHEET TITLE:
PROPOSED FINAL GRADES

| | | |
|---|---|---|
| DRAWN BY: NOLDENR | SCALE: 1"=100' | PROJ. NO. 3081.40 |
| CHECKED BY: DM | | FILE NO. FGRADES.PLT |
| APPROVED BY: BJK | DATE PRINTED: | SHEET 12 OF 23 |
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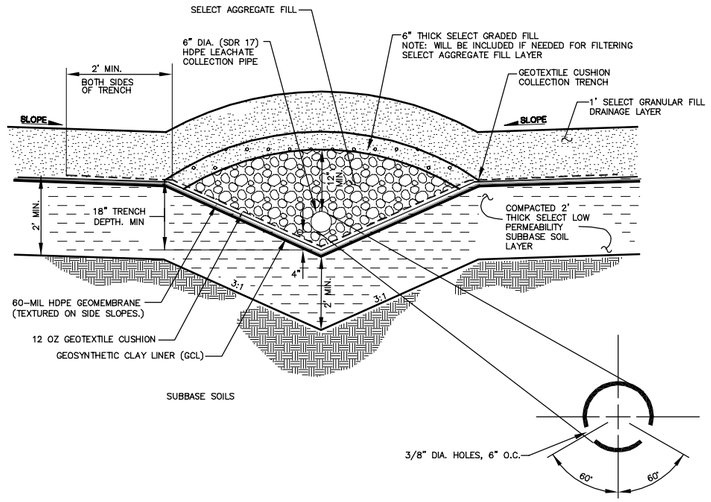
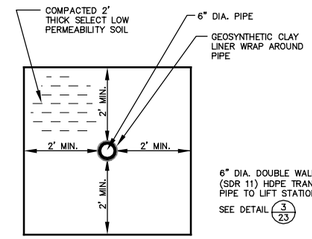
RMT COMPUTER AIDED DESIGN & DRAFTING

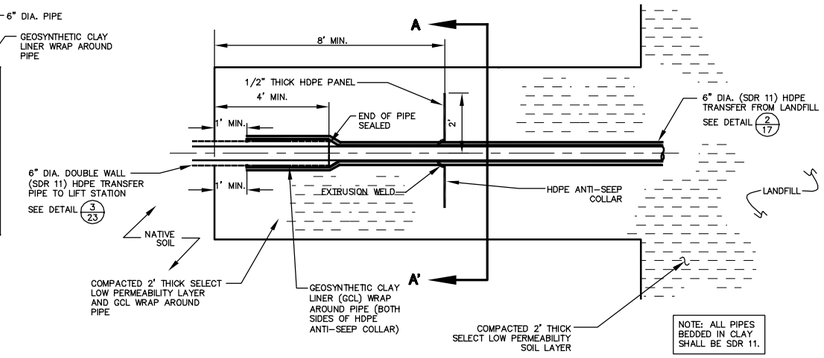



1/17 **LEACHATE COLLECTION/LINER SYSTEM**

(NOT TO SCALE)

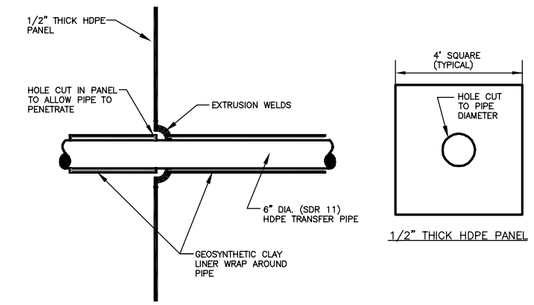



**SECTION A-A'**

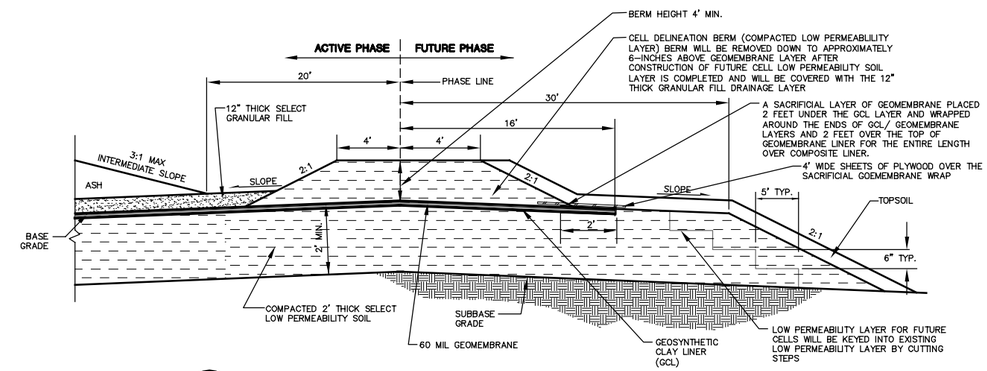



4/17 **LEACHATE TRANSFER PIPE CLAY TRENCH CUT-OFF THROUGH PERIMETER BERM (TYPICAL)**

(NOT TO SCALE)

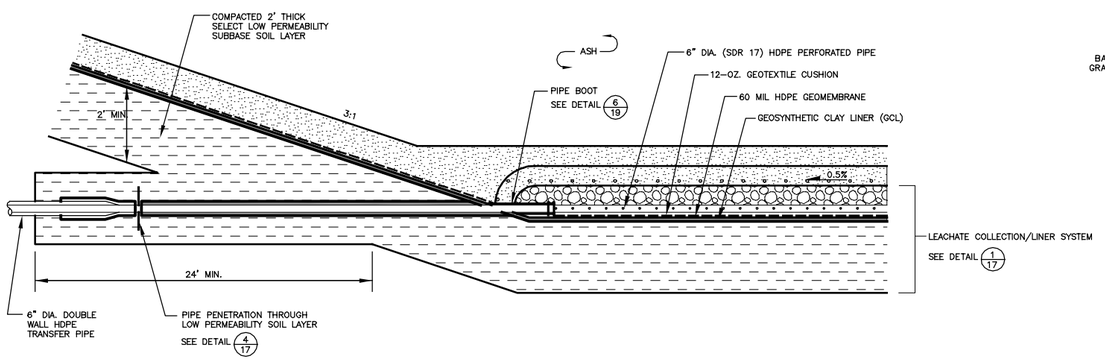



**HDPE ANTI-SEEP COLLAR DETAIL (TYPICAL)**



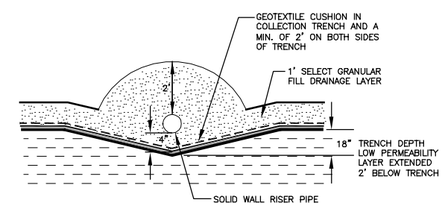

5/17 **CELL DELINEATION BERM**

(NOT TO SCALE)



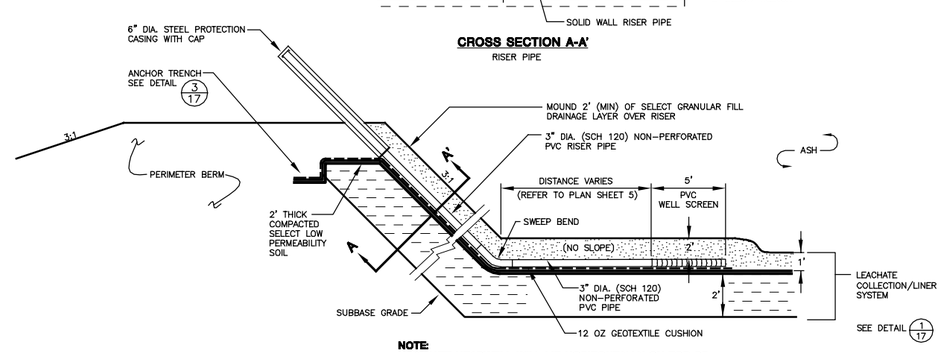

2/17 **PIPE PENETRATION THROUGH LANDFILL PERIMETER BERM (TYPICAL)**

(NOT TO SCALE)
LOOKING EAST




**CROSS SECTION A-A'**

RISER PIPE

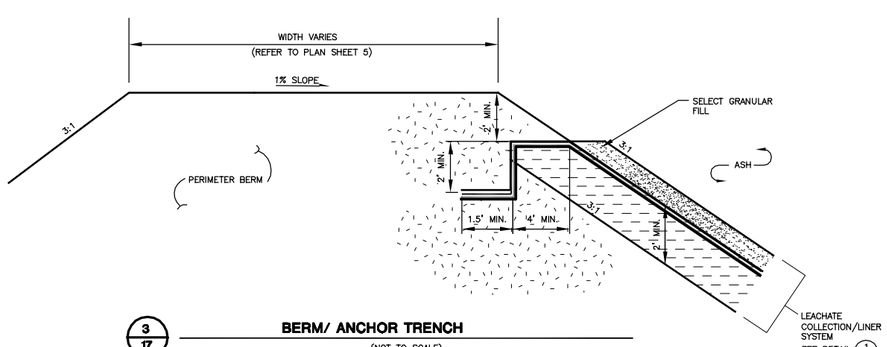



**NOTE:**
**LEACHATE HEADWELL WILL LIE HORIZONTALLY ON TOP OF LINER AND WITHIN 12" SELECT GRANULAR FILL DRAINAGE LAYER.**

**PIPE CONSTRUCTION ON BERM SIDE SLOPE IS ALSO TYPICAL FOR LEACHATE CLEANOUT PIPES.**

6/17 **LEACHATE HEADWELL**

(NOT TO SCALE)




3/17 **BERM/ ANCHOR TRENCH**

(NOT TO SCALE)

## LINE AND SHADING LEGEND

| | | | |
|---|---|---|---|
| | GEOTEXTILE | | GEOMEMBRANE |
| | GEOCOMPOSITE | | GEOSYNTHETIC CLAY LINER (GCL) |
| | TOPSOIL | | NATIVE SOIL |
| | SELECT GRANULAR FILL DRAINAGE LAYER | | CONCRETE |
| | PIPE BEDDING MATERIAL | | RIPRAP |
| | SELECT AGGREGATE FILL | | GRAVEL |
| | COMPACTED SELECT LOW PERMEABILITY SOIL | | GENERAL FILL |

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PROJECT: **DAIRYLAND POWER COOPERATIVE PLAN OF OPERATION BUFFALO COUNTY, WISCONSIN**

SHEET TITLE: **DETAILS- LINER AND COLLECTION PIPES**

| | | |
|---|---|---|
| DRAWN BY: DEFOEJ | SCALE: | PROJ. NO. 3081.40 |
| CHECKED BY: DM | NOT TO SCALE | FILE NO. 30814005.DWG |
| APPROVED BY: BJK | DATE PRINTED: | SHEET 17 OF 23 |
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Madison, WI 53708-8923
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$$SCALE$$
$$PORTB$$
$$PORTRB$$
Attached Xref's: No xref's Attached.
$$DATE$$
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$$HOST$$
$$DWG$$
$$PLOT$$
$$PCP$$
$$COLORMAP$$
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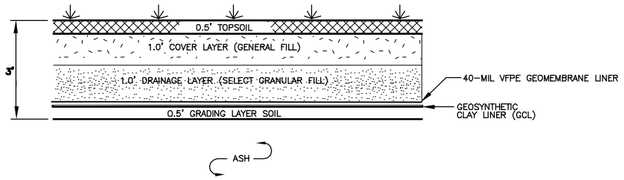
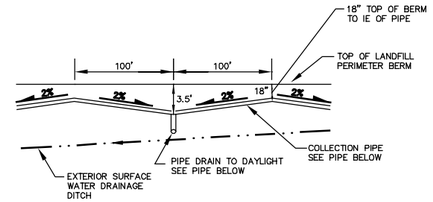


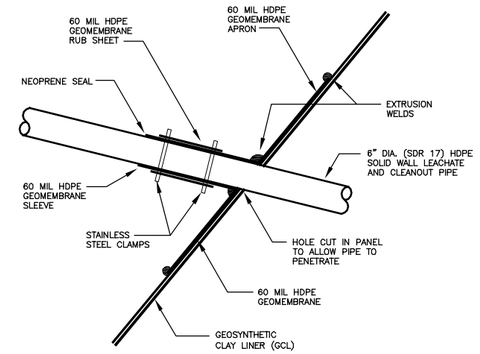

1/19 **FINAL COVER**

(NOT TO SCALE)



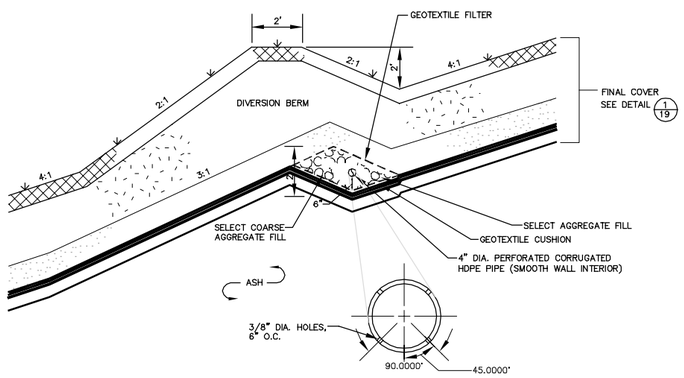

**NOTE: IN AREAS WHERE THE TOP OF BERM SLOPES, THE COLLECTION PIPE WILL FOLLOW THE SAME SLOPE AS THE TOP OF BERM AND WILL OUTLET THROUGH DISCHARGE PIPES LOCATED AT SPECIFIED INTERVALS. REFER TO PLAN SHEET 12.**

**SECTION A-A' OF FINAL COVER DRAINAGE LAYER**




6/19 **PIPE BOOT- PIPES PENETRATING THROUGH FINAL COVER AND LOW PERMEABILITY LAYER (TYPICAL)**

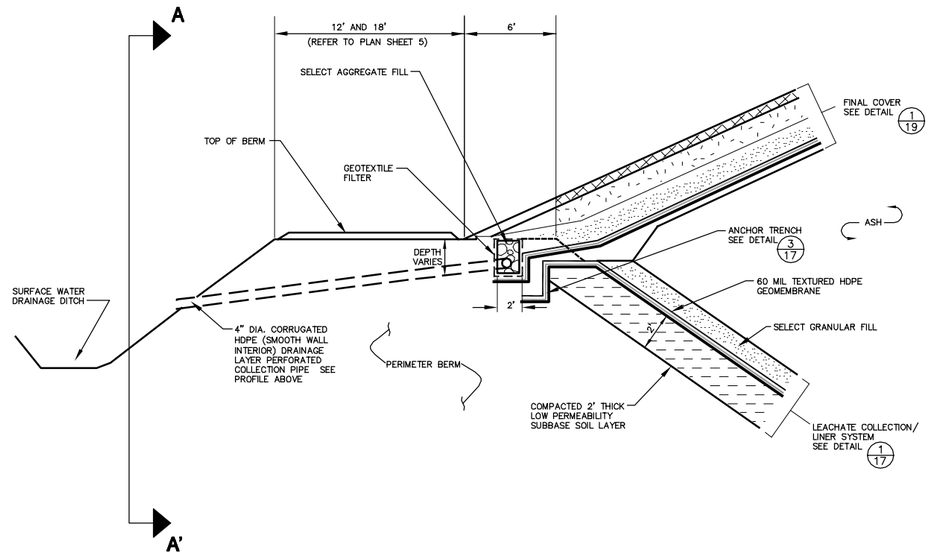
(NOT TO SCALE)




**NOTE:**
**A 4" DIA. PERFORATED CORRUGATED HDPE PIPE WILL BE LOCATED BELOW EVERY DIVERSION BERM ABOVE THE FINAL COVER EXCEPT THE LOWEST BERM LOCATED NEXT TO THE LANDFILL PERIMETER BERM. TO COLLECT WATER IN THE DRAINAGE LAYER ALONG THE PERIMETER BERM PIPES WILL BE CONSTRUCTED IN THE BERM AS SHOWN ON DETAIL 4 OF 19.**

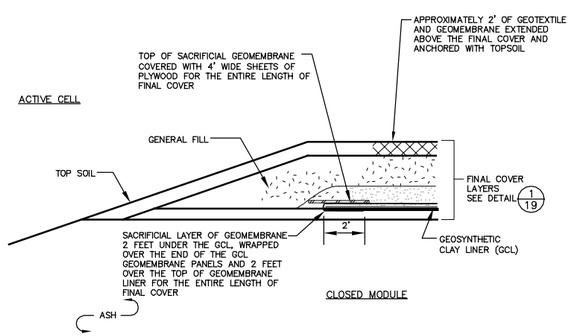
2/19 **SURFACE WATER DIVERSION BERM ON FINAL COVER (TYPICAL)**

(NOT TO SCALE)



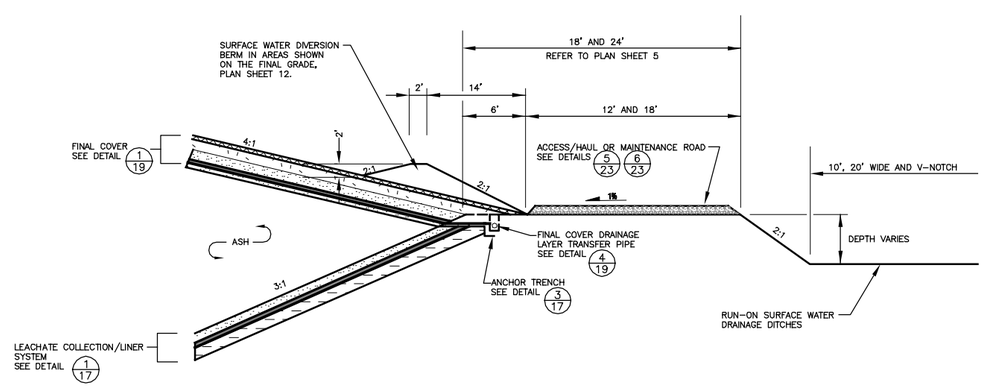

4/19 **PERIMETER BERM FINAL COVER DRAINAGE LAYER DISCHARGE PIPE (TYPICAL)**

(NOT TO SCALE)




3/19 **CONSTRUCTION OF FINAL COVER FOR SPLICING FUTURE FINAL COVER**

(NOT TO SCALE)




5/19 **LANDFILL PERIMETER BERM AND SURFACE WATER DRAINAGE DITCHES (TYPICAL)**

(NOT TO SCALE)

**LINE AND SHADING LEGEND**

| | |
|---|---|
| GEOTEXTILE | GEOMEMBRANE |
| GEOCOMPOSITE | GEOSYNTHETIC CLAY LINER (GCL) |
| TOPSOIL | NATIVE SOIL |
| SELECT GRANULAR FILL DRAINAGE LAYER | CONCRETE |
| PIPE BEDDING MATERIAL | RIPRAP |
| SELECT AGGREGATE FILL | GRAVEL |
| COMPACTED SELECT LOW PERMEABILITY SOIL | GENERAL FILL |

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|---|---|---|---|---|
| 3. | | | | |
| 2. | | | | |
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PROJECT: **DAIRYLAND POWER COOPERATIVE PLAN OF OPERATION BUFFALO COUNTY, WISCONSIN**

SHEET TITLE: **DETAILS- FINAL COVER**

| | | |
|---|---|---|
| DRAWN BY: DEFOEJ | SCALE: | PROJ. NO. 3081.40 |
| CHECKED BY: DM | NOT TO SCALE | FILE NO. 30814004.dwg |
| APPROVED BY: BJK | DATE PRINTED: | SHEET 19 OF 23 |
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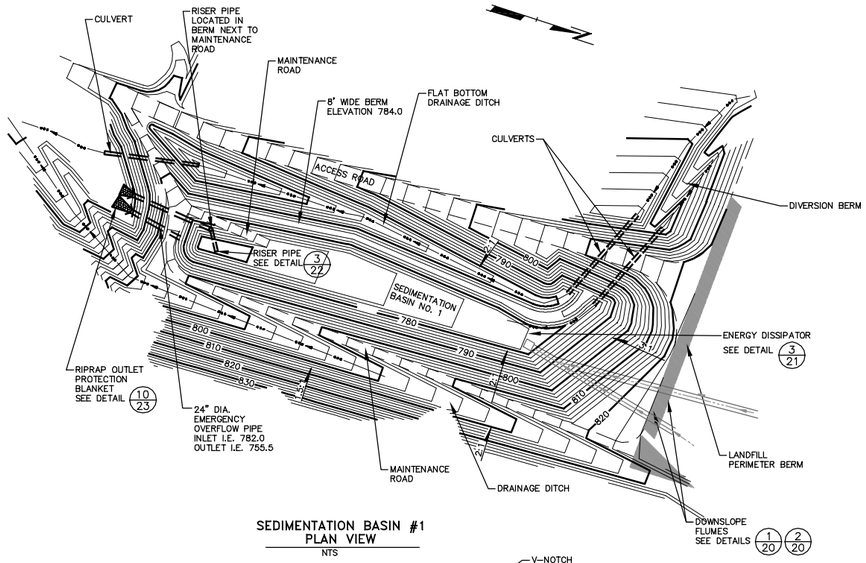
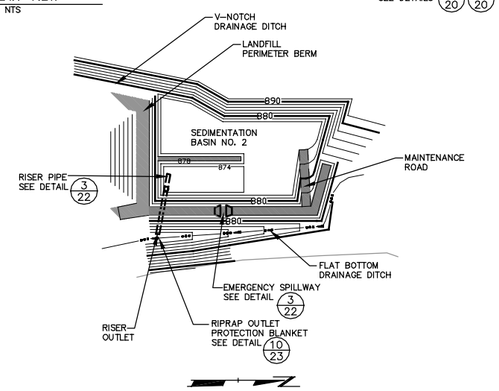


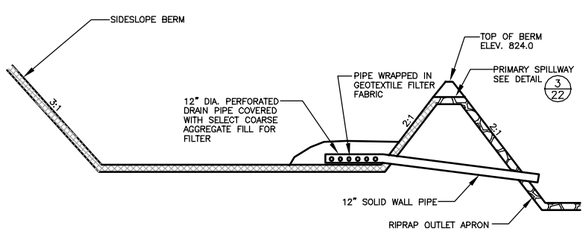

SEDIMENTATION BASIN #1
PLAN VIEW
NTS




SEDIMENTATION BASIN #2
PLAN VIEW
NTS

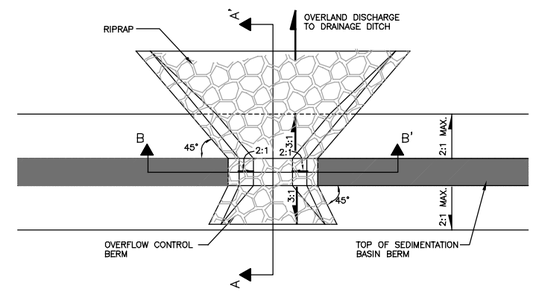
1/22 **SEDIMENTATION BASINS NO. 1 AND NO. 2**

(NOT TO SCALE)



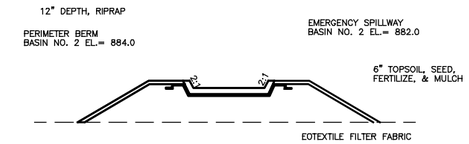

2/22 **TEMPORARY SEDIMENTATION BASIN (TYPICAL)**

(NOT TO SCALE)

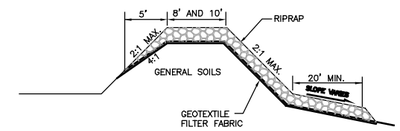



SURFACE WATER PRIMARY OR EMERGENCY SPILLWAY
PLAN VIEW

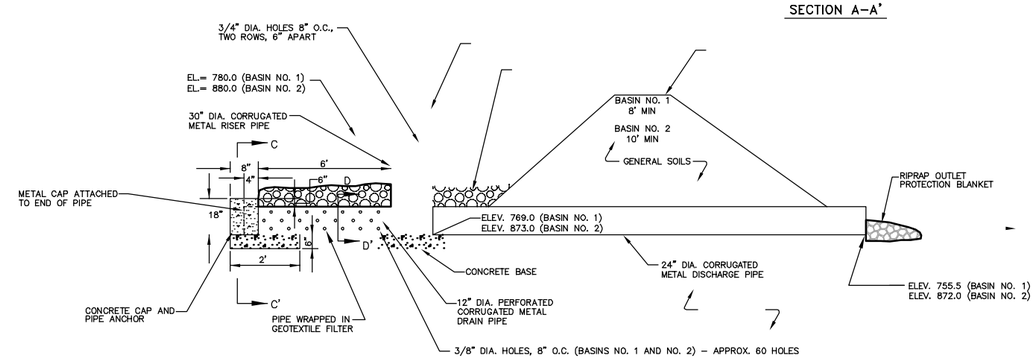
**NOTE:**
**SEDIMENTATION BASIN NO. 1 WILL HAVE A CULVERT PIPE INSTALLED FOR THE EMERGENCY OVERFLOW. SEE DETAIL 1 OF 22.**



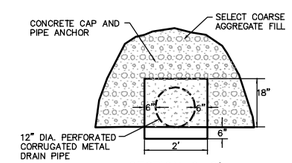

CROSSECTION B–B'



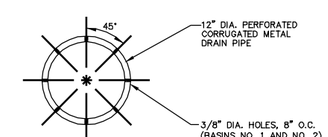

SECTION A–A'




RISER/DISCHARGE PIPE CROSS SECTION (TYPICAL)




SECTION C–C'




SECTION D–D'

3/22 **RISER/DISCHARGE PIPE/EMERGENCY SPILLWAY**

(NOT TO SCALE)

**LINE AND SHADING LEGEND**

| | |
|---|---|
| GEOTEXTILE | GEOMEMBRANE |
| GEOCOMPOSITE | GEOSYNTHETIC CLAY LINER (GCL) |
| TOPSOIL | NATIVE SOIL |
| SELECT GRANULAR FILL DRAINAGE LAYER | CONCRETE |
| PIPE BEDDING MATERIAL | RIPRAP |
| SELECT AGGREGATE FILL | GRAVEL |
| COMPACTED SELECT LOW PERMEABILITY SOIL | GENERAL FILL |

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PROJECT: **DAIRYLAND POWER COOPERATIVE PLAN OF OPERATION BUFFALO COUNTY, WISCONSIN**

SHEET TITLE: **DETAILS- SEDIMENTATION BASINS**

| | | |
|---|---|---|
| DRAWN BY: DETOEJ | SCALE: NOT TO SCALE | PROJ. NO. 3081.40 |
| CHECKED BY: DM | | FILE NO. 30814007.dwg |
| APPROVED BY: BJK | DATE PRINTED: | SHEET 22 OF 23 |
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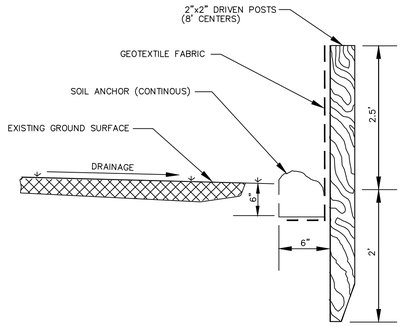
$$SCALE$$ $$SOURCE$$ $$SOURCE$$ Attached Xref's: No xref's Attached.

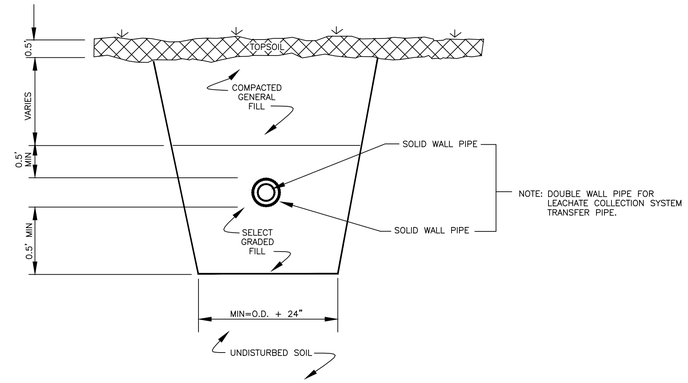
PLOT BY: $$USER$$ PLOT DATE: $$DATE$$ $$USER$$ $$PRFILE$$ $$PLOTTER$$ $$PLOTTER$$

RMT COMPUTER AIDED DESIGN & DRAFTING

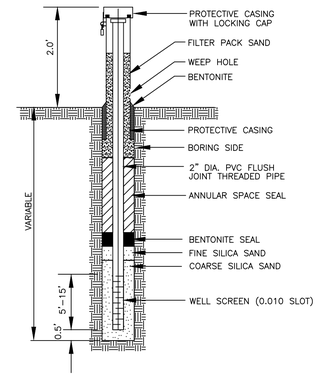



**NOTE:**
DETAIL SHOWN FOR PURPOSES OF IDENTIFYING INSTALLATION METHOD. LOCATION OF FENCE WILL BE DETERMINED AT DEVELOPMENT OF ENGINEERING PLANS FOR EACH PHASE OF CONSTRUCTION AND IN THE FIELD DURING ACTUAL CONSTRUCTION OF EACH PHASE.

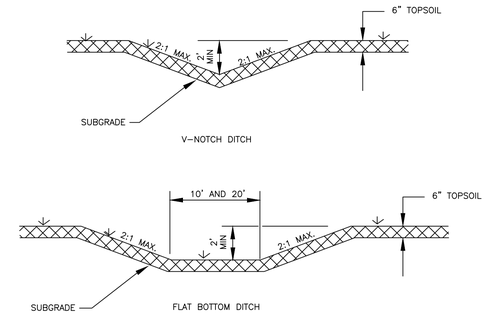
1/23 **SEDIMENT CONTROL FENCE**
(NOT TO SCALE)



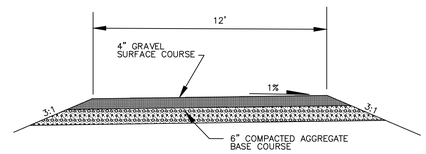

3/23 **DOUBLE WALL TRANSFER PIPE**
(NOT TO SCALE)



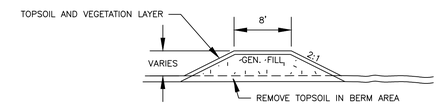

4/23 **WATER TABLE MONITORING WELL**
NOT TO SCALE



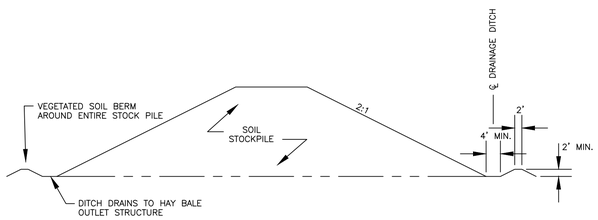

8/23 **DRAINAGE DITCH DETAILS OUTSIDE LANDFILL COVER**
(NOT TO SCALE)



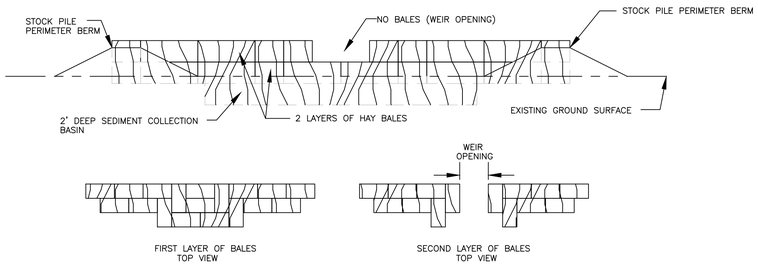

5/23 **MAINTENACE ROAD**
(NOT TO SCALE)



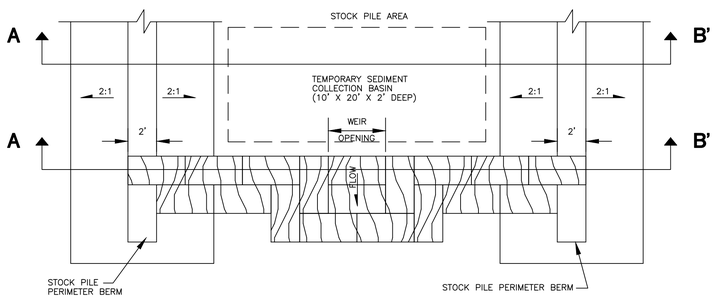

9/23 **TEMPORARY BERM FOR CONTROLLING WATER**
(NOT TO SCALE)



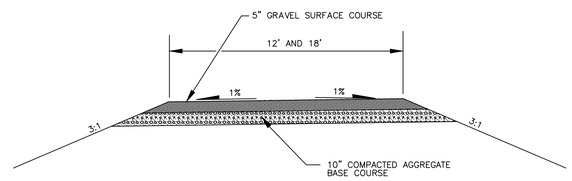

## SECTION B-B'



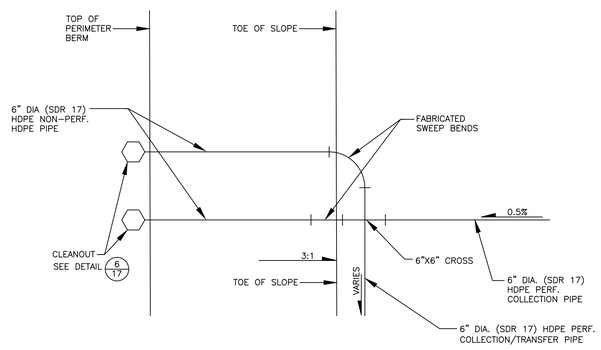

## SECTION A-A'



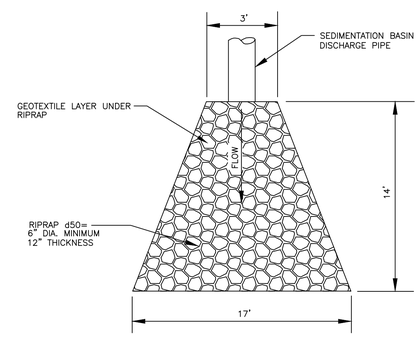

2/23 **SURFACE WATER OUTLET FOR STOCKPILES**
(NOT TO SCALE)




6/23 **ALL WEATHER ACCESS/ HAUL ROAD**
(NOT TO SCALE)




7/23 **PIPE CONNECTIONS (TYPICAL)**
(NOT TO SCALE)




10/23 **DISCHARGE PIPE RIPRAP OUTLET PROTECTION BLANKET**
(NOT TO SCALE)

### LINE AND SHADING LEGEND

| | |
|---|---|
| GEOTEXTILE | GEOMEMBRANE |
| GEOCOMPOSITE | GEOSYNTHETIC CLAY LINER (GCL) |
| TOPSOIL | NATIVE SOIL |
| SELECT GRANULAR FILL DRAINAGE LAYER | CONCRETE |
| PIPE BEDDING MATERIAL | RIPRAP |
| SELECT AGGREGATE FILL | GRAVEL |
| COMPACTED SELECT LOW PERMEABILITY SOIL | GENERAL FILL |

NOTE: THESE PLANS ARE ACCOMPANIED BY A REPORT OF THE TITLE. THESE DOCUMENTS ARE INTERRELATED AND ARE INTENDED TO BE USED AND REVIEWED TOGETHER. THESE DOCUMENTS ARE INTENDED TO BE USED FOR REGULATORY PURPOSES ONLY.
NOT FOR CONSTRUCTION

| NO. | BY | DATE | REVISION | APP'D. |
|---|---|---|---|---|
| 3. | | | | |
| 2. | | | | |
| 1. | | | | |

PROJECT: **DAIRYLAND POWER COOPERATIVE PLAN OF OPERATION BUFFALO COUNTY, WISCONSIN**

SHEET TITLE: **DETAILS- MISCELLANEOUS**

| | | |
|---|---|---|
| DRAWN BY: DEFOEJ | SCALE: NOT TO SCALE | PROJ. NO. 3081.40 |
| CHECKED BY: DM | | FILE NO. 30814003.dwg |
| APPROVED BY: BJK | DATE PRINTED: | SHEET 23 OF 23 |
| DATE: OCTOBER 2000 | | |

RMT
744 Heartland Trail
Madison, WI 53717-1934
P.O. Box 8923
Madison, WI 53708-8923
Phone: 608/831-4444

$$SCALE$$
$$ROT$$
$$ROTB$$
$$XREFS$$
Attached Xref's: No xref's Attached.
CADD DATA
$$DATE$$
$$USER$$
$$PIP$$
$$PLOT$$
$$PLOTTER$$
RMT COMPUTER AIDED DESIGN & DRAFTING

# Appendix L: CCR Well Construction Documentation

State of Wisconsin
Department of Natural Resources

# SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 5-97

Route To: Watershed/Wastewater ☐ Waste Management ☒
Remediation/Redevelopment ☐ Other ☐



| Facility/Project Name | License/Permit/Monitoring Number | Boring Number |
|---|---|---|
| Dairyland Power | | W-100R |

| Boring Drilled By (Firm name and name of crew chief) | Date Drilling Started | Date Drilling Completed | Drilling Method |
|---|---|---|---|
| Boart-longyear / T. Schmalfelt | 5/17/01 | 5/17/01 | 4 1/4 HSA / Rotary |

| WI Unique Well No. | DNR Well ID No. | Common Well Name | Final Static Water Level | Surface Elevation | Borehole Diameter |
|---|---|---|---|---|---|
| JQ 894 | | W-100R | Feet MSL | Feet MSL | 8.0 Inches |

Boring Location or Local Grid Origin (Check if estimated: ☐ )
State Plane S/C/N
NE 1/4 of NE 1/4 of Section 19 T21 N, R 12W
Lat. ___ ° ___ ' ___ "
Long. ___ ° ___ ' ___ "
Local Grid Location (If applicable) ☐ N Feet ☐ S ☐ E Feet ☐ W

| Facility ID | County | County Code | Civil Town/City/ or Village |
|---|---|---|---|
| 3410-1789 | Buffalo | 6 | Alma |

| Sample Number and Type | Length Att. & Recovered (in) | Blow Counts | Depth in Feet | Soil/Rock Description And Geologic Origin For Each Major Unit | U S C S | Graphic Log | Well Diagram | PID/FID | Soil Properties: Compressive Strength | Moisture Content | Liquid Limit | Plasticity Index | P 200 | RQD/ Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | Earth Drill | | | | | | | | | | |
| | | | | 4 1/4" HSA | | | | | | | | | | |
| | | | 2 | No samples taken. See boring log for W100AR. | | | | | | | | | | |
| | | | 3 | | | | | | | | | | | |
| | | | 4 | | | | | | | | | | | |
| | | | 5 | | | | | | | | | | | |
| | | | 6 | | | | | | | | | | | |
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| | | | 8 | | | | | | | | | | | |
| | | | 9 | | | | | | | | | | | |
| | | | 10 | | | | | | | | | | | |
| | | | 11 | | | | | | | | | | | |
| | | | 12 | | | | | | | | | | | |

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature [signature] Firm Boart Longyear
101 Alderson St. Schofield, WI 54476
Tel: (715)359-7090
Fax: (715)355-5715

This form is authorized by Chapters 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats. Completions of this form is mandatory. Failure to file this form may result in forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be be used for any other purpose. NOTE: See instructions for more information, including where the completed form should be sent.

State of Wisconsin
Department of Natural Resources

# SOIL BORING LOG INFORMATION SUPPLEMENT

Form 4400-122A Rev. 5-97

Boring Number W-100R

Use only as an attachment to Form 4400-122.



| Sample Number and Type | Sample Length Att. & Recovered (in) | Blow Counts | Depth In Feet | Soil/Rock Description And Geologic Origin For Each Major Unit | U S C S | Graphic Log | Well Diagram | PID/FID | Soil Properties: Compressive Strength | Moisture Content | Liquid Limit | Plasticity Index | # 200 | RQD/ Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 13 | | | | | | | | | | | |
| | | | 14 | | | | | | | | | | | |
| | | | 15 | Air Rotary | | | | | | | | | | |
| | | | 16 | | | | | | | | | | | |
| | | | 17 | | | | | | | | | | | |
| | | | 18 | | | | | | | | | | | |
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| | | | 31 | | | | | | | | | | | |
| | | | 32 | | | | | | | | | | | |

State of Wisconsin
Department of Natural Resources

# SOIL BORING LOG INFORMATION SUPPLEMENT

Form 4400-122A Rev. 5-97

Boring Number W-100R Use only as an attachment to Form 4400-122. 

| Sample | | | | | | | | | Soil Properties | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number and Type | Length Att. & Recovered (in) | Blow Counts | Depth In Feet | Soil/Rock Description And Geologic Origin For Each Major Unit | U S C S | Graphic Log | Well Diagram | PID/FID | Compressive Strength | Moisture Content | Liquid Limit | Plasticity Index | P 200 | RQD/ Comments |
| | | | 33 | | | | | | | | | | | |
| | | | 34 | | | | | | | | | | | |
| | | | 35 | | | | | | | | | | | |
| | | | 36 | | | | | | | | | | | |
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| | | | 52 | | | | | | | | | | | |

State of Wisconsin
Department of Natural Resources

# SOIL BORING LOG INFORMATION SUPPLEMENT

Form 4400-122A Rev. 5-97

Boring Number W-100R Use only as an attachment to Form 4400-122.



| Sample | | | | | | | | | Soil Properties | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number and Type | Length Att. & Recovered (in) | Blow Counts | Depth In Feet | Soil/Rock Description And Geologic Origin For Each Major Unit | U S C S | Graphic Log | Well Diagram | PID/FID | Compressive Strength | Moisture Content | Liquid Limit | Plasticity Index | P 200 | RQD/ Comments |
| | | | 53 | | | | | | | | | | | |
| | | | 54 | | | | | | | | | | | |
| | | | 55 | | | | | | | | | | | |
| | | | 56 | | | | | | | | | | | |
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| | | | 70 | | | | | | | | | | | |
| | | | 71 | | | | | | | | | | | |
| | | | 72 | | | | | | | | | | | |

State of Wisconsin
Department of Natural Resources

# SOIL BORING LOG INFORMATION SUPPLEMENT

Form 4400-122A Rev. 5-97

Boring Number W-100R Use only as an attachment to Form 4400-122.



| Sample | | | | | | | | | | Soil Properties | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number and Type | Length Att. & Recovered (in) | Blow Counts | Depth In Feet | Soil/Rock Description And Geologic Origin For Each Major Unit | U S C S | Graphic Log | Well Diagram | PID/FID | Compressive Strength | Moisture Content | Liquid Limit | Plasticity Index | P 200 | RQD/ Comments |
| | | | 73 | | | | | | | | | | | |
| | | | 74 | | | | | | | | | | | |
| | | | 75 | | | | | | | | | | | |
| | | | 76 | EOB 76.0'<br>Well Set 75.0' | | | | | | | | | | |

State of Wisconsin
Department of Natural Resources

# SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☒
Remediation/Redevelopment ☐ Other ☐



| Facility/Project Name | License/Permit/Monitoring Number | Boring Number |
|---|---|---|
| Dairyland Power Cooperative | | W-100AR |

| Boring Drilled By: Name of crew chief (first, last) and Firm | Date Drilling Started | Date Drilling Completed | Drilling Method |
|---|---|---|---|
| Boart-Longyear/T. Schmalfelt. | 5/17/2001 | 5/17/2001 | HSA w/SPT/Rotary |

| WI Unique Well No. | DNR Well ID No. | Common Well Name | Final Static Water Level | Surface Elevation | Borehole Diameter |
|---|---|---|---|---|---|
| JQ893 | | W-100AR | 712.4 Feet MSL | 781.8 Feet MSL | 8.0 inches |

Local Grid Origin ☐ (estimated: ☐ ) or Boring Location ☒
State Plane 171,202 N, 1,477,198 E S/C/N
NE 1/4 of NE 1/4 of Section 19, T 21 N, R 12 W
Lat ___° ___' ___"
Long ___° ___' ___"
Local Grid Location
Feet ☐ N ☐ S Feet ☐ E ☐ W

| Facility ID | County | County Code | Civil Town/City/ or Village |
|---|---|---|---|
| | Buffalo | 6 | Alma |

| Sample Number and Type | Length Att. & Recovered (in) | Blow Counts | Depth In Feet | Soil/Rock Description And Geologic Origin For Each Major Unit | U S C S | Graphic Log | Well Diagram | PID/FID | Compressive Strength | Moisture Content | Liquid Limit | Plasticity Index | P 200 | RQD/ Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 0–1 | **SANDY TOPSOIL,** dark brown, dry, loose, trace rootlets. | | | | | | | | | | |
| | | | 1–5 | **SILTY LOESS MATERIAL,** reddish brown, dry, loose, trace rootlets. | | | | | | | | | | |
| 1 SS | 24 14 | 6 8 11 13 (19) | 5–10 | **POORLY GRADED SAND (SP),** some gravel, tan, dry, medium dense. | SP | | | | | | | | | |
| 2 SS | 24 0 | >50 | 10–12 | No recovery, abundant cobbles and boulders. | | | | | | | | | | |

I hereby certify that the information on this form is true and correct to the best of my knowledge.

| Signature | Firm | |
|---|---|---|
| Michael J. Dickey | RMT, Inc<br>744 Heartland Trail Madison, WI 53719 | Tel: 608-831-4444<br>Fax: 608-831-3334 |

This form is authorized by Chapters 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats. Completion of this form is mandatory. Failure to file this form may result in forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be be used for any other purpose. NOTE: See instructions for more information, including where the completed form should be sent.

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State of Wisconsin
Department of Natural Resources

# SOIL BORING LOG INFORMATION SUPPLEMENT

Form 4400-122A

Boring Number W-100AR Use only as an attachment to Form 4400-122.



| Sample: Number and Type | Sample: Length Att. & Recovered (in) | Blow Counts | Depth In Feet | Soil/Rock Description And Geologic Origin For Each Major Unit | U S C S | Graphic Log | Well Diagram | PID/FID | Soil Properties: Compressive Strength | Soil Properties: Moisture Content | Soil Properties: Liquid Limit | Soil Properties: Plasticity Index | Soil Properties: P 200 | RQD/ Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 13 | | | | | | | | | | | |
| | | | 14 | | | | | | | | | | | |
| 3 SS | 24 0 | >50 | 15 | No recovery, same as above. | | | | | | | | | | |
| | | | 16 | | | | | | | | | | | |
| | | | 17 | | | | | | | | | | | |
| | | | 18 | | | | | | | | | | | |
| | | | 19 | Auger refusal around 19 feet, switch to air rotary. | | | | | | | | | | Grab samples from drill cuttings observed. |
| | | | 20 | | | | | | | | | | | |
| | | | 21 | | | | | | | | | | | |
| | | | 22 | | SP | | | | | | | | | |
| | | | 23 | | | | | | | | | | | |
| | | | 24 | | | | | | | | | | | |
| | | | 25 | | | | | | | | | | | |
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| | | | 32 | | | | | | | | | | | |

WDNR_SBL_98 03081W.GPJ WI_DNR98.GDT 6/15/01

State of Wisconsin
Department of Natural Resources

# SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number W-100AR Use only as an attachment to Form 4400-122.



| Sample | | | | | | | | | Soil Properties | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number and Type | Length Att. & Recovered (in) | Blow Counts | Depth In Feet | Soil/Rock Description And Geologic Origin For Each Major Unit | U S C S | Graphic Log | Well Diagram | PID/FID | Compressive Strength | Moisture Content | Liquid Limit | Plasticity Index | P 200 | RQD/ Comments |
| | | | 33 | | | | | | | | | | | |
| | | | 34 | | | | | | | | | | | |
| | | | 35 | | | | | | | | | | | |
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| | | | 37 | | | | | | | | | | | |
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| | | | 40 | | | | | | | | | | | |
| | | | 41 | | | | | | | | | | | |
| | | | 42 | | SP | | | | | | | | | |
| | | | 43 | | | | | | | | | | | |
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State of Wisconsin
Department of Natural Resources

# SOIL BORING LOG INFORMATION SUPPLEMENT

Form 4400-122A

Boring Number W-100AR Use only as an attachment to Form 4400-122.



| Sample: Number and Type | Sample: Length Att. & Recovered (in) | Blow Counts | Depth In Feet | Soil/Rock Description And Geologic Origin For Each Major Unit | U S C S | Graphic Log | Well Diagram | PID/FID | Soil Properties: Compressive Strength | Soil Properties: Moisture Content | Soil Properties: Liquid Limit | Soil Properties: Plasticity Index | Soil Properties: P 200 | RQD/ Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 53 | | | | | | | | | | | |
| | | | 54 | | | | | | | | | | | |
| | | | 55 | | | | | | | | | | | |
| | | | 56 | | SP | | | | | | | | | |
| | | | 57 | | | | | | | | | | | |
| | | | 58 | | | | | | | | | | | |
| | | | 59 | | | | | | | | | | | |
| | | | 60 | **SANDSTONE BEDROCK,** approximate depth. | | | | | | | | | | |
| | | | 61 | | | | | | | | | | | |
| | | | 62 | | | | | | | | | | | |
| | | | 63 | | | | | | | | | | | |
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| | | | 72 | | | | | | | | | | | |

WCNR_SEL_98 03081W.GPJ WI_DNR98.GDT 6/15/01

State of Wisconsin
Department of Natural Resources

# SOIL BORING LOG INFORMATION SUPPLEMENT

Form 4400-122A

Boring Number W-100AR Use only as an attachment to Form 4400-122.



| Sample | | | | | | | | | Soil Properties | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number and Type | Length Att. & Recovered (in) | Blow Counts | Depth in Feet | Soil/Rock Description And Geologic Origin For Each Major Unit | U S C S | Graphic Log | Well Diagram | PID/FID | Compressive Strength | Moisture Content | Liquid Limit | Plasticity Index | P 200 | RQD/ Comments |
| | | | 73 | | | | | | | | | | | |
| | | | 74 | | | | | | | | | | | |
| | | | 75 | **SANDSTONE BEDROCK** | | | | | | | | | | |
| | | | 76 | | | | | | | | | | | |
| | | | 77 | | | | | | | | | | | |
| | | | 78 | | | | | | | | | | | |
| | | | 79 | | | | | | | | | | | |
| | | | 80 | | | | | | | | | | | |
| | | | 81 | | | | | | | | | | | |
| | | | 82 | | | | | | | | | | | |
| | | | 83 | | | | | | | | | | | |
| | | | 84 | | | | | | | | | | | |
| | | | 85 | | | | | | | | | | | |
| | | | 86 | | | | | | | | | | | |
| | | | 87 | | | | | | | | | | | |
| | | | 88 | | | | | | | | | | | |
| | | | 89 | | | | | | | | | | | |
| | | | 90 | | | | | | | | | | | |
| | | | 91 | | | | | | | | | | | |
| | | | 92 | | | | | | | | | | | |

WDNR_SBL_08 0306TW.GPJ WI_DNR98.GDT 6/13/08

State of Wisconsin
Department of Natural Resources

# SOIL BORING LOG INFORMATION SUPPLEMENT

Form 4400-122A

Boring Number W-100AR Use only as an attachment to Form 4400-122.



| Sample: Number and Type | Sample: Length Att. & Recovered (in) | Blow Counts | Depth In Feet | Soil/Rock Description And Geologic Origin For Each Major Unit | U S C S | Graphic Log | Well Diagram | PID/FID | Soil Properties: Compressive Strength | Soil Properties: Moisture Content | Soil Properties: Liquid Limit | Soil Properties: Plasticity Index | Soil Properties: P 200 | RQD/ Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Well set at 92 feet. | | | | | | | | | | |
| | | | 93 | **End of boring at 93 feet.** | | | | | | | | | | |

WDNR_SBL_98 03061W.GPJ WI_DNR98.GDT 6/15/01

State of Wisconsin
Department of Natural Resources

Route To:
☒ Solid Waste
☐ Emergency Response
☐ Wastewater
☐ Haz. Waste
☐ Underground Tanks
☐ Water Resources
☐ Other

# Soil Boring Log Information

Form 4400-122 7-91



| Facility/Project Name | License/Permit/Monitoring Number | Boring Number |
|---|---|---|
| Dairyland Power 3081.23 | 2927 | W101 |

| Boring Drilled By (Firm name and name of crew chief) | Date Drilling Started | Date Drilling Completed | Drilling Method |
|---|---|---|---|
| Environmental & Foundation Drilling, Crew Chief: Frank Badula | 10/25/94 | 10/25/94 | HSA 6 1/4"-6" |

| DNR Facility Well No. | WI Unique Well No. | Common Well Name | Final Static Water Level | Surface Elevation | Borehole Diameter |
|---|---|---|---|---|---|
| | | | 813.1 Feet MSL | 923.2 Feet MSL | 6-10 1/4 Inches |

Boring Location
State Plane 172655.00 N, 1477721.00 E
NE 1/4 of NE 1/4 of Section 19 T 21 N,R 12W
Lat ° ' "
Long ° ' "
Local Grid Location (If applicable)
Feet ☐ N ☐ S Feet ☐ E ☐ W

| County | DNR County Code | Civil Town/City/ or Village |
|---|---|---|
| Buffalo County | 06 | Belvidere |

| Sample Number | Length (In) Recovered | Blow Counts | Depth In Feet | Soil/Rock Description And Geologic Origin For Each Major Unit | USCS | Graphic Log | Well Diagram | PID/FID | Standard Penetration | Moisture Content | Liquid Limit | Plastic Limit | P 200 | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 12 | 20 | 1–3 | **POORLY GRADED SAND (SP)** fine, brownish yellow 10YR 6/6 medium to very dense, (with sandstone fragments), Fluvial. | SP | | | | | M | | | | SS |
| 2 | 14 | 8 | 4–5 | Grades to yellow 10YR 7/6. | | | | | | M | | | | SS |
| 3 | 16 | 11 | 6–8 | Rust colored mottles. Sand is interbedded with pale yellow and brownish yellow lenses. | | | | | | M | | | | SS |
| 4 | 10 | 100/12" | 9–14 | | | | | | | M | | | | SS |
| 5 | 18 | 24 | 15–19 | | SP | | | | | M | | | | SS |
| 6 | | 100/14" | 20–25 | Very fine silty sand at ~21.0'. | | | | | | M | | | | SS |

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: Daniel O. Lis

Firm: RMT
744 Heartland Trail, Madison Wisconsin
Tel: 608-831-4444, Fax: 608-831-3334

This form is authorized by Chapters 144, 147 and 162, Wis. Stats. Completion of this report is mandatory. Penalties: Forfeit not less than $10 nor more than $5,000 for each violation. Fined not less than $10 or more than $100 or imprisoned not less than 30 days, or both for each violation. Each day of continued violation is a separate offense, pursuant to ss 144.99 and 162.06, Wis. Stats.

Boring Number **W101** Use only as an attachment to Form 4400-122.



| Sample Number | Length (In) Recovered | Blow Counts | Depth In Feet | Soil/Rock Description And Geologic Origin For Each Major Unit | USCS | Graphic Log | Well Diagram | PID/FID | Standard Penetration | Moisture Content | Liquid Limit | Plastic Limit | P 200 | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7 | 8 | 100/6" | 26 | More cemented, yellow 10YR 7.8 very dense, 20% silt. | | | | | | M | | | | SS |
| | | | 27 | | | | | | | | | | | |
| | | | 28 | | | | | | | | | | | |
| 8 | 4 | 100/4" | 29 | | | | | | | | | | | SS |
| | | | 30 | **DOLOMITE**, bedrock, highly weathered and fractured, brown 7.5YR 5/2, fractures/voids filled with silt and sand. | | | | | | | | | | |
| 9 | | | 31 | | | | | | | | | | | Grab |
| | | | 32 | | | | | | | | | | | |
| 10 | | | 33 | | | | | | | | | | | Grab |
| | | | 34 | | | | | | | | | | | |
| | | | 35 | | | | | | | | | | | |
| | | | 36 | | | | | | | | | | | |
| | | | 37 | | | | | | | | | | | |
| 11 | | | 38 | | | | | | | | | | | Grab |
| | | | 39 | | | | | | | | | | | |
| | | | 40 | | | | | | | | | | | |
| | | | 41 | | | | | | | | | | | |
| | | | 42 | | | | | | | | | | | |
| | | | 43 | | | | | | | | | | | |
| 12 | 6 | 100/6" | 44 | | | | | | | | | | | SS |
| | | | 45 | | | | | | | | | | | |
| 13 | | | 46 | Rock becomes more competent at ~46'. | | | | | | | | | | Grab |
| | | | 47 | | | | | | | | | | | |
| | | | 48 | | | | | | | | | | | |
| 14 | | | 49 | | | | | | | | | | | Grab |
| | | | 50 | | | | | | | | | | | |
| | | | 51 | Fracture zone at ~48.0' - 50.0' (loose air circulation). | | | | | | | | | | |
| | | | 52 | | | | | | | | | | | |
| | | | 53 | | | | | | | | | | | |
| | | | 54 | | | | | | | | | | | Grab |
| | | | 55 | | | | | | | | | | | |
| | | | 56 | | | | | | | | | | | |
| | | | 57 | | | | | | | | | | | |
| | | | 58 | | | | | | | | | | | |
| 15 | | 100/2" | 59 | | | | | | | | | | | SS |
| | | | 60 | | | | | | | | | | | |
| | | | 61 | | | | | | | | | | | |
| | | | 62 | | | | | | | | | | | |
| | | | 63 | | | | | | | | | | | |
| 16 | | | 64 | | | | | | | | | | | Grab |
| | | | 65 | | | | | | | | | | | |
| 17 | | | 66 | | | | | | | | | | | Grab |

Boring Number **W101** Use only as an attachment to Form 4400-122.



| Sample Number | Sample Length (In) Recovered | Blow Counts | Depth In Feet | Soil/Rock Description And Geologic Origin For Each Major Unit | USCS | Graphic Log | Well Diagram | PID/FID | Standard Penetration | Moisture Content | Liquid Limit | Plastic Limit | P 200 | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 67 | | | | | | | | | | | |
| | | | 68 | | | | | | | | | | | |
| | | | 69 | | | | | | | | | | | |
| 18 | | | 70 | **SANDSTONE**, fine grained glauconitic, friable poorly-cemented, olive. | | | | | | | | | | Grab |
| | | | 71 | | | | | | | | | | | |
| | | | 72 | | | | | | | | | | | |
| | | | 73 | | | | | | | | | | | |
| | | | 74 | | | | | | | | | | | |
| | | | 75 | | | | | | | | | | | |
| 19 | | | 76 | **DOLOMITE**, weathered fractured interbedded with glauconitic sandstone (or glauconitic silty sand in fractures). | | | | | | | | | | Grab |
| | | | 77 | | | | | | | | | | | |
| | | | 78 | | | | | | | | | | | |
| | | | 79 | | | | | | | | | | | |
| | | | 80 | | | | | | | | | | | |
| 20 | | | 81 | | | | | | | | | | | Grab |
| | | | 82 | **SANDSTONE**, fine grained, very friable, poorly cemented, olive weathered. | | | | | | | | | | |
| | | | 83 | | | | | | | | | | | |
| | | | 84 | | | | | | | | | | | |
| | | | 85 | | | | | | | | | | | |
| 21 | | | 86 | | | | | | | | | | | Grab |
| | | | 87 | | | | | | | | | | | |
| | | | 88 | | | | | | | | | | | |
| | | | 89 | | | | | | | | | | | |
| | | | 90 | | | | | | | | | | | |
| 22 | | | 91 | Color change to rust brown at ~91.0', color change to olive at ~93'. | | | | | | D | | | | Grab |
| | | | 92 | | | | | | | | | | | |
| | | | 93 | | | | | | | | | | | |
| | | | 94 | | | | | | | | | | | |
| | | | 95 | | | | | | | | | | | |
| 23 | | | 96 | Color changes from rust brown to olive. | | | | | | D | | | | Grab |
| | | | 97 | | | | | | | | | | | |
| | | | 98 | | | | | | | | | | | |
| | | | 99 | | | | | | | | | | | |
| | | | 100 | | | | | | | | | | | |
| 24 | | | 101 | | | | | | | | | | | Grab |
| | | | 102 | | | | | | | | | | | |
| | | | 103 | | | | | | | D | | | | |
| | | | 104 | | | | | | | | | | | |
| | | | 105 | | | | | | | | | | | |
| 25 | | | 106 | | | | | | | | | | | Grab |
| | | | 107 | | | | | | | | | | | |
| | | | 108 | | | | | | | | | | | |

Boring Number **W101** Use only as an attachment to Form 4400-122. 

| Sample Number | Sample Length (In) Recovered | Blow Counts | Depth In Feet | Soil/Rock Description And Geologic Origin For Each Major Unit | USCS | Graphic Log | Well Diagram | PID/FID | Soil Properties: Standard Penetration | Moisture Content | Liquid Limit | Plastic Limit | P 200 | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 109 | Attempt to core from 108 to 118 feet below ground surface but got no recovery. | | | | | | W | | | | 0 |
| 26 | | | 110 | | | | | | | | | | | |
| | | | 111 | | | | | | | | | | | |
| | | | 112 | | | | | | | | | | | |
| | | | 113 | | | | | | | | | | | |
| | | | 114 | | | | | | | | | | | |
| | | | 115 | | | | | | | | | | | |
| | | | 116 | | | | | | | | | | | |
| | | | 117 | | | | | | | | | | | KH = 1X10 cm/sec Grab |
| 27 | | | 118 | | | | | | | W | | | | |
| | | | 119 | | | | | | | | | | | |
| | | | 120 | | | | | | | | | | | |
| | | | 121 | | | | | | | | | | | |
| | | | 122 | End of Boring at 122 Ft. | | | | | | | | | | |

State of Wisconsin
Department of Natural Resources

# SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 5-97

Route To: Watershed/Wastewater ☐ Waste Management ☒
Remediation/Redevelopment ☐ Other ☐



| Facility/Project Name | License/Permit/Monitoring Number | Boring Number |
|---|---|---|
| Dairyland Power | | W-102R |

| Boring Drilled By (Firm name and name of crew chief) | Date Drilling Started | Date Drilling Completed | Drilling Method |
|---|---|---|---|
| Boart-Longyear / T. Schmalfelt | 5/16/01 | 5/16/01 | w/sper/rotary |

| WI Unique Well No. | DNR Well ID No. | Common Well Name | Final Static Water Level | Surface Elevation | Borehole Diameter |
|---|---|---|---|---|---|
| JQ872 | | W-102R | Feet MSL | Feet MSL | 8.0 Inches |

Boring Location or Local Grid Origin (Check if estimated: ☐ )
State Plane S/C/N
NE 1/4 of NE 1/4 of Section 19 T21 N. R 12W
Lat. ° ' "
Long. ° ' "
Local Grid Location (If applicable) ☐ N Feet ☐ S ☐ E Feet ☐ W

| Facility ID | County | County Code | Civil Town/City/ or Village |
|---|---|---|---|
| 3410-1789 | Buffalo | 6 | Alma |

| Sample Number and Type | Length Att. & Recovered (in) | Blow Counts | Depth in Feet | Soil/Rock Description And Geologic Origin For Each Major Unit | USCS | Graphic Log | Well Diagram | PID/FID | Soil Properties: Compressive Strength | Moisture Content | Liquid Limit | Plasticity Index | P 200 | RQD/ Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | Earth Drill | | | | | | | | | | |
| | | | | 4 1/4" HSA | | | | | | | | | | |
| | | | 2 | No samples taken. | | | | | | | | | | |
| | | | | See boring log for | | | | | | | | | | |
| | | | 3 | W102AR | | | | | | | | | | |
| | | | 4 | | | | | | | | | | | |
| | | | 5 | | | | | | | | | | | |
| | | | 6 | | | | | | | | | | | |
| | | | 7 | | | | | | | | | | | |
| | | | 8 | | | | | | | | | | | |
| | | | 9 | | | | | | | | | | | |
| | | | 10 | | | | | | | | | | | |
| | | | 11 | | | | | | | | | | | |
| | | | 12 | | | | | | | | | | | |

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature [signature] Firm Boart Longyear
101 Alderson St. Schofield, WI 54476
Tel: (715)359-3090
Fax: (715)355-5715

This form is authorized by Chapters 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats. Completions of this form is mandatory. Failure to file this form may result in forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be be used for any other purpose. NOTE: See instructions for more information, including where the completed form should be sent.

State of Wisconsin
Department of Natural Resources

# SOIL BORING LOG INFORMATION SUPPLEMENT

Form 4400-122A Rev. 5-97

Boring Number W-102R Use only as an attachment to Form 4400-122.



| Sample Number and Type | Length Att. & Recovered (in) | Blow Counts | Depth In Feet | Soil/Rock Description And Geologic Origin For Each Major Unit | U S C S | Graphic Log | Well Diagram | PID/FID | Soil Properties: Compressive Strength | Moisture Content | Liquid Limit | Plasticity Index | P 200 | RQD/ Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 13 | | | | | | | | | | | |
| | | | 14 | | | | | | | | | | | |
| | | | 15 | | | | | | | | | | | |
| | | | 16 | | | | | | | | | | | |
| | | | 17 | | | | | | | | | | | |
| | | | 18 | | | | | | | | | | | |
| | | | 19 | | | | | | | | | | | |
| | | | 20 | | | | | | | | | | | |
| | | | 21 | | | | | | | | | | | |
| | | | 22 | | | | | | | | | | | |
| | | | 23 | | | | | | | | | | | |
| | | | 24 | | | | | | | | | | | |
| | | | 25 | | | | | | | | | | | |
| | | | 26 | | | | | | | | | | | |
| | | | 27 | | | | | | | | | | | |
| | | | 28 | | | | | | | | | | | |
| | | | 29 | | | | | | | | | | | |
| | | | 30 | Air Rotary | | | | | | | | | | |
| | | | 31 | | | | | | | | | | | |
| | | | 32 | | | | | | | | | | | |

State of Wisconsin
Department of Natural Resources

# SOIL BORING LOG INFORMATION SUPPLEMENT

Form 4400-122A Rev. 5-97

Boring Number W-102R Use only as an attachment to Form 4400-122.



| Sample | | | | | | | | | Soil Properties | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number and Type | Length Att. & Recovered (in) | Blow Counts | Depth in Feet | Soil/Rock Description And Geologic Origin For Each Major Unit | U S C S | Graphic Log | Well Diagram | PID/FID | Compressive Strength | Moisture Content | Liquid Limit | Plasticity Index | P 200 | RQD/ Comments |
| | | | 33 | | | | | | | | | | | |
| | | | 34 | | | | | | | | | | | |
| | | | 35 | | | | | | | | | | | |
| | | | 36 | | | | | | | | | | | |
| | | | 37 | | | | | | | | | | | |
| | | | 38 | | | | | | | | | | | |
| | | | 39 | | | | | | | | | | | |
| | | | 40 | | | | | | | | | | | |
| | | | 41 | | | | | | | | | | | |
| | | | 42 | | | | | | | | | | | |
| | | | 43 | | | | | | | | | | | |
| | | | 44 | | | | | | | | | | | |
| | | | 45 | | | | | | | | | | | |
| | | | 46 | | | | | | | | | | | |
| | | | 47 | | | | | | | | | | | |
| | | | 48 | | | | | | | | | | | |
| | | | 49 | | | | | | | | | | | |
| | | | 50 | | | | | | | | | | | |
| | | | 51 | | | | | | | | | | | |
| | | | 52 | | | | | | | | | | | |

State of Wisconsin
Department of Natural Resources

# SOIL BORING LOG INFORMATION SUPPLEMENT

Form 4400-122A Rev. 5-97

Boring Number W-102R Use only as an attachment to Form 4400-122.



| Sample | | | | | | | | | Soil Properties | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number and Type | Length Att. & Recovered (in) | Blow Counts | Depth In Feet | Soil/Rock Description And Geologic Origin For Each Major Unit | U S C S | Graphic Log | Well Diagram | PID/FID | Compressive Strength | Moisture Content | Liquid Limit | Plasticity Index | P 200 | RQD/ Comments |
| | | | 53 | | | | | | | | | | | |
| | | | 54 | | | | | | | | | | | |
| | | | 55 | | | | | | | | | | | |
| | | | 56 | | | | | | | | | | | |
| | | | 57 | | | | | | | | | | | |
| | | | 58 | | | | | | | | | | | |
| | | | 59 | | | | | | | | | | | |
| | | | 60 | | | | | | | | | | | |
| | | | 61 | | | | | | | | | | | |
| | | | 62 | | | | | | | | | | | |
| | | | 63 | | | | | | | | | | | |
| | | | 64 | | | | | | | | | | | |
| | | | 65 | | | | | | | | | | | |
| | | | 66 | | | | | | | | | | | |
| | | | 67 | | | | | | | | | | | |
| | | | 68 | | | | | | | | | | | |
| | | | 69 | | | | | | | | | | | |
| | | | 70 | | | | | | | | | | | |
| | | | 71 | | | | | | | | | | | |
| | | | 72 | | | | | | | | | | | |

State of Wisconsin
Department of Natural Resources

# SOIL BORING LOG INFORMATION SUPPLEMENT

Form 4400-122A Rev. 5-97

Boring Number W-102R

Use only as an attachment to Form 4400-122.



| Sample Number and Type | Sample Length Att. & Recovered (in) | Blow Counts | Depth In Feet | Soil/Rock Description And Geologic Origin For Each Major Unit | U S C S | Graphic Log | Well Diagram | PID/FID | Soil Properties: Compressive Strength | Moisture Content | Liquid Limit | Plasticity Index | P 200 | RQD/ Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 73 | | | | | | | | | | | |
| | | | 74 | | | | | | | | | | | |
| | | | 75 | | | | | | | | | | | |
| | | | 76 | | | | | | | | | | | |
| | | | 77 | | | | | | | | | | | |
| | | | 78 | | | | | | | | | | | |
| | | | 79 | EOB 79.0'<br>Well Set 78.0' | | | | | | | | | | |

State of Wisconsin
Department of Natural Resources

# SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 5-97

Route To: Watershed/Wastewater ☐ Waste Management ☐ Remediation/Redevelopment ☐ Other ☐



| Facility/Project Name | License/Permit/Monitoring Number | Boring Number |
|---|---|---|
| Dairyland Power | | W-102AR |

| Boring Drilled By (Firm name and name of crew chief) | Date Drilling Started | Date Drilling Completed | Drilling Method |
|---|---|---|---|
| | | | |

| WI Unique Well No. | DNR Well ID No. | Common Well Name | Final Static Water Level | Surface Elevation | Borehole Diameter |
|---|---|---|---|---|---|
| | | W-102AR | Feet MSL | Feet MSL | 8.0 Inches |

Boring Location or Local Grid Origin (Check if estimated: ☐ )
State Plane S / C / N
1/4 of 1/4 of Section , T N, R
Lat. ° ' "
Long. ° ' "
Local Grid Location (If applicable) ☐ N ☐ E Feet ☐ S Feet ☐ W

| Facility ID | County | County Code | Civil Town/City/ or Village |
|---|---|---|---|
| 3410-1789 | Buffalo | 6 | Alma |

| Sample Number and Type | Length Att. & Recovered (in) | Blow Counts | Depth In Feet | Soil/Rock Description And Geologic Origin For Each Major Unit | U S C S | Graphic Log | Well Diagram | PID/FID | Compressive Strength | Moisture Content | Liquid Limit | Plasticity Index | P 200 | RQD/ Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 SS | 24 13 | 2 3 3 3 | 1 | Br SILT<br>4 1/4" HSA | | | | | | M | | | | |
| | | | 2 | | | | | | | | | | | |
| | | | 3 | | | | | | | | | | | |
| | | | 4 | | | | | | | | | | | |
| 2 SS | 24 14 | 6 9 9 11 | 5 | | | | | | | M | | | | |
| | | | 6 | | | | | | | | | | | |
| | | | 7 | | | | | | | | | | | |
| | | | 8 | | | | | | | | | | | |
| | | | 9 | | | | | | | | | | | |
| 3 SS | 18 2 | 15 18 50/.2 | 10 | BEDROCK | | | | | | D | | | | |
| | | | 11 | | | | | | | | | | | |
| | | | 12 | | | | | | | | | | | |

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature

Firm Boart Longyear
101 Alderson St. Schofield, WI 54476

Tel: (715)359-70[illegible]
Fax: (715)355-57[illegible]

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State of Wisconsin
Department of Natural Resources

# SOIL BORING LOG INFORMATION SUPPLEMENT

Form 4400-122A Rev. 5-97

Boring Number W-102AR Use only as an attachment to Form 4400-122.



| Sample Number and Type | Length Att. & Recovered (in) | Blow Counts | Depth In Feet | Soil/Rock Description And Geologic Origin For Each Major Unit | U S C S | Graphic Log | Well Diagram | PID/FID | Soil Properties: Compressive Strength | Moisture Content | Liquid Limit | Plasticity Index | P 200 | RQD/ Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 13 | | | | | | | | | | | |
| | | | 14 | | | | | | | | | | | |
| 4 SS | 6 3 | 50/.2 | 15 | | | | | | | D | | | | |
| | | | 16 | Air Rotary | | | | | | | | | | |
| | | | 17 | | | | | | | | | | | |
| | | | 18 | | | | | | | | | | | |
| | | | 19 | | | | | | | | | | | |
| | | | 20 | | | | | | | | | | | |
| | | | 21 | | | | | | | | | | | |
| | | | 22 | | | | | | | | | | | |
| | | | 23 | | | | | | | | | | | |
| | | | 24 | | | | | | | | | | | |
| | | | 25 | | | | | | | | | | | |
| | | | 26 | | | | | | | | | | | |
| | | | 27 | | | | | | | | | | | |
| | | | 28 | | | | | | | | | | | |
| | | | 29 | | | | | | | | | | | |
| | | | 30 | | | | | | | | | | | |
| | | | 31 | | | | | | | | | | | |
| | | | 32 | | | | | | | | | | | |

State of Wisconsin
Department of Natural Resources

# SOIL BORING LOG INFORMATION SUPPLEMENT

Form 4400-122A Rev. 5-97

Boring Number W-102AR Use only as an attachment to Form 4400-122.



| Sample | | | | | | | | | Soil Properties | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number and Type | Length Att. & Recovered (in) | Blow Counts | Depth In Feet | Soil/Rock Description And Geologic Origin For Each Major Unit | U S C S | Graphic Log | Well Diagram | PID/FID | Compressive Strength | Moisture Content | Liquid Limit | Plasticity Index | P 200 | RQD/ Comments |
| | | | 33 | | | | | | | | | | | |
| | | | 34 | | | | | | | | | | | |
| | | | 35 | | | | | | | | | | | |
| | | | 36 | | | | | | | | | | | |
| | | | 37 | | | | | | | | | | | |
| | | | 38 | | | | | | | | | | | |
| | | | 39 | | | | | | | | | | | |
| | | | 40 | | | | | | | | | | | |
| | | | 41 | | | | | | | | | | | |
| | | | 42 | | | | | | | | | | | |
| | | | 43 | | | | | | | | | | | |
| | | | 44 | | | | | | | | | | | |
| | | | 45 | | | | | | | | | | | |
| | | | 46 | | | | | | | | | | | |
| | | | 47 | | | | | | | | | | | |
| | | | 48 | | | | | | | | | | | |
| | | | 49 | | | | | | | | | | | |
| | | | 50 | | | | | | | | | | | |
| | | | 51 | | | | | | | | | | | |
| | | | 52 | | | | | | | | | | | |

State of Wisconsin
Department of Natural Resources

# SOIL BORING LOG INFORMATION SUPPLEMENT

Form 4400-122A Rev. 5-97

Boring Number W-102AR Use only as an attachment to Form 4400-122.



| Sample | | | | | | | | | Soil Properties | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number and Type | Length Att. & Recovered (in) | Blow Counts | Depth In Feet | Soil/Rock Description And Geologic Origin For Each Major Unit | U S C S | Graphic Log | Well Diagram | PID/FID | Compressive Strength | Moisture Content | Liquid Limit | Plasticity Index | P 200 | RQD/ Comments |
| | | | 53 | | | | | | | | | | | |
| | | | 54 | | | | | | | | | | | |
| | | | 55 | | | | | | | | | | | |
| | | | 56 | | | | | | | | | | | |
| | | | 57 | | | | | | | | | | | |
| | | | 58 | | | | | | | | | | | |
| | | | 59 | | | | | | | | | | | |
| | | | 60 | | | | | | | | | | | |
| | | | 61 | | | | | | | | | | | |
| | | | 62 | | | | | | | | | | | |
| | | | 63 | | | | | | | | | | | |
| | | | 64 | | | | | | | | | | | |
| | | | 65 | | | | | | | | | | | |
| | | | 66 | | | | | | | | | | | |
| | | | 67 | | | | | | | | | | | |
| | | | 68 | | | | | | | | | | | |
| | | | 69 | | | | | | | | | | | |
| | | | 70 | | | | | | | | | | | |
| | | | 71 | | | | | | | | | | | |
| | | | 72 | | | | | | | | | | | |

State of Wisconsin
Department of Natural Resources

# SOIL BORING LOG INFORMATION SUPPLEMENT

Form 4400-122A Rev. 5-97

Boring Number W-102AR Use only as an attachment to Form 4400-122.



| Sample | | | | | | | | | Soil Properties | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number and Type | Length Att. & Recovered (in) | Blow Counts | Depth In Feet | Soil/Rock Description And Geologic Origin For Each Major Unit | U S C S | Graphic Log | Well Diagram | PID/FID | Compressive Strength | Moisture Content | Liquid Limit | Plasticity Index | P 200 | RQD/ Comments |
| | | | 73 | | | | | | | | | | | |
| | | | 74 | | | | | | | | | | | |
| | | | 75 | | | | | | | | | | | |
| | | | 76 | | | | | | | | | | | |
| | | | 77 | | | | | | | | | | | |
| | | | 78 | | | | | | | | | | | |
| | | | 79 | | | | | | | | | | | |
| | | | 80 | | | | | | | | | | | |
| | | | 81 | | | | | | | | | | | |
| | | | 82 | | | | | | | | | | | |
| | | | 83 | | | | | | | | | | | |
| | | | 84 | | | | | | | | | | | |
| | | | 85 | | | | | | | | | | | |
| | | | 86 | | | | | | | | | | | |
| | | | 87 | | | | | | | | | | | |
| | | | 88 | | | | | | | | | | | |
| | | | 89 | | | | | | | | | | | |
| | | | 90 | | | | | | | | | | | |
| | | | 91 | | | | | | | | | | | |
| | | | 92 | | | | | | | | | | | |

State of Wisconsin
Department of Natural Resources

# SOIL BORING LOG INFORMATION SUPPLEMENT

Form 4400-122A Rev. 5-97

Boring Number W-102AR Use only as an attachment to Form 4400-122.



| Sample | | | | | | | | | Soil Properties | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number and Type | Length Att. & Recovered (in) | Blow Counts | Depth In Feet | Soil/Rock Description And Geologic Origin For Each Major Unit | U S C S | Graphic Log | Well Diagram | PID/FID | Compressive Strength | Moisture Content | Liquid Limit | Plasticity Index | P 200 | RQD/ Comments |
| | | | 93 | | | | | | | | | | | |
| | | | 94 | | | | | | | | | | | |
| | | | 95 | | | | | | | | | | | |
| | | | 96 | | | | | | | | | | | |
| | | | 97 | | | | | | | | | | | |
| | | | 98 | | | | | | | | | | | |
| | | | 99 | EOB 99.0'<br>Well Set 98.0' | | | | | | | | | | |

State of Wisconsin
Department of Natural Resources

Route To:
- [x] Solid Waste
- [ ] Emergency Response
- [ ] Wastewater
- [ ] Haz. Waste
- [ ] Underground Tanks
- [ ] Water Resources
- [ ] Other

# Soil Boring Log Information

Form 4400-122 7-91



| Facility/Project Name | License/Permit/Monitoring Number | Boring Number |
|---|---|---|
| Dairyland Power 3081.23 | 2927 | W105 |

| Boring Drilled By (Firm name and name of crew chief) | Date Drilling Started | Date Drilling Completed | Drilling Method |
|---|---|---|---|
| Boart Longyear, Crew Chief: Eric Shoenberg | 11/7/95 | 11/9/95 | HSA |

| DNR Facility Well No. | WI Unique Well No. | Common Well Name | Final Static Water Level | Surface Elevation | Borehole Diameter |
|---|---|---|---|---|---|
| | | | 732.9 Feet MSL | 818.3 Feet MSL | 8 1/4 Inches |

Boring Location
State Plane 171180.00 N, 1477404.00 E
NE 1/4 of NE 1/4 of Section 19 T 21 N,R 12W
Lat ° ' "
Long ° ' "

Local Grid Location (If applicable)
Feet [ ] N [ ] S Feet [ ] E [ ] W

| County | DNR County Code | Civil Town/City/ or Village |
|---|---|---|
| Buffalo County | 06 | Belvidere |

| Sample Number | Length (In) Recovered | Blow Counts | Depth In Feet | Soil/Rock Description And Geologic Origin For Each Major Unit | U S C S | Graphic Log | Well Diagram | PID/FID | Standard Penetration | Moisture Content | Liquid Limit | Plastic Limit | P 200 | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | Not sampled. | | | | | | | | | | |
| | | | 2 | | | | | | | | | | | |
| | | | 3 | | | | | | | | | | | |
| | | | 4 | | | | | | | | | | | |
| 1 | 15 | 14 | 5 | **SILT (ML)**, 98% silt, 2.5Y 5/4 light olive brown, (almost fine sand size just in visual spectrum), (Loess, fluvial/lacustrine). | ML | | | | | D | | | | SS |
| | | | 6 | | | | | | | | | | | |
| | | | 7 | | | | | | | | | | | |
| | | | 8 | | | | | | | | | | | |
| | | | 9 | | | | | | | | | | | |
| 2 | 17 | 25 | 10 | As above. | | | | | | | | | | SS |
| | | | 11 | | | | | | | | | | | |
| | | | 12 | | | | | | | | | | | |
| | | | 13 | | | | | | | | | | | |
| | | | 14 | | | | | | | | | | | |
| 3 | 15 | 103 | 15 | Attempted shelby - only went 4". | GP | | | | | | | | | SS |
| | | | 16 | | | | | | | | | | | |
| | | | 17 | **POORLY GRADED GRAVEL WITH SAND (GP)**, 55-60% fine angular dolomite gravel, 40-45% fine to coarse sand, 10YR 5/6 yellowish brown, very dense. | | | | | | | | | | |
| | | | 18 | | | | | | | | | | | |
| | | | 19 | | | | | | | | | | | |
| 4 | 18 | 130 | 20 | | | | | | | | | | | SS |
| | | | 21 | | | | | | | | | | | |
| | | | 22 | **POORLY GRADED SAND WITH GRAVEL (SP)**, 10YR 5/6 yellowish brown, very dense. | | | | | | | | | | |
| | | | 23 | | | | | | | | | | | |
| | | | 24 | Very hard drilling to ~24.0 feet. | | | | | | | | | | |
| | | | 25 | | | | | | | | | | | |

I hereby certify that the information on this form is true and correct to the best of my knowledge.

| Signature | Firm |
|---|---|
| Craig O Bartholomew | RMT<br>744 Heartland Trail, Madison Wisconsin<br>Tel: 608-831-4444, Fax: 608-831-3334 |

This form is authorized by Chapters 144, 147 and 162, Wis. Stats. Completion of this report is mandatory. Penalties: Forfeit not less than $10 nor more than $5,000 for each violation. Fined not less than $10 or more than $100 or imprisoned not less than 30 days, or both for each violation. Each day of continued violation is a separate offense, pursuant to ss 144.99 and 162.06, Wis. Stats.

Boring Number **W105** Use only as an attachment to Form 4400-122.



| Sample Number | Sample Length (In) Recovered | Blow Counts | Depth In Feet | Soil/Rock Description And Geologic Origin For Each Major Unit | USCS | Graphic Log | Well Diagram | PID/FID | Standard Penetration | Moisture Content | Liquid Limit | Plastic Limit | P 200 | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | dolomite boulder, (fluvial). | | | | | | | | | | |
| | | | 26 | No sample, (weathered rock). | | | | | | | | | | |
| | | | 27 | | | | | | | | | | | |
| | | | 28 | | | | | | | | | | | |
| | | | 29 | | | | | | | | | | | |
| 5 | 12 | 86 | 30 | **WEATHERED SANDSTONE,** ~50-60% very fine sand, 40-50% fines, 2% gravel, yellowish brown and green. | | | | | | M | | | | SS |
| | | | 31 | | | | | | | | | | | |
| | | | 32 | | | | | | | | | | | |
| | | | 33 | | | | | | | | | | | |
| | | | 34 | | | | | | | | | | | |
| 6 | 5 | 100/5" | 35 | Weathered glauconitic **SANDSTONE**, fine grained, olive brown. | | | | | | | | | | SS |
| | | | 36 | | | | | | | | | | | |
| | | | 37 | | | | | | | | | | | |
| | | | 38 | | | | | | | | | | | |
| | | | 39 | | | | | | | | | | | |
| 7 | | | 40 | As above. | | | | | | | | | | GRAB |
| | | | 41 | | | | | | | | | | | |
| | | | 42 | | | | | | | | | | | |
| | | | 43 | | | | | | | | | | | |
| | | | 44 | | | | | | | | | | | |
| 8 | | | 45 | As above. | | | | | | | | | | GRAB |
| | | | 46 | | | | | | | | | | | |
| | | | 47 | | | | | | | | | | | |
| | | | 48 | | | | | | | | | | | |
| | | | 49 | | | | | | | | | | | |
| 9 | | | 50 | As above. | | | | | | | | | | GRAB |
| | | | 51 | | | | | | | | | | | |
| | | | 52 | | | | | | | | | | | |
| | | | 53 | | | | | | | | | | | |
| | | | 54 | | | | | | | | | | | |
| 10 | | | 55 | As above. | | | | | | | | | | GRAB |
| | | | 56 | | | | | | | | | | | |
| | | | 57 | | | | | | | | | | | |
| | | | 58 | | | | | | | | | | | |
| | | | 59 | | | | | | | | | | | |
| 11 | | | 60 | As above. | | | | | | | | | | GRAB |
| | | | 61 | | | | | | | | | | | |
| | | | 62 | | | | | | | | | | | |
| | | | 63 | | | | | | | | | | | |
| | | | 64 | | | | | | | | | | | |
| 12 | | | 65 | As above. | | | | | | | | | | GRAB |
| | | | 66 | | | | | | | | | | | |

State of Wisconsin
Department of Natural Resources

# Soil Boring Log Information Supplement

Form 4400-122A 7-91

Boring Number **W105** Use only as an attachment to Form 4400-122.



| Sample Number | Sample Length (In) Recovered | Blow Counts | Depth In Feet | Soil/Rock Description And Geologic Origin For Each Major Unit | USCS | Graphic Log | Well Diagram | PID/FID | Soil Properties: Standard Penetration | Moisture Content | Liquid Limit | Plastic Limit | P 200 | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 67 | | | | | | | | | | | |
| | | | 68 | | | | | | | | | | | |
| | | | 69 | | | | | | | | | | | |
| 13 | | | 70 | As above. | | | | | | | | | | GRAB |
| | | | 71 | | | | | | | | | | | |
| | | | 72 | | | | | | | | | | | |
| | | | 73 | | | | | | | | | | | |
| | | | 74 | | | | | | | | | | | |
| 14 | | | 75 | As above. | | | | | | | | | | GRAB |
| | | | 76 | | | | | | | | | | | |
| | | | 77 | | | | | | | | | | | |
| | | | 78 | | | | | | | | | | | |
| | | | 79 | | | | | | | | | | | |
| 15 | | | 80 | No sample taken. | | | | | | | | | | GRAB |
| | | | 81 | | | | | | | | | | | |
| | | | 82 | | | | | | | | | | | |
| | | | 83 | | | | | | | | | | | |
| | | | 84 | | | | | | | | | | | |
| 16 | | | 85 | As above. | | | | | | | | | | KH = 3X10-3 cm/sec |
| | | | 86 | | | | | | | | | | | |
| | | | 87 | No return from 87.0 to 90.0 feet. | | | | | | | | | | GRAB |
| | | | 88 | | | | | | | | | | | |
| | | | 89 | | | | | | | | | | | |
| 17 | | | 90 | | | | | | | | | | | |
| | | | 91 | | | | | | | | | | | GRAB |
| | | | 92 | | | | | | | | | | | |
| | | | 93 | | | | | | | | | | | |
| | | | 94 | | | | | | | | | | | |
| | | | 95 | End of boring at 95.0 feet. | | | | | | | | | | |

State of Wisconsin
Department of Natural Resources

Route To:
☒ Solid Waste
☐ Emergency Response
☐ Wastewater
☐ Haz. Waste
☐ Underground Tanks
☐ Water Resources
☐ Other

# Soil Boring Log Information

Form 4400-122 7-91



| Facility/Project Name | License/Permit/Monitoring Number | Boring Number |
|---|---|---|
| Dairyland Power 3081.23 | 2927 | W106 |

| Boring Drilled By (Firm name and name of crew chief) | Date Drilling Started | Date Drilling Completed | Drilling Method |
|---|---|---|---|
| Boart Longyear, Crew Chief: Paul Dickinson | 11/2/95 | 11/7/95 | 8"MUD ROTARY |

| DNR Facility Well No. | WI Unique Well No. | Common Well Name | Final Static Water Level | Surface Elevation | Borehole Diameter |
|---|---|---|---|---|---|
| | | | 773.6 Feet MSL | 848.3 Feet MSL | 8.0 Inches |

Boring Location
State Plane 171530.00 N, 1476837.00 E
NE 1/4 of NE 1/4 of Section 19 T 21 N,R 12W
Lat ° ' "
Long ° ' "

Local Grid Location (If applicable)
Feet ☐ N ☐ S Feet ☐ E ☐ W

| County | DNR County Code | Civil Town/City/ or Village |
|---|---|---|
| Buffalo County | 06 | Belvidere |

| Sample Number | Length (In) Recovered | Blow Counts | Depth In Feet | Soil/Rock Description And Geologic Origin For Each Major Unit | U S C S | Graphic Log | Well Diagram | PID/FID | Standard Penetration | Moisture Content | Liquid Limit | Plastic Limit | P 200 | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1–25 | **SILTY SAND WITH GRAVEL (SM)**, fine to coarse, 15-30% silt, 10YR 6/6 yellowish brown, medium dense, (Fill). | | | | | | M | | | | |
| 1 | 20 | 12 | | | SM | | | | | | | | | SS |
| 2 | 18 | 19 | | As above. | | | | | | | | | | SS |
| 3 | 14 | 38 | | As above. | | | | | | | | | | SS |
| 4 | 14 | 20 | | As above. | | | | | | | | | | SS |

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: Craig [illegible]

Firm: RMT
744 Heartland Trail, Madison Wisconsin
Tel: 608-831-4444, Fax: 608-831-3334

This form is authorized by Chapters 144, 147 and 162, Wis. Stats. Completion of this report is mandatory. Penalties: Forfeit not less than $10 nor more than $5,000 for each violation. Fined not less than $10 or more than $100 or imprisoned not less than 30 days, or both for each violation. Each day of continued violation is a separate offense, pursuant to ss 144.99 and 162.06, Wis. Stats.

Boring Number **W106** Use only as an attachment to Form 4400-122.



| Sample Number | Length (In) Recovered | Blow Counts | Depth In Feet | Soil/Rock Description And Geologic Origin For Each Major Unit | USCS | Graphic Log | Well Diagram | PID/FID | Standard Penetration | Moisture Content | Liquid Limit | Plastic Limit | P 200 | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 | 18 | 100/.5" | 26–27 | As above, but native soil. | | | | | | | | | | SS |
| | | | 28–29 | **SILTY SAND (SM)**, fine to medium, 10% clay, 5Y 4/4 olive, very dense, (glauconitic), (weathered sandstone). | | | | | | M | | | | |
| 6 | 20 | 46 | 30–34 | | SM | | | | | | | | | SS |
| 7 | 10 | 12 | 35–39 | | | | | | | | | | | SS |
| 8 | 12 | 100/14" | 40–44 | As above, but interbedded with silt and fines. | | | | | | | | | | SS |
| 9 | 8 | 100/10" | 45–49 | As above, but very dense. | | | | | | | | | | SS |
| 10 | 6 | 100/8" | 50–54 | As above. | | | | | | | | | | SS |
| 11 | 6 | 100/6" | 55–59 | As above. | | | | | | | | | | SS |
| 12 | 3 | 100/3" | 60–63 | As above. | | | | | | | | | | SS |
| | | | 64–66 | **SANDSTONE**, tan to greenish tan, weathered, some fracturing, only 2 pieces longer than 4". | | | | | | | | | | |

Boring Number **W106** Use only as an attachment to Form 4400-122.



| Sample Number | Sample Length (In) Recovered | Blow Counts | Depth In Feet | Soil/Rock Description And Geologic Origin For Each Major Unit | USCS | Graphic Log | Well Diagram | PID/FID | Soil Properties: Standard Penetration | Moisture Content | Liquid Limit | Plastic Limit | P 200 | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13 | | NA | 67 | Recovery=32%, RQD=5%. | | | | | | | | | | RC |
| | | | 68 | | | | | | | | | | | |
| | | | 69 | | | | | | | | | | | |
| | | | 70 | | | | | | | | | | | |
| | | | 71 | | | | | | | | | | | |
| | | | 72 | | | | | | | | | | | |
| | | | 73 | | | | | | | | | | | |
| 14 | | NA | 74 | | | | | | | W | | | | RC |
| | | | 75 | | | | | | | | | | | |
| | | | 76 | | | | | | | | | | | |
| | | | 77 | Recovery=25%, RQD=4%. | | | | | | | | | | |
| | | | 78 | | | | | | | | | | | |
| | | | 79 | | | | | | | | | | | |
| | | | 80 | | | | | | | | | | | |
| | | | 81 | | | | | | | | | | | |
| | | | 82 | | | | | | | | | | | |
| | | | 83 | | | | | | | | | | | |
| | | | 84 | End of boring at 84.0 feet. | | | | | | | | | | |

State of Wisconsin
Department of Natural Resources

Route To:
- [x] Solid Waste
- [ ] Emergency Response
- [ ] Wastewater
- [ ] Haz. Waste
- [ ] Underground Tanks
- [ ] Water Resources
- [ ] Other

# Soil Boring Log Information

Form 4400-122 7-91



| Facility/Project Name | License/Permit/Monitoring Number | Boring Number |
|---|---|---|
| Dairyland Power 3081.30 | 2927 | W107 |

| Boring Drilled By (Firm name and name of crew chief) | Date Drilling Started | Date Drilling Completed | Drilling Method |
|---|---|---|---|
| Boart Longyear, Crew Chief: T. Schmalfeldt | 4/29/97 | 5/1/97 | 6 1/4 HSA |

| DNR Facility Well No. | WI Unique Well No. | Common Well Name | Final Static Water Level | Surface Elevation | Borehole Diameter |
|---|---|---|---|---|---|
| | | | Feet MSL | 906.2 Feet MSL | 6.0 Inches |

Boring Location
State Plane 173527.44 N, 1477214.99 E
NE 1/4 of NE 1/4 of Section 19 T 21 N,R 12W
Lat ° ' "
Long ° ' "

Local Grid Location (If applicable)
Feet [ ] N [ ] S Feet [ ] E [ ] W

| County | DNR County Code | Civil Town/City/ or Village |
|---|---|---|
| Buffalo County | 06 | Belvidere |

| Sample Number | Length (In) Recovered | Blow Counts | Depth In Feet | Soil/Rock Description And Geologic Origin For Each Major Unit | U S C S | Graphic Log | Well Diagram | PID/FID | Standard Penetration | Moisture Content | Liquid Limit | Plastic Limit | P 200 | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1–3 | SILT (ML), 5% fine to coarse sand, 5% fine gravel, 10-15% clay, slightly plastic, stiff, 7.5YR 4/4 brown. | | | | | | M<br>M | | | | |
| 1 | 8 | 26 | 4–9 | POORLY GRADED SAND WITH GRAVEL (SP) to SILTY SAND WITH GRAVEL (SM), fine to coarse, 10-20% silt, 15-20% fine to coarse gravel, 5% cobbles, 10YR 6/6 brownish yellow, medium dense. | SP | | | | | | | | | SS |
| 2 | 24 | 56 | 10–14 | As above. | | | | | | | | | | SS |
| 3 | 15 | 36 | 15–17 | As above, but with boulder at ~12.0-13.5 feet. | | | | | | | | | | SS |
| 4 | 18 | 26 | 18–25 | POORLY GRADED SAND WITH SILT (SP/SM), 10% silt, 10% fine to medium gravel (angular fragments), 10YR 6/6 brownish yellow, medium dense. | SP/SM | | | | | M | | | | SS |

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: David A. Reed

Firm: RMT
744 Heartland Trail, Madison Wisconsin
Tel: 608-831-4444, Fax: 608-831-3334

This form is authorized by Chapters 144, 147 and 162, Wis. Stats. Completion of this report is mandatory. Penalties: Forfeit not less than $10 nor more than $5,000 for each violation. Fined not less than $10 or more than $100 or imprisoned not less than 30 days, or both for each violation. Each day of continued violation is a separate offense, pursuant to ss 144.99 and 162.06, Wis. Stats.

Boring Number **W107** Use only as an attachment to Form 4400-122.



| Sample Number | Length (In) Recovered | Blow Counts | Depth In Feet | Soil/Rock Description And Geologic Origin For Each Major Unit | USCS | Graphic Log | Well Diagram | PID/FID | Standard Penetration | Moisture Content | Liquid Limit | Plastic Limit | P 200 | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 | 14 | 44 | 26–29 | As above, except ~20% silt. | | | | | | | | | | SS |
| 6 | 15 | 100/5 | 30–32 | **WEATHERED DOLOMITE BEDROCK**, becomes competent at ~31.0 feet. | | | | | | | | | | SS |
| RC1 | 24 | NA | 33–37 | | | | | | | | | | | RQD=0<br>FF=0<br>Rec=40% |
| 7 | | | 38–39 | | | | | | | | | | | GRAB |
| 8 | | | 40–45 | Alternating layers (1-2 feet thick) of light brown dolomite and olive brown to olive green silty sandstone. | | | | | | | | | | GRAB |
| 9 | | | 46–48 | | | | | | | | | | | GRAB |
| 10 | | | 49–53 | Olive brown to olive green SILTY SANDSTONE, glauconitic, fine to medium grained. | | | | | | | | | | GRAB |
| | | | 54 | Driller notes large fractures at ~53.0 feet, loose air circulation. | | | | | | | | | | |
| | | | 55–60 | **DOLOMITE**, light brown to gray, highly weathered with alternating layers of olive brown to olive green silty sandstone. | | | | | | | | | | |
| | | | 61 | Air circulation returns at ~60.0 feet. | | | | | | | | | | |
| | | | 62–66 | Olive brown to olive green Glauconitic SANDSTONE, fine-grained with many silty lenses. | | | | | | | | | | |

Boring Number **W107** Use only as an attachment to Form 4400-122. 

| Sample Number | Length (In) Recovered | Blow Counts | Depth In Feet | Soil/Rock Description And Geologic Origin For Each Major Unit | USCS | Graphic Log | Well Diagram | PID/FID | Standard Penetration | Moisture Content | Liquid Limit | Plastic Limit | P 200 | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 67 | | | | | | | | | | | |
| | | | 68 | | | | | | | | | | | |
| | | | 69 | | | | | | | | | | | |
| | | | 70 | Olive green glauconitic SANDSTONE, fine grained with many silty lenses. | | | | | | | | | | |
| | | | 71 | | | | | | | | | | | |
| | | | 72 | | | | | | | | | | | |
| | | | 73 | | | | | | | | | | | |
| | | | 74 | | | | | | | | | | | |
| | | | 75 | Water at 74.5 feet while drilling. | | | | | | | | | | |
| RC2 | 18 | NA | 76 | | | | | | | | | | | RQD=0 |
| | | | 77 | | | | | | | | | | | FF=0 |
| | | | 78 | | | | | | | | | | | Rec=38% |
| | | | 79 | | | | | | | | | | | |
| | | | 80 | | | | | | | | | | | |
| | | | 81 | | | | | | | | | | | |
| | | | 82 | | | | | | | | | | | |
| | | | 83 | | | | | | | | | | | |
| | | | 84 | | | | | | | | | | | |
| | | | 85 | | | | | | | | | | | |
| | | | 86 | End of boring at 86.0 feet. | | | | | | | | | | |

State of Wisconsin
Department of Natural Resources

Route to: Solid Waste ☒ Haz. Waste ☐ Wastewater ☐
Env. Response & Repair ☐ Underground Tanks ☐ Other ☐

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 4-90

| | | |
|---|---|---|
| Facility/Project Name<br>Dairyland Power Cooperative | Local Grid Location of Well<br>☐N. ☐E.<br>____ft. ☐S. ____ ft. ☐W. | Well Name<br>W-100R |
| Facility License, Permit or Monitoring Number<br>2927 | Grid Origin Location<br>Lat. ___° ___' ___" Long. ___° ___' ___" or<br>St. Plane 171197.15 ft. N, 1477195.77 ft. E. | Wis. Unique Well Number DNR Well Number<br>JQ894 |
| Distance Well is From Waste/Source Boundary<br>Within | Section Location of Waste/Source<br>☐E.<br>NE ¼ of NE ¼ of Sec. 19, T21N, R12 ☒W. | Date Well Installed<br>05/ 17/ 01<br>MM DD YY |
| Type of Well: Water Table Observation Well ☒11<br>Piezometer ☐12 | Location of Well Relative to Waste/Source<br>U ☐Upgradient S ☐Sidegradient<br>D ☒Downgradient N ☐Not Known | Well Installed By: (Person's Name and Firm)<br>T. Schmalfelt<br>Boart Longyear |
| Is Well A Point of Enforcement Std. Application?<br>☒Yes ☐No | | |

A. Protective pipe, top elevation 784.40 ft. MSL

B. Well casing, top elevation 784.38 ft. MSL

C. Land surface elevation 781.4 ft. MSL

D. Surface seal, bottom 777.4 ft. MSL or 4.0 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☐
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☒

13. Sieve analysis attached? Yes ☐ No ☒

14. Drilling method used: Rotary ☒50
Hollow Stem Auger ☐41
Other ☐

15. Drilling fluid used: Water ☒02 Air ☐01
Drilling Mud ☐03 None ☐99

16. Drilling additives used? Yes ☐ No ☒
Describe:

17. Source of water (attach analysis):
On-site tap

E. Bentonite seal, top 728.8 ft. MSL or 53.0 ft.

F. Fine sand, top 726.8 ft. MSL or 55.0 ft.

G. Filter pack, top 725.8 ft. MSL or 56.0 ft.

H. Screen joint, top 721.8 ft. MSL or 60.0 ft.

I. Well bottom 706.8 ft. MSL or 75.0 ft.

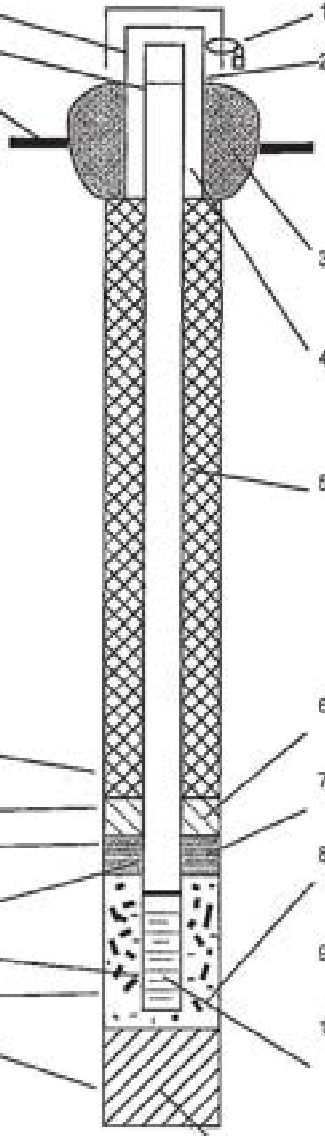
J. Filter pack, bottom 705.8 ft. MSL or 75.0 ft.

K. Borehole, bottom 705.8 ft. MSL or 76.0 ft.

L. Borehole, diameter 8.0 in.

M. O.D. well casing 2.37 in.

N. I.D. well casing 2.06 in.



1. Cap and lock? ☒Yes ☐No

2. Protective cover pipe:
a. Inside diameter: 4.0 in.
b. Length: 7.0 ft.
c. Material: Steel ☒04
Other ☐
d. Additional protection? ☐Yes ☐No
If yes, describe: 6-inch protective posts

3. Surface seal: Bentonite ☒30
Concrete ☐01
Other ☐

4. Material between well casing and protective pipe:
Bentonite ☐30
Annular space seal ☐
#30 American Materials Other ☒

5. Annular space seal: a. Granular Bentonite ☐33
b. Lbs/gal mud weight....Bentonite-sand slurry ☐35
c. X Lbs/gal mud weight..... Bentonite slurry ☒31
d. % Bentonite.....Bentonite-cement grout ☐50
e. $Ft^3$ volume added for any of the above
f. How installed: Tremie ☐01
Tremie pumped ☒02
Gravity ☐08

6. Bentonite seal: a. Bentonite granules ☒33
b. ☐ 1/4 in. ☐ 3/8 in. ☐ 1/2 in. Bentonite pellets ☐32
c. Other ☐

7. Fine sand material: Manufacturer, product name, mesh size
a. #7 Badger
b. Volume added 1 $ft^3$

8. Filter pack material: Manufacturer, product, mesh size
a. #30 American Materials
b. Volume added 19 $ft^3$

9. Well casing: Flush threaded PVC schedule 40 ☒23
Flush threaded PVC schedule 80 ☐24
Other ☐

10. Screen Material: PVC
a. Screen type: Factory cut ☒11
Continuous slot ☐01
Other ☐ b.
Manufacturer Boart Longyear
c. Slot size: 0.010 in.
d. Slotted length: 15.0 ft.

11. Backfill material (below filter pack): None ☐14
#30 sand Other ☒

I hereby certify that the information on this form is true and correct to the best of my knowledge.

| Signature | Firm |
|---|---|
| Craig O'Neill Watson | RMT, Inc. |

Please complete both sides of this form and return to the appropriate DNR office listed at the top of this form as required by chs. 144, 147 and 160, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with ch. 144, Wis. Stats., failure to file this form may result in a forfeiture of not less than $10, nor more than $5,000 for each day of violation. In accordance with ch. 147, Wis. Stats., failure to file this form may result in a forfeiture of not more than $10,000 for each day of violation. NOTE: Shaded areas are for DNR use only. See instructions for more information including where the completed form should be sent.

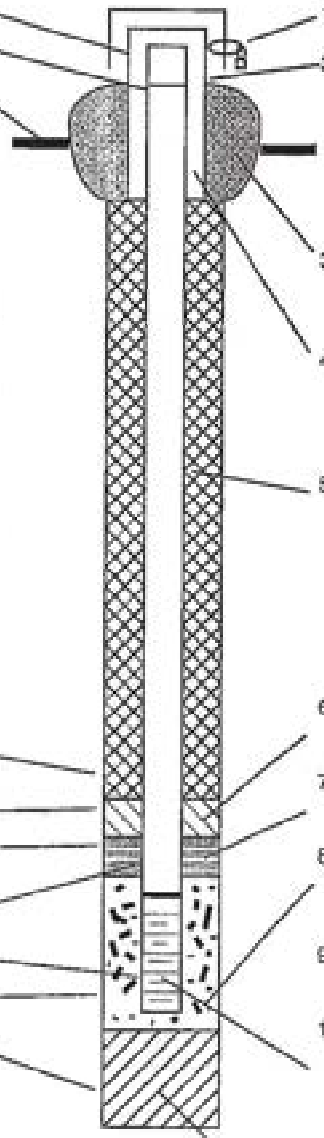
State of Wisconsin
Department of Natural Resources

Route to: Solid Waste ☒ Haz. Waste ☐ Wastewater ☐
Env. Response & Repair ☐ Underground Tanks ☐ Other ☐

# MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 4-90

| | | |
|---|---|---|
| Facility/Project Name<br>Dairyland Power Cooperative | Local Grid Location of Well<br>☐N. ☐E.<br>____ft. ☐S. ____ ft. ☐W. | Well Name<br>W-100AR |
| Facility License, Permit or Monitoring Number<br>2927 | Grid Origin Location<br>Lat. ___° ___' ___" Long. ___° ___' ___" or<br>St. Plane 171202.48 ft. N, 1477198.28 ft. E. | Wis. Unique Well Number DNR Well Number<br>JQ893 |
| Distance Well is From Waste/Source Boundary<br>Within | Section Location of Waste/Source<br>☐E.<br>NE ¼ of NE ¼ of Sec. 19, T21N, R12 ☒W. | Date Well Installed<br>05/ 17/ 01<br>MM DD YY |
| Type of Well: Water Table Observation Well ☐11<br>Piezometer ☒12 | Location of Well Relative to Waste/Source<br>U ☐Upgradient S ☐Sidegradient<br>D ☒Downgradient N ☐Not Known | Well Installed By: (Person's Name and Firm)<br>T. Schmalfelt<br>Boart Longyear |
| Is Well A Point of Enforcement Std. Application?<br>☒Yes ☐No | | |

A. Protective pipe, top elevation 784.80 ft. MSL
B. Well casing, top elevation 784.79 ft. MSL
C. Land surface elevation 781.8 ft. MSL
D. Surface seal, bottom 778.8 ft. MSL or 3.0 ft.



12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☐
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☒

13. Sieve analysis attached? Yes ☐ No ☒

14. Drilling method used: Rotary ☒50
Hollow Stem Auger ☐41
Other ☐

15. Drilling fluid used: Water ☒02 Air ☐01
Drilling Mud ☐03 None ☐99

16. Drilling additives used? Yes ☐ No ☒
Describe:

17. Source of water (attach analysis):
On-site tap

E. Bentonite seal, top 777.8 ft. MSL or 4.0 ft.
F. Fine sand, top 702.8 ft. MSL or 79.0 ft.
G. Filter pack, top 700.8 ft. MSL or 81.0 ft.
H. Screen joint, top 699.8 ft. MSL or 82.0 ft.
I. Well bottom 689.8 ft. MSL or 92.0 ft.
J. Filter pack, bottom 689.8 ft. MSL or 92.0 ft.
K. Borehole, bottom 688.8 ft. MSL or 93.0 ft.
L. Borehole, diameter 8.0 in.
M. O.D. well casing 2.37 in.
N. I.D. well casing 2.06 in.

1. Cap and lock? ☒Yes ☐No
2. Protective cover pipe:
a. Inside diameter: 4.0 in.
b. Length: 7.0 ft.
c. Material: Steel ☒04
Other ☐
d. Additional protection? ☐Yes ☐No
If yes, describe: Bumper post
3. Surface seal: Bentonite ☒30
Concrete ☐01
Other ☐
4. Material between well casing and protective pipe:
Bentonite ☐30
Annular space seal ☐
#30 American Materials Other ☒
5. Annular space seal: a. Granular Bentonite ☐33
b. Lbs/gal mud weight....Bentonite-sand slurry ☐35
c. X Lbs/gal mud weight..... Bentonite slurry ☒31
d. % Bentonite.....Bentonite-cement grout ☐50
e. $Ft^3$ volume added for any of the above
f. How installed: Tremie ☐01
Tremie pumped ☒02
Gravity ☐08
6. Bentonite seal: a. Bentonite granules ☒33
b. ☐ 1/4 in. ☐ 3/8 in. ☐ 1/2 in. Bentonite pellets ☐32
c. Other ☐
7. Fine sand material: Manufacturer, product name, mesh size
a. #7 Badger Mining Company
b. Volume added 1 $ft^3$
8. Filter pack material: Manufacturer, product, mesh size
a. #30 American Materials
b. Volume added 12 $ft^3$
9. Well casing: Flush threaded PVC schedule 40 ☒23
Flush threaded PVC schedule 80 ☐24
Other ☐
10. Screen Material: PVC
a. Screen type: Factory cut ☒11
Continuous slot ☐01
Other ☐ b.
Manufacturer Boart Longyear
c. Slot size: 0.010 in.
d. Slotted length: 10.0 ft.
11. Backfill material (below filter pack): None ☐14
#30 sand Other ☒

I hereby certify that the information on this form is true and correct to the best of my knowledge.

| Signature | Firm |
|---|---|
| Craig O'Bradley | RMT, Inc. |

Please complete both sides of this form and return to the appropriate DNR office listed at the top of this form as required by chs. 144, 147 and 160, Wis. Stats., and ch. NR 146, Wis. Adm. Code. In accordance with ch. 144, Wis. Stats., failure to file this form may result in a forfeiture of not less than $10, nor more than $5,000 for each day of violation. In accordance with ch. 147, Wis. Stats., failure to file this form may result in a forfeiture of not more than $10,000 for each day of violation.
NOTE: Shaded areas are for DNR use only. See instructions for more information including where the completed form should be sent.

State of Wisconsin
Department of Natural Resources

Route to: Solid Waste ☒ Haz. Waste ☐ Wastewater ☐
Env. Response & Repair ☐ Underground Tanks ☐ Other ☐ _____

# MONITORING WELL CONSTRUCTION

Form 4400-113A Rev. 4-90

| | | |
|---|---|---|
| Facility/Project Name<br>Dairyland Power Alma Landfill | Local Grid Location of Well<br>☐N. ☐E.<br>_____ft. ☐S. _____ ft. ☐W. | Well Name<br>W-101 |
| Facility License, Permit or Monitoring Number<br>2927 | Grid Origin Location<br>Lat. ___ ° ___ ' ___ " Long. ___ ° ___ ' ___ " or<br>St. Plane 172654.50 ft. N, 1477721.28 ft. E. | Wis. Unique Well Number DNR Well Number |
| Distance Well Is From Waste/Source Boundary<br>~130 ft. | Section Location of Waste/Source<br>☒E.<br>NE¼ of NE¼ of Sec.19, T21N, R12 ☐W. | Date Well Installed<br>11/ 02/ 94<br>MM DD YY |
| Type of Well: Water Table Observation Well ☒11<br>Piezometer ☐12 | Location of Well Relative to Waste/Source<br>U ☒Upgradient S ☐Sidegradient<br>D ☐Downgradient N ☐Not Known | Well Installed By: (Person's Name and Firm)<br>Frank Badula<br>Environmental & Foundation Drilling, Inc. |
| Is Well A Point of Enforcement Std. Application?<br>☒Yes ☐No | | |

A. Protective pipe, top elevation 925.7ft. MSL

B. Well casing, top elevation 925.83ft. MSL

C. Land surface elevation 923.2ft. MSL

D. Surface seal, bottom ft. MSL or 2.5ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☐
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☒

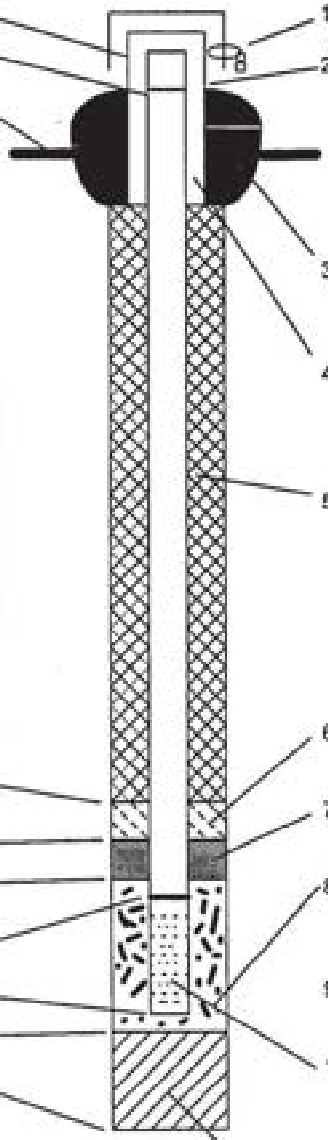
13. Sieve analysis attached? Yes ☐ No ☒

14. Drilling method used: Rotary ☒50
Hollow Stem Auger ☒41
Other ☐

15. Drilling fluid used: Water ☒02 Air ☒01
Drilling Mud ☐03 None ☐99

16. Drilling additives used? Yes ☐ No ☒
Describe:

17. Source of water (attach analysis):
DPC water supply well



E. Bentonite seal, top ft. MSL or 90.0ft.

F. Fine sand, top ft. MSL or 100.0ft.

G. Filter pack, top ft. MSL or 102.0ft.

H. Screen joint, top ft. MSL or107.0ft.

I. Well bottom ft. MSL or 122.0ft.

J. Filter pack, bottom ft. MSL or 122.0ft.

K. Borehole, bottom ft. MSL or 123.0ft.

L. Borehole, diameter 8.3in.

M. O.D. well casing 2.2in.

N. I.D. well casing 2.03in.

1. Cap and lock? ☒Yes ☐No

2. Protective cover pipe:
a. Inside diameter: 4.0in.
b. Length: 7.0ft.
c. Material: Steel ☒04
_____ Other ☐
d. Additional protection? ☒Yes ☐No
If yes, describe: Bumper Posts

3. Surface seal: Bentonite ☒30
Concrete ☐01
_____ Other ☐

4. Material between well casing and protective pipe:
Bentonite ☐30
Annular space seal ☐
_____ Other ☐

5. Annular space seal: a. Granular Bentonite ☐30
b. Lbs/gal mud weight....Bentonite-sand slurry ☐35
c. Lbs/gal mud weight..... Bentonite slurry ☒31
d. % Bentonite..... Bentonite-cement grout ☐50
e. 950 gal ($ft^3$) volume added for any of the above
f. How installed: Tremie ☒01
Tremie pumped ☐02
Gravity ☐08

6. Bentonite seal: a. Bentonite granules ☐33
b. ☐1/4 in. ☒3/8 in. ☐1/2 in. Bentonite pellets ☒32
c. Other ☐

7. Fine sand material: Manufacturer, product name, mesh size
a. Badger #40
b. Volume added 50 lb ($ft^3$)

8. Filter pack material: Manufacturer, product, mesh size
a. Badger Mining #30
b. Volume added 450 lb ($ft^3$)

9. Well casing: Flush threaded PVC schedule 40 ☐23
Flush threaded PVC schedule 80 ☒24
_____ Other ☐

10. Screen Material: PVC
a. Screen type: Factory cut ☒11
Continuous slot ☐01
_____ Other ☐ b.
Manufacturer Northern Air
c. Slot size: 0.010in.
d. Slotted length: 14.3 ft.

11. Backfill material (below filter pack): None ☒14
_____ Other ☐

I hereby certify that the information on this form is true and correct to the best of my knowledge.

| Signature | Firm |
|---|---|
| Daniel R. Reid | RMT, Inc. |

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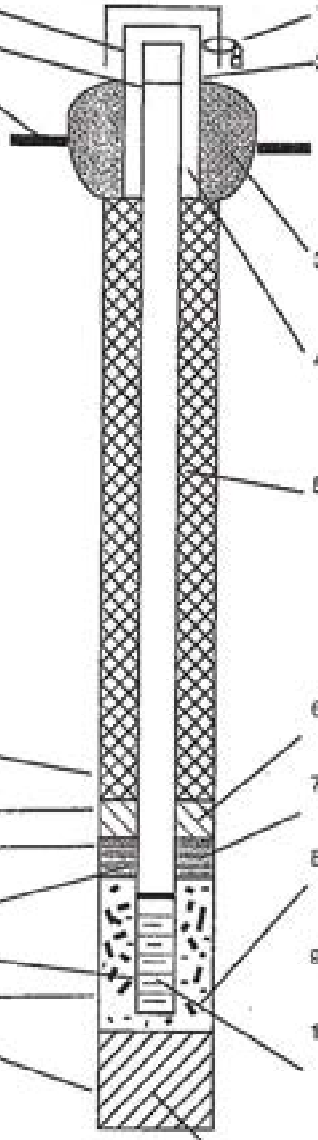
State of Wisconsin
Department of Natural Resources

Route to: Solid Waste ☒ Haz. Waste ☐ Wastewater ☐
Env. Response & Repair ☐ Underground Tanks ☐ Other ☐

# MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 4-90

| | | |
|---|---|---|
| Facility/Project Name<br>Dairyland Power Cooperative | Local Grid Location of Well<br>☐N. ☐E.<br>____ft. ☐S. ____ ft. ☐W. | Well Name<br>W-102R |
| Facility License, Permit or Monitoring Number<br>2927 | Grid Origin Location<br>Lat. __ ° __ ' __ " Long. __ ° __ ' __ " or<br>St. Plane 172319.04 ft. N, 1478318.01 ft. E. | Wis. Unique Well Number DNR Well Number<br>JQ892 |
| Distance Well is From Waste/Source Boundary<br>120' SW. | Section Location of Waste/Source<br>☐E.<br>NE ¼ of NE ¼ of Sec. 19, T21N, R12 ☒W. | Date Well Installed<br>05/ 16/ 01<br>MM DD YY |
| Type of Well:Water Table Observation Well ☒11<br>Piezometer ☐12 | Location of Well Relative to Waste/Source<br>U ☒Upgradient S ☐Sidegradient<br>D ☐Downgradient N ☐Not Known | Well Installed By: (Person's Name and Firm)<br>T. Schmalfelt<br>Boart Longyear |
| Is Well A Point of Enforcement Std. Application?<br>☒Yes ☐No | | |

A. Protective pipe, top elevation 878.17 ft. MSL
B. Well casing, top elevation 876.10 ft. MSL
C. Land surface elevation 873.1ft. MSL
D. Surface seal, bottom 869.1 ft. MSL or 4.0 ft.



1. Cap and lock? ☒Yes ☐No
2. Protective cover pipe:
   a. Inside diameter: 4.0 in.
   b. Length: 7.0 ft.
   c. Material: Steel ☒04 Other ☐
   d. Additional protection? ☒Yes ☐No
   If yes, describe: 8-inch protective posts
3. Surface seal: Bentonite ☒30 Concrete ☐01 Other ☐
4. Material between well casing and protective pipe: Bentonite ☐30 Annular space seal ☐ Other ☒
   # 30 American Materials
5. Annular space seal: a. Granular Bentonite ☐33
   b. Lbs/gal mud weight....Bentonite-sand slurry ☐35
   c. x Lbs/gal mud weight..... Bentonite slurry ☒31
   d. % Bentonite.....Bentonite-cement grout ☐50
   e. $Ft^3$ volume added for any of the above
   f. How installed: Tremie ☐01 Tremie pumped ☒02 Gravity ☐08
6. Bentonite seal: a. Bentonite granules ☒33
   b. ☐ 1/4 in. ☐ 3/8 in. ☐ 1/2 in.Bentonite pellets ☐32
   c. Other ☐
7. Fine sand material: Manufacturer, product name, mesh size
   a. #7 Badger
   b. Volume added 1 $ft^3$
8. Filter pack material: Manufacturer, product, mesh size
   a. #30 American Materials
   b. Volume added 13 $ft^3$
9. Well casing: Flush threaded PVC schedule 40 ☒23 Flush threaded PVC schedule 80 ☐24 Other ☐
10. Screen Material: PVC
    a. Screen type: Factory cut ☒11 Continuous slot ☐01 Other ☐ b.
    Manufacturer Boart Longyear
    c. Slot size: 010 in.
    d. Slotted length: 5.0 ft.
11. Backfill material (below filter pack): None ☒14 Other ☐
    #30 sand

12. USCS classification of soil near screen:
    GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☐
    SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
    Bedrock ☒
13. Sieve analysis attached? Yes ☐ No ☒
14. Drilling method used: Rotary ☒50 Hollow Stem Auger ☐41 Other ☐
15. Drilling fluid used: Water ☒02 Air ☐01 Drilling Mud ☐03 None ☐99
16. Drilling additives used? Yes ☐ No ☒
    Describe:
17. Source of water (attach analysis):
    On-site tap

E. Bentonite seal, top 807.1 ft. MSL or 66.0 ft.
F. Fine sand, top 805.1 ft. MSL or 68.0 ft.
G. Filter pack, top 804.1 ft. MSL or 69.0 ft.
H. Screen joint, top 800.1 ft. MSL or 73.0 ft.
I. Well bottom 795.1 ft. MSL or 78.0 ft.
J. Filter pack, bottom 795.1 ft. MSL or 78.0 ft.
K. Borehole, bottom 794.1 ft. MSL or 79.0 ft.
L. Borehole, diameter 8.0 in.
M. O.D. well casing 2.37 in.
N. I.D. well casing 2.06 in.

I hereby certify that the information on this form is true and correct to the best of my knowledge.

| Signature | Firm |
|---|---|
| [signature] | RMT, Inc. |

Please complete both sides of this form and return to the appropriate DNR office listed at the top of this form as required by chs. 144, 147 and 160, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with ch. 144, Wis. Stats., failure to file this form may result in a forfeiture of not less than $10, nor more than $5,000 for each day of violation. In accordance with ch. 147, Wis. Stats., failure to file this form may result in a forfeiture of not more than $10,000 for each day of violation.
NOTE: Shaded areas are for DNR use only. See instructions for more information including where the completed form should be sent.

State of Wisconsin
Department of Natural Resources

Route to: Solid Waste ☒ Haz. Waste ☐ Wastewater ☐
Env. Response & Repair ☐ Underground Tanks ☐ Other ☐

# MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 4-90

| | | |
|---|---|---|
| Facility/Project Name<br>Dairyland Power Alma Landfill | Local Grid Location of Well<br>☐N. ☐E.<br>_____ft. ☐S. _____ ft. ☐W. | Well Name<br>W-105 |
| Facility License, Permit or Monitoring Number<br>2927 | Grid Origin Location<br>Lat. ___ ° ___ ' ___ " Long. ___ ° ___ ' ___ " or<br>St. Plane 171180.0 ft. N, 1477404.0 ft. E. | Wis. Unique Well Number DNR Well Numb |
| Distance Well is From Waste/Source Boundary<br>~140 ft. | Section Location of Waste/Source<br>☒E.<br>NE¼ of NE¼ of Sec.19, T21N, R12 ☐W. | Date Well Installed<br>11/ 03/ 95<br>MM DD YY |
| Type of Well:Water Table Observation Well ☒11<br>Piezometer ☐12 | Location of Well Relative to Waste/Source<br>U ☐Upgradient S ☒Sidegradient<br>D ☐Downgradient N ☐Not Known | Well Installed By: (Person's Name and Firm)<br>Eric Schoenberg<br>Boart Longyear |
| Is Well A Point of Enforcement Std. Application?<br>☒Yes ☐No | | |

A. Protective pipe, top elevation 821.4ft. MSL

B. Well casing, top elevation 821.21ft. MSL

C. Land surface elevation 818.3ft. MSL

D. Surface seal, bottom ft. MSL or 5.0ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☐
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☒

13. Sieve analysis attached? Yes ☐ No ☒

14. Drilling method used: Rotary ☒50
Hollow Stem Auger ☐41
Other ☐

15. Drilling fluid used: Water ☐02 Air ☒01
Drilling Mud ☐03 None ☐99

16. Drilling additives used? Yes ☐ No ☒
Describe:

17. Source of water (attach analysis):
DPC water supply well

E. Bentonite seal, top ft. MSL or 65.0ft.

F. Fine sand, top ft. MSL or 75.0ft.

G. Filter pack, top ft. MSL or 77.0ft.

H. Screen joint, top ft. MSL or79.0ft.

I. Well bottom ft. MSL or 94.0ft.

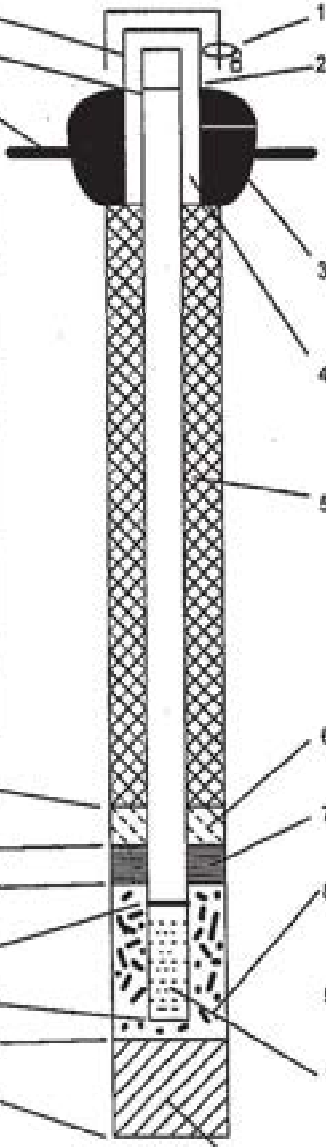
J. Filter pack, bottom ft. MSL or 96.0ft.

K. Borehole, bottom ft. MSL or 96.0ft.

L. Borehole, diameter 8.0in.

M. O.D. well casing 2.37in.

N. I.D. well casing 2.06in.



1. Cap and lock? ☒Yes ☐No

2. Protective cover pipe:
a. Inside diameter: 4.0in.
b. Length: 7.0ft.
c. Material: Steel ☒04
Other ☐
d. Additional protection? ☒Yes ☐No
If yes, describe: Bumper Posts

3. Surface seal: Bentonite ☒30
Concrete ☐01
Other ☐

4. Material between well casing and protective pipe:
Bentonite ☐30
Annular space seal ☐
Sand Other ☒

5. Annular space seal: a. Granular Bentonite ☐3
b. Lbs/gal mud weight....Bentonite-sand slurry ☒35
c. Lbs/gal mud weight..... Bentonite slurry ☐31
d. % Bentonite..... Bentonite-cement grout ☐50
e. 16.0 ($ft^3$) volume added for any of the above
f. How installed: Tremie ☐01
Tremie pumped ☒02
Gravity ☐08

6. Bentonite seal: a. Bentonite granules ☒33
b. ☐1/4 in. ☐3/8 in. ☐1/2 in. Bentonite pellets ☐32
c. Other ☐

7. Fine sand material:Manufacturer,product name,mesh size
a. Badger #40
b. Volume added 50 lbs ($ft^3$)

8. Filter pack material: Manufacturer, product, mesh size
a. #30 American Material
b. Volume added 550 lb ($ft^3$)

9. Well casing: Flush threaded PVC schedule 40 ☐23
Flush threaded PVC schedule 80 ☒24
Other ☐

10. Screen Material: PVC
a. Screen type: Factory cut ☒11
Continuous slot ☐01
Other ☐ b.
Manufacturer Boart Longyear
c. Slot size: 0.010in.
d. Slotted length: 15.0 ft.

11. Backfill material (below filter pack): None ☒14
Other ☐

I hereby certify that the information on this form is true and correct to the best of my knowledge.

| Signature | Firm |
|---|---|
| | RMT, Inc. |

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State of Wisconsin
Department of Natural Resources

Route to: Solid Waste ☒ Haz. Waste ☐ Wastewater ☐
Env. Response & Repair ☐ Underground Tanks ☐ Other ☐ _____

# MONITORING WELL CONSTRUCTION

Form 4400-113A Rev. 4-90

| | | |
|---|---|---|
| Facility/Project Name<br>Dairyland Power Alma Landfill | Local Grid Location of Well<br>☐N. ☐E.<br>_____ft. ☐S. _____ ft. ☐W. | Well Name<br>W-106 |
| Facility License, Permit or Monitoring Number<br>2927 | Grid Origin Location<br>Lat. ___ ° ___ ' ___ " Long. ___ ° ___ ' ___ " or<br>St. Plane 171530.0 ft. N. 1476837.0 ft. E. | Wis. Unique Well Number DNR Well Number |
| Distance Well is From Waste/Source Boundary<br>~140 ft. | Section Location of Waste/Source<br>☒E.<br>NE¼ of NE¼ of Sec.19, T21N, R12 ☐W. | Date Well Installed<br>11/ 07/ 95<br>MM DD YY |
| Type of Well: Water Table Observation Well ☒11<br>Piezometer ☐12 | Location of Well Relative to Waste/Source<br>U ☐Upgradient S ☒Sidegradient<br>D ☐Downgradient N ☐Not Known | Well Installed By: (Person's Name and Firm)<br>Eric Schoenberg<br>Boart Longyear |
| Is Well A Point of Enforcement Std. Application?<br>☒Yes ☐No | | |

A. Protective pipe, top elevation 851.1ft. MSL

B. Well casing, top elevation 850.84ft. MSL

C. Land surface elevation 848.3ft. MSL

D. Surface seal, bottom ft. MSL or 6.0ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☐
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☒

13. Sieve analysis attached? Yes ☐ No ☒

14. Drilling method used: Rotary ☒50
Hollow Stem Auger ☐41
Other ☐

15. Drilling fluid used: Water ☐02 Air ☐01
Drilling Mud ☒03 None ☐99

16. Drilling additives used? Yes ☒ No ☐
Describe:
Drilling mud

17. Source of water (attach analysis):
DPC water supply well

E. Bentonite seal, top ft. MSL or 63.0ft.

F. Fine sand, top ft. MSL or 68.0ft.

G. Filter pack, top ft. MSL or 70.0ft.

H. Screen joint, top ft. MSL or72.0ft.

I. Well bottom ft. MSL or 82.0ft.

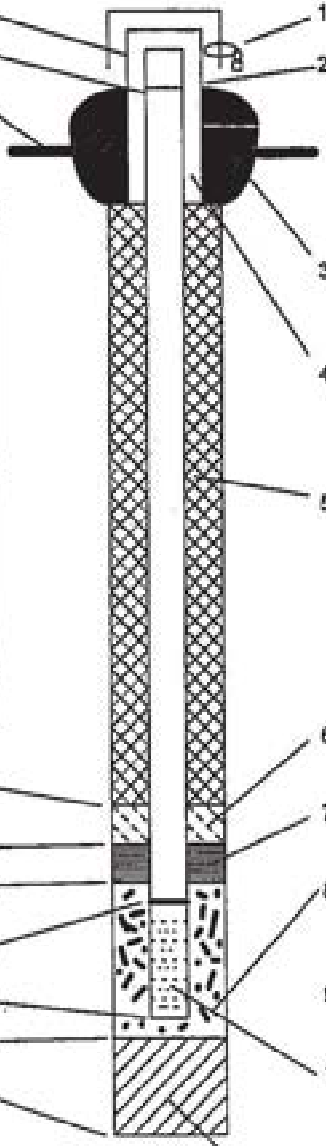
J. Filter pack, bottom ft. MSL or 84.0ft.

K. Borehole, bottom ft. MSL or 84.0ft.

L. Borehole, diameter 8.0in.

M. O.D. well casing 2.37in.

N. I.D. well casing 2.06in.



1. Cap and lock? ☒Yes ☐No

2. Protective cover pipe:
a. Inside diameter: 4.0in.
b. Length: 7.0ft.
c. Material: Steel ☒04
_____ Other ☐
d. Additional protection? ☒Yes ☐No
If yes, describe: Bumper posts

3. Surface seal: Bentonite ☒30
Concrete ☐01
_____ Other ☐

4. Material between well casing and protective pipe:
Bentonite ☐30
Annular space seal ☐
Sand Other ☒

5. Annular space seal: a. Granular Bentonite ☐33
b. Lbs/gal mud weight....Bentonite-sand slurry ☒35
c. Lbs/gal mud weight..... Bentonite slurry ☐31
d. % Bentonite..... Bentonite-cement grout ☐50
e. 13.5 ($ft^3$) volume added for any of the above
f. How installed: Tremie ☐01
Tremie pumped ☒02
Gravity ☐08

6. Bentonite seal: a. Bentonite granules ☐33
b. ☐1/4 in. ☒3/8 in. ☐1/2 in. Bentonite pellets ☒32
c. Other ☐

7. Fine sand material: Manufacturer, product name, mesh size
a. #7 Badger
b. Volume added 50 lb. ($ft^3$)

8. Filter pack material: Manufacturer, product, mesh size
a. #35-45 American Material
b. Volume added 250 lb. ($ft^3$)

9. Well casing: Flush threaded PVC schedule 40 ☐23
Flush threaded PVC schedule 80 ☒24
_____ Other ☐

10. Screen Material: PVC
a. Screen type: Factory cut ☒11
Continuous slot ☐01
_____ Other ☐ b.
Manufacturer Boart Longyear
c. Slot size: 0.010in.
d. Slotted length: 10.0 ft.

11. Backfill material (below filter pack): None ☐14
Sand Other ☒

I hereby certify that the information on this form is true and correct to the best of my knowledge.

| Signature | Firm |
|---|---|
| Craig Obradovich | RMT, Inc. |

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State of Wisconsin
Department of Natural Resources

Route to: Solid Waste ☒ Haz. Waste ☐ Wastewater ☐
Env. Response & Repair ☐ Underground Tanks ☐ Other ☐

# MONITORING WELL CONSTRUCTION

Form 4400-113A Rev. 4-90

| | | |
|---|---|---|
| Facility/Project Name<br>Dairyland Power Cooperative | Local Grid Location of Well<br>☐N. ☐E.<br>____ft. ☐S. ____ft. ☐W. | Well Name<br>W107 |
| Facility License, Permit or Monitoring Number<br>2927 | Grid Origin Location<br>Lat. ___ ° ___ ' ___ " Long. ___ ° ___ ' ___ " or<br>St. Plane 173527.44 ft. N, 1477214.99 ft. E. | Wis. Unique Well Number DNR Well Num |
| Distance Well is From Waste/Source Boundary<br>200ft. | Section Location of Waste/Source<br>☐E.<br>NE¼ of NE¼ of Sec.19, T21N, R12 ☒W. | Date Well Installed<br>05/ 01/ 97<br>MM DD YY |
| Type of Well: Water Table Observation Well ☒11<br>Piezometer ☐12 | Location of Well Relative to Waste/Source<br>U ☒Upgradient S ☐Sidegradient<br>D ☐Downgradient N ☐Not Known | Well Installed By: (Person's Name and Firm)<br>Todd Schmalfeldt<br>Boart Longyear |
| Is Well A Point of Enforcement Std. Application?<br>☒Yes ☐No | | |

A. Protective pipe, top elevation 908.23ft. MSL

B. Well casing, top elevation 908.29ft. MSL

C. Land surface elevation 906.2ft. MSL

D. Surface seal, bottom ft. MSL or 3.0ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☐
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☒

13. Sieve analysis attached? Yes ☐ No ☒

14. Drilling method used: Rotary ☒50
Hollow Stem Auger ☐41
Other ☐

15. Drilling fluid used: Water ☐02 Air ☒01
Drilling Mud ☐03 None ☐99

16. Drilling additives used? Yes ☐ No ☒
Describe:

17. Source of water (attach analysis):

E. Bentonite seal, top ft. MSL or 3.0ft.

F. Fine sand, top ft. MSL or 64.0ft.

G. Filter pack, top ft. MSL or 67.0ft.

H. Screen joint, top ft. MSL or69.0ft.

I. Well bottom ft. MSL or 84.0ft.

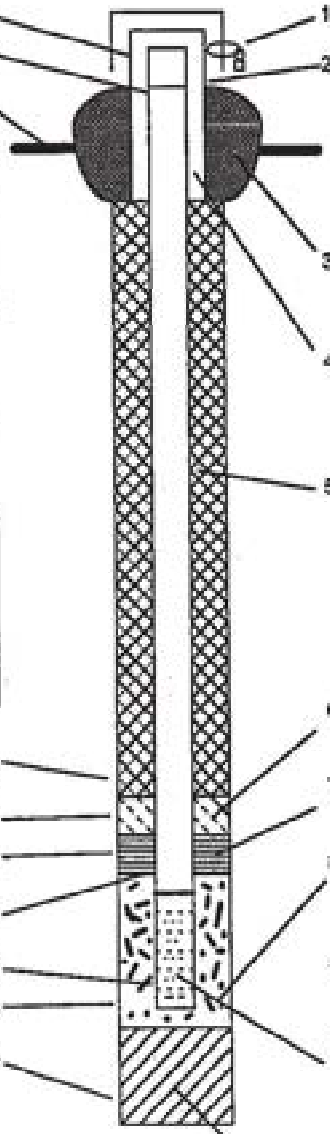
J. Filter pack, bottom ft. MSL or 86.0ft.

K. Borehole, bottom ft. MSL or 86.0ft.

L. Borehole, diameter 6.0in.

M. O.D. well casing 2.37in.

N. I.D. well casing 2.06in.



1. Cap and lock? ☒Yes ☐No

2. Protective cover pipe:
a. Inside diameter: 4.0in.
b. Length: 7.0ft.
c. Material: Steel ☒04
Other ☐
d. Additional protection? ☒Yes ☐No
If yes, describe: 3" Bumper Post

3. Surface seal: Bentonite ☒30
Concrete ☐01
Other ☒

4. Material between well casing and protective pipe:
Bentonite ☐30
Annular space seal ☐
#30 American Material Sand Other ☒

5. Annular space seal: a. Granular Bentonite ☒
b. Lbs/gal mud weight.... Bentonite-sand slurry ☐
c. Lbs/gal mud weight..... Bentonite slurry ☐31
d. % Bentonite..... Bentonite-cement grout ☐50
e. 600 lbs. volume added for any of the above
f. How installed: Tremie ☐01
Tremie pumped ☐02
Gravity ☒08

6. Bentonite seal: a. Bentonite granules ☒33
b. ☐1/4 in. ☒3/8 in. ☐1/2 in. Bentonite pellets ☐32
c. Other ☐

7. Fine sand material:Manufacturer,product name,mesh size
a. #70 Badger Mining
b. Volume added ~125 lbs.

8. Filter pack material: Manufacturer, product, mesh size
a. #30 American Material
b. Volume added 600 lbs.

9. Well casing: Flush threaded PVC schedule 40 ☒23
Flush threaded PVC schedule 80 ☐24
Other☐

10. Screen Material: Sch 40 PVC
a. Screen type: Factory cut ☒11
Continuous slot ☐01
Other ☐ b.
Manufacturer Boart Longyear
c. Slot size: 0.010in.
d. Slotted length: 15.0 ft.

11. Backfill material (below filter pack): None ☒14
Other ☐

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature

Daniel Q. Reid

Firm
RMT, Inc.
744 Heartland Trail
Madison, WI 53717

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State of Wisconsin
Department of Natural Resources

# MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 6-97

Route To: Watershed/Wastewater ☐ Waste Management ☐ Remediation/Redevelopment ☐ Other ☐

| Facility/Project Name | County | Well Name |
|---|---|---|
| Dairyland Power | Buffalo | W-100R |

| Facility License, Permit or Monitoring Number | County Code | Wis. Unique Well Number | DNR Well Number |
|---|---|---|---|
| | 6 | | |

1. Can this well be purged dry? ☐ Yes ☒ No

2. Well development method:
   - surged with bailer and bailed ☐ 4 1
   - surged with bailer and pumped ☐ 6 1
   - surged with block and bailed ☐ 4 2
   - surged with block and pumped ☐ 6 2
   - surged with block, bailed, and pumped ☐ 7 0
   - compressed air ☐ 2 0
   - bailed only ☐ 1 0
   - pumped only ☐ 5 1
   - pumped slowly ☐ 5 0
   - other Pumped & Surged ☒

3. Time spent developing well 45 min.

4. Depth of well (from top of well casing) 79.6 ft.

5. Inside diameter of well 2.06 in.

6. Volume of water in filter pack and well casing 19.9 gal.

7. Volume of water removed from well 50.0 gal.

8. Volume of water added (if any) gal.

9. Source of water added

10. Analysis performed on water added? ☐ Yes ☐ No
(If yes, attach results)

| | | Before Development | After Development |
|---|---|---|---|
| 11. Depth to Water (from top of well casing) | a. | 56.90 ft. | 59.92 ft. |
| Date | b. | 05/17/2001 | 05/17/2001 |
| Time | c. | 11:00 am | 11:45 am |
| 12. Sediment in well bottom | | 0.010 inches | 0.0 inches |
| 13. Water clarity | | Clear ☐ 1 0<br>Turbid ☒ 1 5<br>(Describe) Cloudy Green Tint | Clear ☒ 2 0<br>Turbid ☐ 2 5<br>(Describe) Clear Green Stain |

Fill in if drilling fluids were used and well is at solid waste facility:

| | | |
|---|---|---|
| 14. Total suspended solids | mg/l | mg/l |
| 15. COD | mg/l | mg/l |

16. Well developed by: Person's Name and Firm
T. Schmalfeldt
Boart Longyear

17. Additional comments on development:
Silty Well - Pumped and Surged Slow

Facility Address or Owner/Responsible Party Address

Name:

Firm:

Street:

City/State/Zip:

I hereby certify that the above information is true and correct to the best of my knowledge.

Signature: [signature]

Print Name: Ron Thalacker

Firm: Boart Longyear

NOTE: See instructions for more information including a list of county codes and well type codes.

State of Wisconsin
Department of Natural Resources

# MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 6-97

Route To: Watershed/Wastewater ☐ Waste Management ☐ Remediation/Redevelopment ☐ Other ☐

| Facility/Project Name | County | Well Name |
|---|---|---|
| Dairyland Power | Buffalo | W-100AR |

| Facility License, Permit or Monitoring Number | County Code | Wis. Unique Well Number | DNR Well Number |
|---|---|---|---|
| | 6 | | |

1. Can this well be purged dry? ☐ Yes ☒ No

2. Well development method:
   - surged with bailer and bailed ☐ 4 1
   - surged with bailer and pumped ☐ 6 1
   - surged with block and bailed ☐ 4 2
   - surged with block and pumped ☐ 6 2
   - surged with block, bailed, and pumped ☐ 7 0
   - compressed air ☐ 2 0
   - bailed only ☐ 1 0
   - pumped only ☐ 5 1
   - pumped slowly ☐ 5 0
   - other Pumped & Surged Grundfos ☒

3. Time spent developing well 45 min.

4. Depth of well (from top of well casing) 99.7 ft.

5. Inside diameter of well 2.06 in.

6. Volume of water in filter pack and well casing 27.2 gal.

7. Volume of water removed from well gal.

8. Volume of water added (if any) gal.

9. Source of water added

10. Analysis performed on water added? ☐ Yes ☐ No
(If yes, attach results)

| | | Before Development | After Development |
|---|---|---|---|
| 11. Depth to Water (from top of well casing) | a. | 68.82 ft. | 69.16 ft. |
| Date | b. | 05/21/2001 | 05/21/2001 |
| Time | c. | 10:00 am | 10:45 pm |
| 12. Sediment in well bottom | | 0.010 inches | 0.0 inches |
| 13. Water clarity | | Clear ☐ 1 0<br>Turbid ☒ 1 5 | Clear ☒ 2 0<br>Turbid ☐ 2 5 |
| | | (Describe)<br>Cloudy Yellow | (Describe)<br>Clear Yellow<br>Stain |

Fill in if drilling fluids were used and well is at solid waste facility:

| | | |
|---|---|---|
| 14. Total suspended solids | mg/l | mg/l |
| 15. COD | mg/l | mg/l |

16. Well developed by: Person's Name and Firm
T. Schmalfeldt
Boart Longyear

17. Additional comments on development:

Facility Address or Owner/Responsible Party Address

Name:

Firm:

Street:

City/State/Zip:

I hereby certify that the above information is true and correct to the best of my knowledge.

Signature: [signature]

Print Name: Ron Thalacker

Firm: Boart Longyear

NOTE: See instructions for more information including a list of county codes and well type codes.

State of Wisconsin
Department of Natural Resources

# MONITORING WELL DEVELOPMENT
Form 4400-113B Rev. 4-90

Route to: Solid Waste ☒Haz. Waste ☐Wastewater ☐
Env. Response & Repair ☐Underground Tanks ☐Other ☐ _____

| Facility/Project Name | County Name | Well Name |
|---|---|---|
| Dairyland Power Alma Landfill | Buffalo | W-101 |

| Facility License, Permit or Monitoring Number | County Code | Wis. Unique Well Number | DNR Well Number |
|---|---|---|---|
| 2927 | 08 | | |

1. Can this well be purged dry? ☐Yes ☒No

2. Well development method
   - surged with bailer and bailed ☒41
   - surged with bailer and pumped ☒61
   - surged with block and bailed ☐42
   - surged with block and pumped ☐62
   - surged with block, bailed and pumped ☐70
   - compressed air ☐20
   - bailed only ☐10
   - pumped only ☐51
   - pumped slowly ☐50
   - Other Bailed_____ ☐

3. Time spent developing well 180min.

4. Depth of well (from top of well casing) 124.5ft.

5. Inside diameter of well 2.00in.

6. Volume of water in filter pack and well casing 5.0gal.

7. Volume of water removed from well 125.0gal.

8. Volume of water added (if any) 20.0gal.

9. Source of water added _____

10. Analysis performed on water added? ☒Yes ☐No
(If yes, attach results)

| | Before Development | After Development |
|---|---|---|
| 11. Depth to Water (from top of well casing) | a. 112.54ft | 112.60ft |
| Date | b. 11/20/94 | 11/21/94 |
| Time | c. 10:40 ☒a.m. ☐p.m. | 12:05 ☐a.m. ☒p.m. |
| 12. Sediment in well bottom | 0.0inches | 0.0inches |
| 13. Water clarity | Clear ☐10<br>Turbid ☒15<br>(Describe)<br>Olive green<br>Very turbid | Clear ☐20<br>Turbid ☒25<br>(Describe)<br>Light olive green<br>Slightly trubid |
| 14. Total suspended solids | NAmg/l | 14000.0mg/l |
| 15. COD | _____mg/l | _____mg/l |

Fill in if drilling fluids were used and well is at solid waste facility:

16. Additional comments on development: Field Development Data

| | Pre-Dev. | ~2 vols | ~6 vols | Post-Dev. |
|---|---|---|---|---|
| pH | 7.3 | 7.3 | 7.3 | 7.3 |
| Temp. | 7°C | 8°C | 8°C | 8°C |
| Cond. | 402 | 415 | 415 | 415 |

Well developed by: Person's Name and Firm

Name: Daniel Reid

Firm: RMT, Inc.

I hereby certify that the above information is true and correct to the best of my knowledge.

Signature: Daniel R. Reid

Print Initials: D.D.R

Firm: RMT, Inc.

NOTE: Shaded areas are for DNR use only. See instructions for more information including a list of county codes.

State of Wisconsin
Department of Natural Resources

# MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 6-97

Route To: Watershed/Wastewater ☐ Waste Management ☐ Remediation/Redevelopment ☐ Other ☐

| Facility/Project Name | County | Well Name |
|---|---|---|
| Dairyland Power | Buffalo | W-102R |

| Facility License, Permit or Monitoring Number | County Code | Wis. Unique Well Number | DNR Well Number |
|---|---|---|---|
| | 6 | | |

. Can this well be purged dry? ☐ Yes ☒ No

. Well development method:

- surged with bailer and bailed ☐ 4 1
- surged with bailer and pumped ☐ 6 1
- surged with block and bailed ☐ 4 2
- surged with block and pumped ☐ 6 2
- surged with block, bailed, and pumped ☐ 7 0
- compressed air ☐ 2 0
- bailed only ☐ 1 0
- pumped only ☐ 5 1
- pumped slowly ☐ 5 0
- other Surged w/Sub Pump during Pumping ☒

. Time spent developing well 120 min.

. Depth of well (from top of well casing) 81.6 ft.

. Inside diameter of well 2.06 in.

. Volume of water in filter pack and well casing 18.6 gal.

. Volume of water removed from well gal.

. Volume of water added (if any) gal.

. Source of water added

10. Analysis performed on water added? ☐ Yes ☐ No
(If yes, attach results)

| | | Before Development | After Development |
|---|---|---|---|
| 11. Depth to Water (from top of well casing) | a. | 60.65 ft. | 60.65 ft. |
| Date | b. | 05/17/2001 | 05/17/2001 |
| Time | c. | 11:00 am | 01:00 pm |
| 12. Sediment in well bottom | | 0.010 inches | 0.0 inches |
| 13. Water clarity | | Clear ☐ 1 0<br>Turbid ☒ 1 5<br>(Describe) Opaque Lt Br | Clear ☒ 2 0<br>Turbid ☐ 2 5<br>(Describe) Semi-Clear Yellow |

Fill in if drilling fluids were used and well is at solid waste facility:

| | | |
|---|---|---|
| 14. Total suspended solids | mg/l | mg/l |
| 15. COD | mg/l | mg/l |

16. Well developed by: Person's Name and Firm

Client

RMT

17. Additional comments on development:

Client Developed

Facility Address or Owner/Responsible Party Address

Name:

Firm:

Street:

City/State/Zip:

I hereby certify that the above information is true and correct to the best of my knowledge.

Signature:

Print Name: Ron Thalacker

Firm: Boart Longyear

NOTE: See instructions for more information including a list of county codes and well type codes.

State of Wisconsin
Department of Natural Resources

# MONITORING WELL DEVELOPMENT
Form 4400-113B Rev. 4-90

Route to: Solid Waste ☐ Haz. Waste ☐ Wastewater ☐
Env. Response & Repair ☐ Underground Tanks ☐ Other ☐ _____

| Facility/Project Name | County Name | Well Name |
|---|---|---|
| Dairyland Power Cooperative | Buffalo | W105 |

| Facility License, Permit or Monitoring Number | County Code | Wis. Unique Well Number | DNR Well Number |
|---|---|---|---|
| 2927 | 06 | | |

1. Can this well be purged dry? ☒ Yes ☐ No

2. Well development method
- surged with bailer and bailed ☒ 41
- surged with bailer and pumped ☐ 61
- surged with block and bailed ☐ 42
- surged with block and pumped ☐ 62
- surged with block, bailed and pumped ☐ 70
- compressed air ☐ 20
- bailed only ☐ 10
- pumped only ☐ 51
- pumped slowly ☐ 50
- Other Bailed_____ ☐

3. Time spent developing well 160 min.

4. Depth of well (from top of well casing) 96.5 ft.

5. Inside diameter of well 2.00 in.

6. Volume of water in filter pack and well casing 5 gal.

7. Volume of water removed from well 25 gal.

8. Volume of water added (if any) ____ gal.

9. Source of water added _____

10. Analysis performed on water added? ☐ Yes ☐ No
(If yes, attach results)

| | Before Development | After Development |
|---|---|---|
| 11. Depth to Water (from top of well casing) | a. 88.45 ft<br>TD=96.52<br>+ 0.22 | 88.33 ft |
| Date | b. 11/28/95 | 11/28/95 |
| Time | c. 3:24 ☐ a.m. ☒ p.m. | 6:00 ☐ a.m. ☒ p.m. |
| 12. Sediment in well bottom | 0.0 inches | 0.0 inches |
| 13. Water clarity | Clear ☐ 10<br>Turbid ☒ 15<br>(Describe)<br>Greenish-gray | Clear ☐ 20<br>Turbid ☒ 25<br>(Describe)<br>Tan |
| 14. Total suspended solids | NA mg/l | 1100.0 mg/l |
| 15. COD | NA mg/l | 6.3 mg/l |

Fill in if drilling fluids were used and well is at solid waste facility:

16. Additional comments on development:

| Gals. | pH | Temp. | Cond. | Turb. | Color |
|---|---|---|---|---|---|
| 6 | 3.4 | 7.9 | 260 | H | Green-gray |
| 15 | 5.8 | 8.7 | 322 | H | Green-gray |
| 19 | | Dry | | | |
| 25 | 7.1 | 9.2 | 325 | M-H | Tan |

Well developed by: Person's Name and Firm

Name: Craig Bartholomew

Firm: RMT, Inc.

I hereby certify that the above information is true and correct to the best of my knowledge.

Signature: Daniel O. Lee

Print Initials: C.O.B

Firm: RMT, Inc.

NOTE: Shaded areas are for DNR use only. See instructions for more information including a list of county codes.

State of Wisconsin
Department of Natural Resources

# MONITORING WELL DEVELOPMENT
Form 4400-113B Rev. 4-90

Route to: Solid Waste ☒ Haz. Waste ☐ Wastewater ☐
Env. Response & Repair ☐ Underground Tanks ☐ Other ☐ _____

| Facility/Project Name | County Name | Well Name |
|---|---|---|
| Dairyland Power Cooperative | Buffalo | W106 |

| Facility License, Permit or Monitoring Number | County Code | Wis. Unique Well Number | DNR Well Number |
|---|---|---|---|
| 2927 | 06 | | |

1. Can this well be purged dry? ☐ Yes ☒ No

2. Well development method
   - surged with bailer and bailed ☐ 41
   - surged with bailer and pumped ☐ 61
   - surged with block and bailed ☐ 42
   - surged with block and pumped ☐ 62
   - surged with block, bailed and pumped ☐ 70
   - compressed air ☐ 20
   - bailed only ☐ 10
   - pumped only ☐ 51
   - pumped slowly ☐ 50
   - Other Grundfos Pump ☒

3. Time spent developing well: 90 min.

4. Depth of well (from top of well casing): 84 ft.

5. Inside diameter of well: 2.00 in.

6. Volume of water in filter pack and well casing: 3.0 gal.

7. Volume of water removed from well: 190 gal.

8. Volume of water added (if any): ____ gal.

9. Source of water added _____

10. Analysis performed on water added? ☐ Yes ☐ No
(If yes, attach results)

| | Before Development | After Development |
|---|---|---|
| 11. Depth to Water (from top of well casing) | a. 79.50 ft | 79.60 ft |
| Date | b. 11/10/95 | 11/10/95 |
| Time | c. 12:30 ☐ a.m. ☒ p.m. | 2:00 ☐ a.m. ☒ p.m. |
| 12. Sediment in well bottom | 0.0 inches | 0.0 inches |
| 13. Water clarity | Clear ☒ 10; Turbid ☐ 15; (Describe) | Clear ☐ 20; Turbid ☒ 25; (Describe) Green |

Fill in if drilling fluids were used and well is at solid waste facility:

| | | |
|---|---|---|
| 14. Total suspended solids | NA mg/l | 1300.0 mg/l |
| 15. COD | NA mg/l | 7.1 mg/l |

16. Additional comments on development:

| Gals. | pH | Cond. | Temp. | Turb. |
|---|---|---|---|---|
| 2 | 6.1 | 360 | 8.8°C | H |
| 25 | 6.4 | 350 | 9.3°C | H |
| 75 | 6.1 | 349 | 9.0°C | M |
| 130 | 6.4 | 342 | 9.0°C | L |
| 160 | 6.3 | 352 | 9.1°C | L |
| 190 | 6.4 | 345 | 9.2°C | L |

Well developed by: Person's Name and Firm

Name: Eric Schoenberg

Firm: Boart Longyear

I hereby certify that the above information is true and correct to the best of my knowledge.

Signature: Daniel R. Reid

Print initials: C O B

Firm: RMT, Inc.

NOTE: Shaded areas are for DNR use only. See instructions for more information including a list of county codes.

State of Wisconsin
Department of Natural Resources

# MONITORING WELL DEVELOPMENT
Form 4400-113B Rev. 4-90

Route to: Solid Waste ☒Haz. Waste ☐Wastewater ☐
Env. Response & Repair ☐Underground Tanks ☐Other ☐ _____

| Facility/Project Name | County Name | Well Name |
|---|---|---|
| Dairyland Power Cooperative | Buffalo | W107 |

| Facility License, Permit or Monitoring Number | County Code | Wis. Unique Well Number | DNR Well Number |
|---|---|---|---|
| 2927 | 06 | | |

1. Can this well be purged dry? ☐Yes ☒No

2. Well development method
- surged with bailer and bailed ☒41
- surged with bailer and pumped ☐61
- surged with block and bailed ☐42
- surged with block and pumped ☐62
- surged with block, bailed and pumped ☐70
- compressed air ☐20
- bailed only ☐10
- pumped only ☐51
- pumped slowly ☐50
- Other Bailed_____ ☐

3. Time spent developing well 180min.

4. Depth of well (from top of well casing) 88.8ft.

5. Inside diameter of well 2.06in.

6. Volume of water in filter pack and well casing 5.7gal.

7. Volume of water removed from well 40.0gal.

8. Volume of water added (if any) 0.0gal.

9. Source of water added _____

10. Analysis performed on water added? ☐Yes ☐No
(If yes, attach results) NA

| | Before Development | After Development |
|---|---|---|
| 11. Depth to Water (from top of well casing) | a. 77.37ft | 77.40ft |
| Date | b. 050197 | 05/01/97 |
| Time | c. 11:20 ☒a.m. ☐p.m. | 03:40 ☐a.m. ☒p.m. |
| 12. Sediment in well bottom | 0.0inches | 0.1inches |
| 13. Water clarity | Clear ☐10<br>Turbid ☒15<br>(Describe)<br>Olive green<br>Very turbid<br>No odor | Clear ☐20<br>Turbid ☒25<br>(Describe)<br>Olive green<br>Medium turbid<br>No odor |

Fill in if drilling fluids were used and well is at solid waste facility:

| | | |
|---|---|---|
| 14. Total suspended solids | _____mg/l | 590.0mg/l |
| 15. COD | _____mg/l | <5.3mg/l |

16. Additional comments on development: Field Development Data

| | Initial | Volume 2 | Volume 4 | Volume 6 |
|---|---|---|---|---|
| pH | 6.8 | 6.8 | 6.9 | 6.9 |
| Temp | 11° | 12° | 12° | 12° |
| Cond. | 540 | 519 | 519 | 519 |

Well developed by: Person's Name and Firm

Name: Daniel Reid

Firm: RMT, Inc.

I hereby certify that the above information is true and correct to the best of my knowledge.

Signature: Daniel R. Reid

Print Initials: D D R

Firm: RMT, Inc.

NOTE: Shaded areas are for DNR use only. See instructions for more information including a list of county codes.

# Appendix M: Baseline CCR Groundwater Monitoring Data

**Table A-1**
**Summary of Baseline Groundwater Monitoring**
**Dairyland Power Cooperative - Off-site Disposal Facility, Phase IV Landfill**
**Buffalo County, Wisconsin**

| PARAMETER | UNITS | W-100R 9/25/2015 150925-X02 | W-100R 12/11/2015 151211-X02 | W-100R 3/17/2016 160317-X02 | W-100R 6/15/2016 160615-X02 | W-100R 9/15/2016 160915-X02 | W-100R 12/15/2016 161215-X02 | W-100R 3/23/2017 170323-X02 | W-100R 6/28/2017 170628-X02 |
|---|---|---|---|---|---|---|---|---|---|
| **Appendix III** | | | | | | | | | |
| Boron, total | µg/L | 52.6 | < 20 | < 20 | 18.9 | 25.8 | 23.5 | 28.1 | 18.3 |
| Calcium, total | µg/L | 77100 | 66400 | 73820 | 74830 | 71700 | 77100 | 84000 | 79200 |
| Chloride, total | mg/L | 5.4 | 4.9 | 5.5 | 6 | 5 | 4.9 | 5.5 | 5.4 |
| Fluoride, total | mg/L | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.1 | < 0.1 | < 0.1 |
| pH, field | SU | 7.09 | 6.94 | 7.01 | 7.13 | 7.1 | 6.95 | 6.89 | 6.95 |
| Sulfate | mg/L | 32.7 | 14.1 | 14.8 | 14.3 | 16.4 | 18.3 | 20.63 | 16.6 |
| Total Dissolved Solids (TDS) | mg/L | 361 | 333 | 360 | 383 | 389 | 366 | 378 | 452 |
| **Appendix IV** | | | | | | | | | |
| Antimony, total | µg/L | < 7.95 | < 7.95 | < 7.95 | < 0.762 | < 0.762 | < 0.762 | < 0.762 | < 0.762 |
| Arsenic, total | µg/L | < 1 | < 1 | < 1 | < 0.746 | < 0.746 | < 0.746 | < 0.746 | < 0.746 |
| Barium, total | µg/L | 62.1 | 42.8 | 47.96 | 54.3 | 55 | 55.9 | 59.3 | 57.6 |
| Beryllium, total | µg/L | < 0.19 | < 0.19 | < 0.19 | < 0.19 | < 0.19 | < 0.28 | < 0.28 | < 0.28 |
| Cadmium, total | µg/L | < 0.38 | < 0.38 | < 0.38 | < 0.38 | < 0.38 | < 0.39 | < 0.39 | < 0.39 |
| Chromium, total | µg/L | 1.5 | 1.37 | 1.245 | 1.4 | 1.34 | 1.49 | 1.24 | 1.45 |
| Cobalt, total | µg/L | < 2.9 | < 2.9 | < 2.9 | < 2.9 | < 2.9 | < 1.9 | < 1.9 | < 1.9 |
| Fluoride, total | mg/L | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.1 | < 0.1 | < 0.1 |
| Lead, total | µg/L | < 4.74 | < 4.74 | < 4.74 | < 0.89 | < 0.89 | < 0.89 | < 0.89 | < 0.89 |
| Lithium, total | µg/L | 1.8 | 1.6 | 1.4 | 1.6 | 1.6 | 1.6 | 1.8 | 1.6 |
| Mercury, total | µg/L | < 0.1 | < 0.1 | < 0.1 | < 0.13 | < 0.13 | < 0.13 | < 0.13 | < 0.13 |
| Molybdenum, total | µg/L | < 2.69 | < 2.69 | < 2.69 | < 2.69 | < 2.69 | < 1.3 | < 1.3 | < 1.3 |
| Radium, total | pCi/L | 2.53 | 1.54 | 0.777 | 0.853 | 1.611 | 0.708 | -0.0758 | 0.48699 |
| Radium - 226 | pCi/L | 1.3 | 0.667 | 0.427 | 0.321 | 0.551 | 0.379 | -0.111 | 0.495 |
| Radium - 228 | pCi/L | 1.23 | 0.874 | 0.35 | 0.532 | 1.06 | 0.329 | 0.0352 | -0.00801 |
| Selenium, total | µg/L | < 2 | < 2 | < 2 | < 1.19 | < 1.19 | < 1.19 | < 1.19 | < 1.19 |
| Thallium, total | µg/L | < 2 | < 2 | < 2 | < 0.78 | < 0.78 | < 0.78 | < 0.78 | < 0.78 |
| **Water Elevation** | | | | | | | | | |
| Water elevation | Feet MSL | 726.74 | 726.43 | 726.38 | 726.42 | 726.67 | 726.45 | 726.63 | 727.09 |

**Table A-1**
**Summary of Baseline Groundwater Monitoring**
**Dairyland Power Cooperative - Off-site Disposal Facility, Phase IV Landfill**
**Buffalo County, Wisconsin**

| PARAMETER | UNITS | W-100AR 9/25/2015 150925-X01 | W-100AR 12/11/2015 151211-X01 | W-100AR 3/17/2016 160317-X01 | W-100AR 6/15/2016 160615-X01 | W-100AR 9/15/2016 160915-X01 | W-100AR 12/15/2016 161215-X01 | W-100AR 3/23/2017 170323-X01 | W-100AR 6/28/2017 170628-X01 |
|---|---|---|---|---|---|---|---|---|---|
| **Appendix III** | | | | | | | | | |
| Boron, total | µg/L | < 20 | 25.6 | < 20 | 16.2 | 24.5 | 23.7 | 25.7 | 13.5 |
| Calcium, total | µg/L | 71700 | 73100 | 78770 | 76000 | 72700 | 79600 | 82600 | 78900 |
| Chloride, total | mg/L | 5.3 | 5.1 | 5.3 | 5.8 | 4.8 | 5 | 5 | 5.1 |
| Fluoride, total | mg/L | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.1 | < 0.1 | < 0.1 |
| pH, field | SU | 7.25 | 7.11 | 7.22 | 7.29 | 7.04 | 7.11 | 7.11 | 6.9 |
| Sulfate | mg/L | 15 | 14.4 | 16.6 | 16.5 | 17.5 | 17.5 | 18.45 | 16.5 |
| Total Dissolved Solids (TDS) | mg/L | 268 | 358 | 378 | 403 | 415 | 373 | 385 | 454 |
| **Appendix IV** | | | | | | | | | |
| Antimony, total | µg/L | < 7.95 | < 7.95 | < 7.95 | < 0.762 | < 0.762 | < 0.762 | < 0.762 | < 0.762 |
| Arsenic, total | µg/L | < 1 | < 1 | < 1 | < 0.746 | < 0.746 | < 0.746 | < 0.746 | < 0.746 |
| Barium, total | µg/L | 53.7 | 52.2 | 51.51 | 54.35 | 52 | 52.3 | 54.5 | 53.5 |
| Beryllium, total | µg/L | < 0.19 | < 0.19 | < 0.19 | < 0.19 | < 0.19 | < 0.28 | < 0.28 | < 0.28 |
| Cadmium, total | µg/L | < 0.38 | < 0.38 | < 0.38 | < 0.38 | < 0.38 | < 0.39 | < 0.39 | < 0.39 |
| Chromium, total | µg/L | 1.53 | 1.96 | 1.649 | 1.39 | 1.4 | 1.49 | 1.29 | 1.06 |
| Cobalt, total | µg/L | < 2.9 | < 2.9 | < 2.9 | < 2.9 | < 2.9 | < 1.9 | < 1.9 | < 1.9 |
| Fluoride, total | mg/L | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.1 | < 0.1 | < 0.1 |
| Lead, total | µg/L | < 4.74 | < 4.74 | < 4.74 | < 0.89 | < 0.89 | < 0.89 | < 0.89 | < 0.89 |
| Lithium, total | µg/L | 2.1 | 2.1 | 1.7 | 1.8 | 1.9 | 1.9 | 1.9 | 1.9 |
| Mercury, total | µg/L | < 0.1 | < 0.1 | < 0.1 | < 0.13 | < 0.13 | < 0.13 | < 0.13 | < 0.13 |
| Molybdenum, total | µg/L | < 2.69 | < 2.69 | < 2.69 | < 2.69 | < 2.69 | < 1.3 | < 1.3 | < 1.3 |
| Radium, total | pCi/L | 2.17 | 2.03 | 0.1214 | 0.479 | 0.58 | 0.187 | 0.425 | 0.404 |
| Radium - 226 | pCi/L | 1.08 | 1.03 | 0.0791 | -0.391 | 0.169 | 0.073 | < 0 | < 0 |
| Radium - 228 | pCi/L | 1.09 | 0.996 | 0.0423 | 0.87 | 0.411 | 0.114 | 0.425 | 0.404 |
| Selenium, total | µg/L | < 2 | < 2 | < 2 | < 1.19 | < 1.19 | < 1.19 | < 1.19 | < 1.19 |
| Thallium, total | µg/L | < 2 | < 2 | < 2 | < 0.78 | < 0.78 | < 0.78 | < 0.78 | < 0.78 |
| **Water Elevation** | | | | | | | | | |
| Water elevation | Feet MSL | 717.81 | 716.7 | 716.35 | 716.23 | 716.08 | 715.32 | 715.5 | 716.57 |

**Table A-1**
**Summary of Baseline Groundwater Monitoring**
**Dairyland Power Cooperative - Off-site Disposal Facility, Phase IV Landfill**
**Buffalo County, Wisconsin**

| PARAMETER | UNITS | W-101 9/23/2015 150925-X08 | W-101 12/10/2015 151211-X08 | W-101 3/17/2016 160317-X04 | W-101 6/16/2016 160615-X04 | W-101 9/15/2016 160915-X04 | W-101 12/14/2016 161215-X04 | W-101 3/22/2017 170323-X04 | W-101 6/28/2017 170628-X04 |
|---|---|---|---|---|---|---|---|---|---|
| **Appendix III** | | | | | | | | | |
| Boron, total | µg/L | < 20 | < 20 | < 20 | < 10 | < 10 | < 10 | < 10 | < 10 |
| Calcium, total | µg/L | 62400 | 69900 | 69940 | 67760 | 64200 | 67800 | 72450 | 67200 |
| Chloride, total | mg/L | 6.9 | 6.9 | 7.1 | 7.4 | 6.4 | 6.4 | 6.7 | 6.6 |
| Fluoride, total | mg/L | < 0.2 | < 0.2 | < 0.2 | 0.21 | < 0.2 | < 0.1 | < 0.1 | < 0.1 |
| pH, field | SU | 7.47 | 7.45 | 7.31 | 7.46 | 7.46 | 6.98 | 7.46 | 7.29 |
| Sulfate | mg/L | 13.7 | 15 | 15.6 | 15.7 | 17.7 | 15.4 | 16.33 | 17.6 |
| Total Dissolved Solids (TDS) | mg/L | 349 | 311 | 348 | 389 | 325 | 347 | 339 | 408 |
| **Appendix IV** | | | | | | | | | |
| Antimony, total | µg/L | < 7.95 | < 7.95 | < 7.95 | < 0.762 | < 0.762 | < 0.762 | < 0.762 | < 0.762 |
| Arsenic, total | µg/L | < 1 | < 1 | < 1 | < 0.746 | < 0.746 | < 0.746 | < 0.746 | < 0.746 |
| Barium, total | µg/L | 45.3 | 43.2 | 39.47 | 42.05 | 39.4 | 39.7 | 40.4 | 39.9 |
| Beryllium, total | µg/L | < 0.19 | < 0.19 | < 0.19 | < 0.19 | < 0.19 | < 0.28 | < 0.28 | < 0.28 |
| Cadmium, total | µg/L | < 0.38 | < 0.38 | < 0.38 | < 0.38 | < 0.38 | < 0.39 | < 0.39 | < 0.39 |
| Chromium, total | µg/L | 3.76 | 3.33 | 1.337 | 1.49 | 1.35 | 1.49 | 1.23 | 1.06 |
| Cobalt, total | µg/L | < 2.9 | < 2.9 | < 2.9 | < 2.9 | < 2.9 | < 1.9 | < 1.9 | < 1.9 |
| Fluoride, total | mg/L | < 0.2 | < 0.2 | < 0.2 | 0.21 | < 0.2 | < 0.1 | < 0.1 | < 0.1 |
| Lead, total | µg/L | < 4.74 | < 4.74 | < 4.74 | < 0.89 | < 0.89 | < 0.89 | < 0.89 | < 0.89 |
| Lithium, total | µg/L | 2.1 | 1.7 | 1.3 | 1.5 | 1.6 | 1.5 | 1.5 | 1.6 |
| Mercury, total | µg/L | < 0.1 | < 0.1 | < 0.1 | < 0.13 | < 0.13 | < 0.13 | < 0.13 | < 0.13 |
| Molybdenum, total | µg/L | < 2.69 | < 2.69 | < 2.69 | < 2.69 | < 2.69 | < 1.3 | < 1.3 | < 1.3 |
| Radium, total | pCi/L | 0.733 | 1.3 | 0.8263 | 0.287 | 0.366 | 0.485 | 0.375 | 0.7054 |
| Radium - 226 | pCi/L | 0.437 | 0.496 | 0.0753 | < 0 | 0.079 | 0.3 | -0.176 | 0.0654 |
| Radium - 228 | pCi/L | 0.296 | 0.802 | 0.751 | 0.287 | 0.287 | 0.185 | 0.551 | 0.64 |
| Selenium, total | µg/L | < 2 | < 2 | < 2 | < 1.19 | < 1.19 | < 1.19 | < 1.19 | < 1.19 |
| Thallium, total | µg/L | < 2 | < 2 | < 2 | < 0.78 | < 0.78 | < 0.78 | < 0.78 | < 0.78 |
| **Water Elevation** | | | | | | | | | |
| Water elevation | Feet MSL | 814.15 | 813.85 | 813.35 | 813.81 | 814.73 | 813.81 | 814.59 | 816.46 |

**Table A-1**
**Summary of Baseline Groundwater Monitoring**
**Dairyland Power Cooperative - Off-site Disposal Facility, Phase IV Landfill**
**Buffalo County, Wisconsin**

| PARAMETER | UNITS | W-102R 9/23/2015 150925-X04 | W-102R 12/10/2015 151211-X04 | W-102R 3/18/2016 160317-X03 | W-102R 6/16/2016 160615-X03 | W-102R 9/14/2016 160915-X03 | W-102R 12/14/2016 161215-X03 | W-102R 3/23/2017 170323-X03 | W-102R 6/28/2017 170628-X03 |
|---|---|---|---|---|---|---|---|---|---|
| **Appendix III** | | | | | | | | | |
| Boron, total | µg/L | < 20 | < 20 | < 20 | < 10 | < 10 | < 10 | < 10 | < 10 |
| Calcium, total | µg/L | 57400 | 59900 | 61170 | 61710 | 58100 | 62400 | 65200 | 62200 |
| Chloride, total | mg/L | 4.7 | 4.7 | 4.7 | 5 | 3.9 | 3.5 | 3.6 | 3.4 |
| Fluoride, total | mg/L | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.1 | < 0.1 | < 0.1 |
| pH, field | SU | 7.49 | 7.36 | 7.42 | 7.44 | 7.42 | 7.05 | 7.32 | 7.12 |
| Sulfate | mg/L | 14.5 | 15.3 | 13.6 | 13.8 | 15.5 | 14.4 | 14.78 | 13.7 |
| Total Dissolved Solids (TDS) | mg/L | 263 | 269 | 311 | 325 | 298 | 287 | 301 | 356 |
| **Appendix IV** | | | | | | | | | |
| Antimony, total | µg/L | < 7.95 | < 7.95 | < 7.95 | < 0.762 | < 0.762 | < 0.762 | < 0.762 | < 0.762 |
| Arsenic, total | µg/L | < 1 | < 1 | < 1 | < 0.746 | < 0.746 | < 0.746 | < 0.746 | < 0.746 |
| Barium, total | µg/L | 33.5 | 32.3 | 31.29 | 34.12 | 31.6 | 32 | 33.1 | 32.8 |
| Beryllium, total | µg/L | < 0.19 | < 0.19 | < 0.19 | < 0.19 | < 0.19 | < 0.28 | < 0.28 | < 0.28 |
| Cadmium, total | µg/L | < 0.38 | < 0.38 | < 0.38 | < 0.38 | < 0.38 | < 0.39 | < 0.39 | < 0.39 |
| Chromium, total | µg/L | 1.61 | 1.26 | 1.113 | 1.22 | 1 | 1.14 | 1.02 | 0.844 |
| Cobalt, total | µg/L | < 2.9 | < 2.9 | < 2.9 | < 2.9 | < 2.9 | < 1.9 | < 1.9 | < 1.9 |
| Fluoride, total | mg/L | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.1 | < 0.1 | < 0.1 |
| Lead, total | µg/L | < 4.74 | < 4.74 | < 4.74 | < 0.89 | < 0.89 | < 0.89 | < 0.89 | < 0.89 |
| Lithium, total | µg/L | 1.2 | 1.3 | 0.95 | 1.1 | 1.3 | 1.2 | 1.2 | 1.2 |
| Mercury, total | µg/L | < 0.1 | < 0.1 | < 0.1 | < 0.13 | < 0.13 | < 0.13 | < 0.13 | < 0.13 |
| Molybdenum, total | µg/L | < 2.69 | < 2.69 | < 2.69 | < 2.69 | < 2.69 | < 1.3 | < 1.3 | < 1.3 |
| Radium, total | pCi/L | 1.856 | 1.1 | -0.076 | 0.14 | 1.303 | 0.024 | 0.722 | 2.382 |
| Radium - 226 | pCi/L | 0.806 | 0.486 | 0.118 | -0.05 | 0.313 | 0.215 | 0.105 | 1.65 |
| Radium - 228 | pCi/L | 1.05 | 0.61 | -0.194 | 0.19 | 0.99 | -0.191 | 0.617 | 0.732 |
| Selenium, total | µg/L | < 2 | < 2 | < 2 | < 1.19 | < 1.19 | < 1.19 | < 1.19 | < 1.19 |
| Thallium, total | µg/L | < 2 | < 2 | < 2 | < 0.78 | < 0.78 | < 0.78 | < 0.78 | < 0.78 |
| **Water Elevation** | | | | | | | | | |
| Water elevation | Feet MSL | 814.74 | 814.52 | 813.94 | 814.47 | 815.38 | 814.82 | 815.43 | 817.18 |

**Table A-1**
**Summary of Baseline Groundwater Monitoring**
**Dairyland Power Cooperative - Off-site Disposal Facility, Phase IV Landfill**
**Buffalo County, Wisconsin**

| PARAMETER | UNITS | W-105 9/23/2015 150925-X12 | W-105 12/9/2015 151211-X12 | W-105 3/16/2016 160317-X05 | W-105 6/16/2016 160615-X05 | W-105 9/14/2016 160915-X05 | W-105 12/15/2016 161215-X05 | W-105 3/23/2017 170323-X05 | W-105 6/28/2017 170628-X05 |
|---|---|---|---|---|---|---|---|---|---|
| **Appendix III** | | | | | | | | | |
| Boron, total | µg/L | < 20 | < 20 | < 20 | < 10 | 11 | 17.7 | 10.8 | < 10 |
| Calcium, total | µg/L | 60600 | 65200 | 64780 | 64990 | 61400 | 66000 | 70100 | 65900 |
| Chloride, total | mg/L | 5.2 | 5 | 5.2 | 5.5 | 4.5 | 4 | 4.2 | 4 |
| Fluoride, total | mg/L | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.1 | < 0.1 | < 0.1 |
| pH, field | SU | 7.4 | 7.23 | 7.28 | 7.37 | 7.23 | 7.08 | 7.29 | 7.17 |
| Sulfate | mg/L | 11.5 | 13.5 | 13.5 | 12 | 13.9 | 11.9 | 13.44 | 13.8 |
| Total Dissolved Solids (TDS) | mg/L | 316 | 308 | 329 | 360 | 335 | 288 | 323 | 390 |
| **Appendix IV** | | | | | | | | | |
| Antimony, total | µg/L | < 7.95 | < 7.95 | < 7.95 | < 0.762 | < 0.762 | < 0.762 | < 0.762 | < 0.762 |
| Arsenic, total | µg/L | < 1 | < 1 | < 1 | < 0.746 | < 0.746 | < 0.746 | < 0.746 | < 0.746 |
| Barium, total | µg/L | 36.4 | 35.1 | 34.86 | 37.38 | 34.8 | 35.8 | 36.6 | 36.6 |
| Beryllium, total | µg/L | < 0.19 | < 0.19 | < 0.19 | < 0.19 | < 0.19 | < 0.28 | < 0.28 | < 0.28 |
| Cadmium, total | µg/L | < 0.38 | < 0.38 | < 0.38 | < 0.38 | < 0.38 | < 0.39 | < 0.39 | < 0.39 |
| Chromium, total | µg/L | 1.3 | 1.52 | 1.108 | 1.16 | 1.14 | 1.32 | 1.21 | 0.976 |
| Cobalt, total | µg/L | < 2.9 | < 2.9 | < 2.9 | < 2.9 | < 2.9 | < 1.9 | < 1.9 | < 1.9 |
| Fluoride, total | mg/L | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.1 | < 0.1 | < 0.1 |
| Lead, total | µg/L | < 4.74 | < 4.74 | < 4.74 | < 0.89 | < 0.89 | < 0.89 | < 0.89 | < 0.89 |
| Lithium, total | µg/L | 1.5 | 1.6 | 1.2 | 1.4 | 1.5 | 1.4 | 1.5 | 1.4 |
| Mercury, total | µg/L | < 0.1 | < 0.1 | < 0.1 | < 0.13 | < 0.13 | < 0.13 | < 0.13 | < 0.13 |
| Molybdenum, total | µg/L | < 2.69 | < 2.69 | < 2.69 | < 2.69 | < 2.69 | < 1.3 | < 1.3 | < 1.3 |
| Radium, total | pCi/L | 1.218 | 0.969 | 1.143 | 1.142 | 0.897 | 0.705 | 0.399 | 0.881 |
| Radium - 226 | pCi/L | 0.629 | 0.789 | 0.485 | 0.212 | 0.172 | 0.316 | -0.094 | 0.518 |
| Radium - 228 | pCi/L | 0.589 | 0.18 | 0.658 | 0.93 | 0.725 | 0.389 | 0.493 | 0.363 |
| Selenium, total | µg/L | < 2 | < 2 | < 2 | < 1.19 | < 1.19 | < 1.19 | < 1.19 | < 1.19 |
| Thallium, total | µg/L | < 2 | < 2 | < 2 | < 0.78 | < 0.78 | < 0.78 | < 0.78 | < 0.78 |
| **Water Elevation** | | | | | | | | | |
| Water elevation | Feet MSL | 732.25 | 732.88 | 732.68 | 732.87 | 733.03 | 732.91 | 733.01 | 733.46 |

**Table A-1**
**Summary of Baseline Groundwater Monitoring**
**Dairyland Power Cooperative - Off-site Disposal Facility, Phase IV Landfill**
**Buffalo County, Wisconsin**

| PARAMETER | UNITS | W-106 12/28/2015 151228-X01 | W-106 3/18/2016 160317-X06 | W-106 6/16/2016 160615-X06 | W-106 9/14/2016 160915-X06 | W-106 12/14/2016 161215-X06 | W-106 1/27/2017 170127-X06 | W-106 3/23/2017 170323-X06 | W-106 6/28/2017 170628-X06 |
|---|---|---|---|---|---|---|---|---|---|
| **Appendix III** | | | | | | | | | |
| Boron, total | µg/L | < 20 | < 20 | < 10 | < 10 | < 10 | 17 | 19.6 | < 10 |
| Calcium, total | µg/L | 67700 | 68850 | 66790 | 63800 | 67800 | 70900 | 71800 | 67300 |
| Chloride, total | mg/L | 7.4 | 7.3 | 7.9 | 6.7 | 6.9 | 7.1 | 7.3 | 7.4 |
| Fluoride, total | mg/L | < 0.20 | < 0.2 | 0.21 | < 0.2 | < 0.1 | 0.17 | < 0.1 | < 0.1 |
| pH, field | SU | 7.21 | 7.43 | 7.51 | 7.33 | 7.43 | 7.43 | 7.4 | 7.21 |
| Sulfate | mg/L | 17.3 | 18 | 17.6 | 16.8 | 16.9 | 18.5 | 17.37 | 16.3 |
| Total Dissolved Solids (TDS) | mg/L | 319 | 340 | 393 | 327 | 326 | 343 | 338 | 398 |
| **Appendix IV** | | | | | | | | | |
| Antimony, total | µg/L | < 7.95 | < 7.95 | < 0.762 | < 0.762 | < 0.762 | 0.16 | < 0.762 | < 0.762 |
| Arsenic, total | µg/L | 0.25 | < 1 | < 0.746 | < 0.746 | < 0.746 | 0.2 | < 0.746 | < 0.746 |
| Barium, total | µg/L | 35.5 | 34.09 | 37.46 | 34.6 | 35.3 | 36 | 35.1 | 36.1 |
| Beryllium, total | µg/L | < 0.19 | < 0.19 | < 0.19 | < 0.19 | < 0.28 | < 0.28 | < 0.28 | < 0.28 |
| Cadmium, total | µg/L | < 0.38 | < 0.38 | < 0.38 | < 0.38 | < 0.39 | < 0.39 | < 0.39 | < 0.39 |
| Chromium, total | µg/L | 1.42 | 1.21 | 1.39 | 1.26 | 1.41 | 1.68 | 1.3 | 1.12 |
| Cobalt, total | µg/L | < 2.9 | < 2.9 | < 2.9 | < 2.9 | < 1.9 | < 1.9 | < 1.9 | < 1.9 |
| Fluoride, total | mg/L | < 0.20 | < 0.2 | 0.21 | < 0.2 | < 0.1 | 0.17 | < 0.1 | < 0.1 |
| Lead, total | µg/L | < 4.74 | < 4.74 | < 0.89 | < 0.89 | < 0.89 | 0.21 | < 0.89 | < 0.89 |
| Lithium, total | µg/L | 1.4 | 1.3 | 1.4 | 1.5 | 1.5 | 1.4 | 1.5 | 1.6 |
| Mercury, total | µg/L | < 0.10 | < 0.1 | < 0.13 | < 0.13 | < 0.13 | < 0.13 | < 0.13 | < 0.13 |
| Molybdenum, total | µg/L | < 2.69 | < 2.69 | < 2.69 | < 2.69 | < 1.3 | < 1.3 | < 1.3 | < 1.3 |
| Radium, total | pCi/L | 0.501 | 0.564 | 0.86 | 0.731 | 0.512 | 0.799 | 0.1584 | 0.847 |
| Radium - 226 | pCi/L | 0.1 | -0.318 | 0.321 | -0.16 | 0.0768 | 0.323 | 0.155 | 0.407 |
| Radium - 228 | pCi/L | 0.501 | 0.882 | 0.539 | 0.891 | 0.435 | 0.476 | 0.0034 | 0.44 |
| Selenium, total | µg/L | 0.44 | < 2 | < 1.19 | < 1.19 | < 1.19 | 0.7 | < 1.19 | < 1.19 |
| Thallium, total | µg/L | <0.018 | < 2 | < 0.78 | < 0.78 | < 0.78 | 0.27 | < 0.78 | < 0.78 |
| **Water Elevation** | | | | | | | | | |
| Water elevation | Feet MSL | 772.82 | 772.82 | 772.96 | 773.06 | 772.94 | 773 | 773.05 | 773.44 |

**Table A-1**
**Summary of Baseline Groundwater Monitoring**
**Dairyland Power Cooperative - Off-site Disposal Facility, Phase IV Landfill**
**Buffalo County, Wisconsin**

| PARAMETER | UNITS | W-107 9/23/2015 150925-X13 | W-107 12/11/2015 151211-X13 | W-107 3/17/2016 160317-X07 | W-107 6/15/2016 160615-X07 | W-107 9/14/2016 160915-X07 | W-107 12/14/2016 161215-X07 | W-107 3/22/2017 170323-X07 | W-107 6/27/2017 170628-X07 |
|---|---|---|---|---|---|---|---|---|---|
| **Appendix III** | | | | | | | | | |
| Boron, total | µg/L | < 20 | < 20 | < 20 | < 10 | < 10 | < 10 | 12.3 | < 10 |
| Calcium, total | µg/L | 61700 | 75300 | 72640 | 72780 | 69400 | 72900 | 76300 | 73800 |
| Chloride, total | mg/L | 7.7 | 10.3 | 10.5 | 10.7 | 9.4 | 10.5 | 11.1 | 11.6 |
| Fluoride, total | mg/L | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.1 | < 0.1 | < 0.1 |
| pH, field | SU | 7.7 | 7.35 | 7.32 | 7.49 | 7.18 | 6.9 | 7.16 | 7.43 |
| Sulfate | mg/L | 16.9 | 20.6 | 19.5 | 18.7 | 19 | 17.9 | 18.93 | 17.3 |
| Total Dissolved Solids (TDS) | mg/L | 335 | 341 | 351 | 422 | 313 | 355 | 370 | 459 |
| **Appendix IV** | | | | | | | | | |
| Antimony, total | µg/L | < 7.95 | < 7.95 | < 7.95 | < 0.762 | < 0.762 | < 0.762 | < 0.762 | < 0.762 |
| Arsenic, total | µg/L | < 1 | < 1 | < 1 | < 0.746 | < 0.746 | < 0.746 | < 0.746 | < 0.746 |
| Barium, total | µg/L | 35.1 | 44.9 | 41.11 | 36.57 | 42.4 | 41.4 | 42.9 | 46.1 |
| Beryllium, total | µg/L | < 0.19 | < 0.19 | < 0.19 | < 0.19 | < 0.19 | < 0.28 | < 0.28 | < 0.28 |
| Cadmium, total | µg/L | < 0.38 | < 0.38 | < 0.38 | < 0.38 | < 0.38 | < 0.39 | < 0.39 | < 0.39 |
| Chromium, total | µg/L | 1.51 | 2.2 | 1.505 | 1.55 | 1.39 | 1.51 | 1.43 | 1.24 |
| Cobalt, total | µg/L | < 2.9 | < 2.9 | < 2.9 | < 2.9 | < 2.9 | < 1.9 | < 1.9 | < 1.9 |
| Fluoride, total | mg/L | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.1 | < 0.1 | < 0.1 |
| Lead, total | µg/L | < 4.74 | < 4.74 | < 4.74 | < 0.89 | < 0.89 | < 0.89 | < 0.89 | < 0.89 |
| Lithium, total | µg/L | 1.7 | 1.8 | 1.5 | 1.7 | 1.7 | 1.7 | 1.7 | 1.6 |
| Mercury, total | µg/L | < 0.1 | < 0.1 | < 0.1 | < 0.13 | < 0.13 | < 0.13 | < 0.13 | < 0.13 |
| Molybdenum, total | µg/L | < 2.69 | < 2.69 | < 2.69 | < 2.69 | < 2.69 | < 1.3 | < 1.3 | < 1.3 |
| Radium, total | pCi/L | 0.935 | 0.636 | 0.909 | 0.21 | 0.998 | 0.106 | 0.615 | 1.038 |
| Radium - 226 | pCi/L | -0.029 | 0.069 | -0.087 | < 0 | -0.082 | -0.078 | 0.056 | 0.519 |
| Radium - 228 | pCi/L | 0.964 | 0.567 | 0.996 | 0.21 | 1.08 | 0.184 | 0.559 | 0.519 |
| Selenium, total | µg/L | < 2 | < 2 | < 2 | < 1.19 | < 1.19 | < 1.19 | < 1.19 | < 1.19 |
| Thallium, total | µg/L | < 2 | < 2 | < 2 | < 0.78 | < 0.78 | < 0.78 | < 0.78 | < 0.78 |
| **Water Elevation** | | | | | | | | | |
| Water elevation | Feet MSL | 831 | 830.82 | 830.76 | 830.88 | 831.01 | 830.95 | 831.03 | 831.49 |

# Appendix N: Environmental Sampling Plan

# Environmental Sampling and Analysis Plan

## Alma Offsite Disposal Facility
## Phase IV Landfill
## Alma, Wisconsin

January 2023

**Prepared For:**

Dairyland Power Cooperative
3200 East Avenue South
La Crosse, Wisconsin 54601

**Prepared By:**

TRC
999 Fourier Drive, Suite 101
Madison, Wisconsin 53717

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Attachment 2: Example Groundwater Sampling Form
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# Introduction

This Environmental Sampling and Analysis Plan (ESAP) describes the methods for monitoring site conditions and for sampling the monitoring devices at the Dairyland Power Cooperative (DPC) Phase IV disposal area. This ESAP has been prepared in accordance with the requirements of ss. NR 514.06(7)(a), NR 507.16, and NR 140.16. Samples will be collected and analyzed in accordance with this ESAP and with NR 507.17. A certified laboratory (NR 149) will perform chemical analyses following the approved methods listed in this ESAP. Figure 1 presents an 11 inch by 17-inch map showing monitoring locations. Attachment 1 includes a Well Information Form.

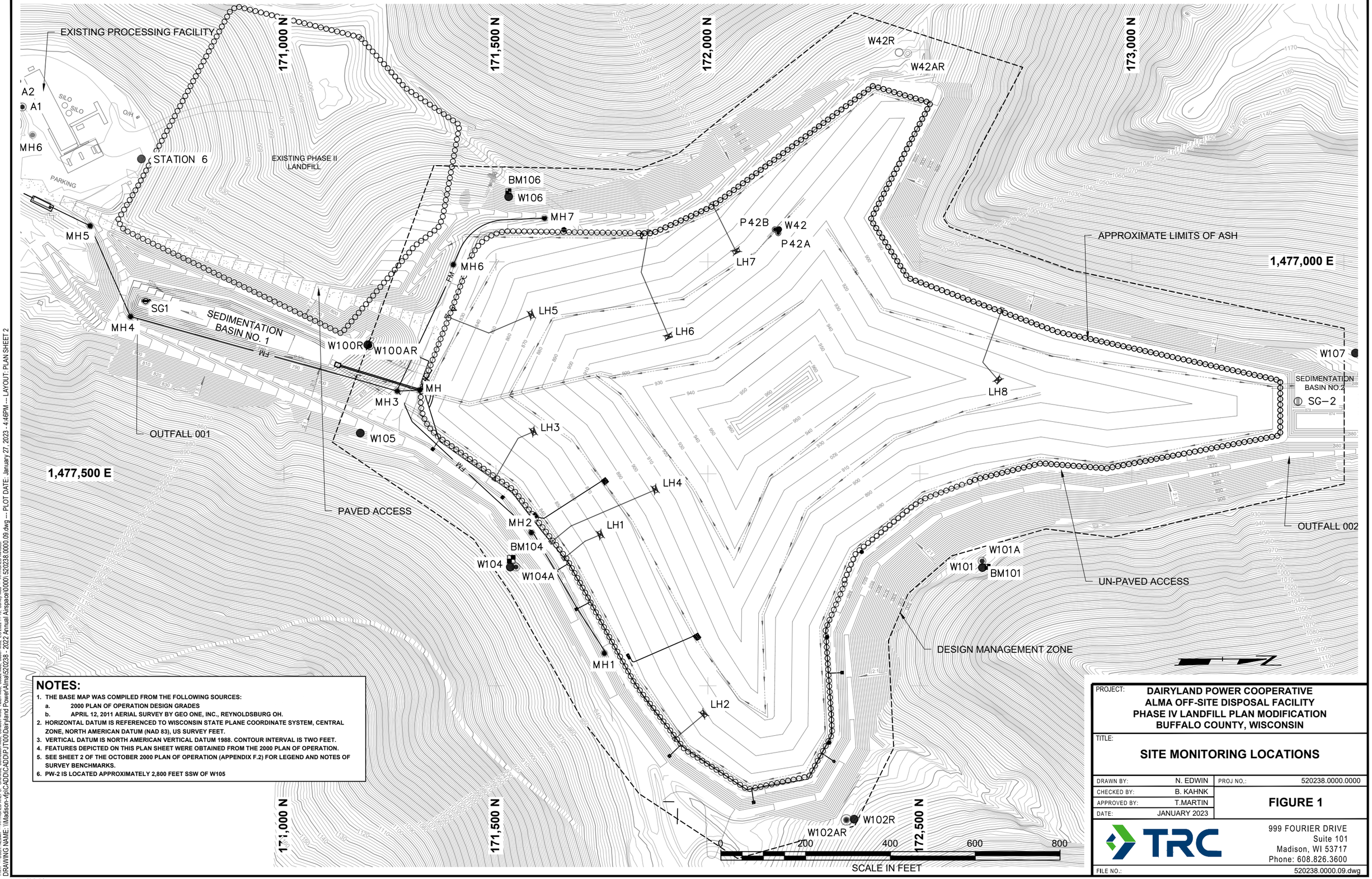
Three basic types of data will be collected during implementation of the ESAP as follows:

- Chemical data derived from samples collected from the various media
- Fluid levels
- Fluid extraction volumes

The environmental media to be monitored are as follows:

- Groundwater
- Surface water/Sedimentation basin outfalls
- Leachate
- Air

DPC sampling personnel will keep and use this ESAP as an independent document (separate from the Plan of Operation or its subsequent modifications). The sampling plan will be followed unless the Wisconsin Department of Natural Resources (WDNR) is notified of, and concurs with, modifications. Written documentation of the approved changes will be submitted to the WDNR.




## NOTES:

1. THE BASE MAP WAS COMPILED FROM THE FOLLOWING SOURCES:
   a. 2000 PLAN OF OPERATION DESIGN GRADES
   b. APRIL 12, 2011 AERIAL SURVEY BY GEO ONE, INC., REYNOLDSBURG OH.
2. HORIZONTAL DATUM IS REFERENCED TO WISCONSIN STATE PLANE COORDINATE SYSTEM, CENTRAL ZONE, NORTH AMERICAN DATUM (NAD 83), US SURVEY FEET.
3. VERTICAL DATUM IS NORTH AMERICAN VERTICAL DATUM 1988. CONTOUR INTERVAL IS TWO FEET.
4. FEATURES DEPICTED ON THIS PLAN SHEET WERE OBTAINED FROM THE 2000 PLAN OF OPERATION.
5. SEE SHEET 2 OF THE OCTOBER 2000 PLAN OF OPERATION (APPENDIX F.2) FOR LEGEND AND NOTES OF SURVEY BENCHMARKS.
6. PW-2 IS LOCATED APPROXIMATELY 2,800 FEET SSW OF W105

PROJECT: DAIRYLAND POWER COOPERATIVE
ALMA OFF-SITE DISPOSAL FACILITY
PHASE IV LANDFILL PLAN MODIFICATION
BUFFALO COUNTY, WISCONSIN

TITLE: SITE MONITORING LOCATIONS

| | | | |
|---|---|---|---|
| DRAWN BY: | N. EDWIN | PROJ NO.: | 520238.0000.0000 |
| CHECKED BY: | B. KAHNK | | FIGURE 1 |
| APPROVED BY: | T.MARTIN | | |
| DATE: | JANUARY 2023 | | |

TRC
999 FOURIER DRIVE
Suite 101
Madison, WI 53717
Phone: 608.826.3600

FILE NO.: 520238.0000.09.dwg

Version: 2017-10-21

11x17 -- USER: KEdwin -- ATTACHED XREFS: GeoMod; Datasets-Mod; Subpot-Mod; Hatch-Mod; Bapd-Mod; Bapd-Mod; EG 2022-11-15; Surve-Mod -- ATTACHED IMAGES:
DRAWING NAME: \\Madison-sfp\CADD\CADD\PJT00\Dairyland Power\Alma\520238 - 2022 Annual Airspace\0000\520238.0000.09.dwg -- PLOT DATE: January 27, 2023 - 4:46PM -- LAYOUT: PLAN SHEET 2

# 1.0 Landfill Monitoring Systems

The design of the DPC Phase IV disposal facility incorporates several different monitoring systems in accordance with ch. NR 507. The landfill monitoring systems are discussed in the following subsections. Specific procedures for purging, sampling, and quality assurance/quality control (QA/QC) are provided in other sections of this ESAP. The monitoring program is summarized in Table 1.

## 1.1 Detection Groundwater Monitoring

Detection groundwater monitoring will be conducted at the DPC Phase IV ash disposal facility in accordance with s. NR 507.19. Figure 1 shows the monitoring wells included in the detection groundwater monitoring program. The wells designated with no “A” or “B” suffix are water table wells. The monitoring wells with the “A” or “B” suffix are piezometers. Monitoring wells with an “R” suffix are replacement wells.

Groundwater beneath the site flows to the south. Therefore, monitoring wells completed to the northwest, north, and northeast of the Phase IV facility (W-42, P-42A, P-42B, W-107, W-101, W-101A, W-102R, and W-102AR) will function as upgradient monitoring points. Wells W-104, W-104A, W-105, W-100R, W-100AR, and W-106 are downgradient monitoring points. Seven of these wells (W-100AR, W-100R, W-101, W-102R, W-105, W-106, and W-107) are designated for the coal combustion residual (CCR) monitoring program under NR 507.15(3). The detection monitoring program includes wells completed in both the unconsolidated sand and silty sand and within the sandstone bedrock. A detailed description of geologic units can be found in the Feasibility Report (RMT, 1997).

Non-CCR wells will be sampled on a semiannual basis (in March and September) for the parameters listed in NR 507, Appendix I, Table 2 for solid waste landfills accepting fly or bottom ash. The CCR wells will be sampled on a semiannual basis (in March and September) for the parameters listed in ch. NR 507, Appendix I, Table 1A for CCR wells at CCR Landfills. Wells and parameters for detection monitoring are summarized in Table 1. Results will be reported in accordance with ch. NR 507 including submittal of sampling results and water elevation data within 60 days of the end of the sampling period per s. NR 507.26, and preparation of an annual groundwater monitoring and corrective action report for CCR wells in accordance with s. NR 507.15(3)(m).

## 1.2 Leachate Monitoring

Leachate collected at the leachate tank will be monitored on a semiannual (March/September) basis for the parameters listed in Table 1, which is consistent with ch. NR 507, Appendix I, Table 4 for landfills accepting fly or bottom ash. The leachate tank will be sampled annually for semivolatile organic compounds (ch. NR 507, Appendix IV).

DPC will maintain records of leachate pumped. Leachate analytical results, volumes, and elevations will be reported to the WDNR on a semiannual basis. Results will be reported in accordance with ch. NR 507.

**Table 1: Environmental Monitoring Program**
**Dairyland Power Cooperative**
**Phase IV Ash Disposal Area**

| Sample Points | Frequency | Parameters |
|---|---|---|
| ***Groundwater*** | | |
| Non-CCR Wells:<br>W-42, P-42A, P-42B, W-101A, W-102AR, W-104, W-104A, PW-2 | Semiannually (March, September) | NR 507, Appendix I, Table 2: Groundwater elevation, field temperature, field conductivity (at 25°C), field pH, alkalinity, dissolved boron, hardness, sulfate; plus dissolved selenium |
| CCR Wells:<br>W-100R, W-100AR, W-101, W-102R, W-105, W-106, and W-107, one MS/MSD | Semiannually (March, September) | NR 507, Appendix I, Table 1A: Groundwater elevation, field temperature, field conductivity (at 25°C), field pH, alkalinity, total boron, calcium, chloride, fluoride, hardness, total dissolved solids (TDS), sulfate; plus dissolved selenium |
| ***Leachate*** | | |
| Leachate tank | Semiannually (March, September) | $BOD_5$, field conductivity at 25°C, field pH, alkalinity, boron, cadmium, chloride, hardness, iron, lead, manganese, mercury, selenium, sulfate, total suspended solids, antimony, beryllium, cobalt, fluoride, lithium, molybdenum, Ra226 and Ra228 combined, thallium |
| | Annually | Semivolatile organic compounds (NR 507, Appendix IV) |
| Leachate collection tank | Monthly | Monthly volume records shall be maintained (reported semiannually) |
| Leachate head wells: LH1, LH2, LH3, LH4, LH5, LH6, LH7, LH8 | Monthly | Leachate level elevation during operation (reported semiannually) |
| ***Surface Water*** | | |
| Sedimentation basins and retention pond | Semiannually (March, September) | Sediment buildup |
| Staff gauges: SG1, SG2 | Semiannually (March, September) | Surface water elevation |
| Outfall 001, Outfall 002 | Semiannually (March, September) | Visual turbidity, field temperature, field conductivity at 25°C, alkalinity, boron, field pH, hardness, selenium, sulfate |

Prepared by: COB, 7/00
Checked by: CCS, 9/19/00
Updated by: S. Sellwood, 12/21/2022

## 1.3 Surface Water Monitoring

Two sedimentation basins are proposed to be constructed at the Phase IV facility, with Sedimentation Basin 1 currently constructed as of January 2023. Surface water in the sedimentation basins will be sampled in accordance with the requirements set forth in s. NR 507.23 and s. 507.26(3) and analyzed for the parameters listed in Table 1 when water is present at the outfall. Surface water monitoring procedures are discussed in Subsection 3.2. Results will be reported in accordance with ch. NR 507.

## 1.4 Settlement Monitoring

Because fly ash and bottom ash, which are disposed after adding moisture, do not experience significant settlement following placement, no settlement monitoring is planned for the Phase IV disposal area. Annual airspace surveys are conducted.

## 2.0 Baseline Groundwater Sampling

Baseline groundwater quality was established for monitoring wells at the Phase IV facility and presented in the Plan of Operation (RMT, 2000). Preventive action limits (PALs) and alternative concentration limits (ACLs) were subsequently proposed for replacement monitoring wells in May 2006 (RMT, 2006). PALs for indicator parameters and ACLs were included in the Conditional Plan of Operation Approval (WDNR, 2001) and a WDNR approval letter dated September 22, 2006 (WDNR, 2006).

Additional baseline groundwater monitoring for the seven CCR monitoring wells was conducted between September 2015 and June 2017. Baseline monitoring in 2015 through 2017 included parameters listed in ch. NR 507 Appendix I, Tables 1A and 3, except for alkalinity, hardness, nitrate+nitrite-N, copper, manganese, silver, zinc, field conductivity, and field temperature. Previous site sampling included alkalinity, hardness, nitrate+nitrite-N, and field conductivity. DPC is in the process of completing the required baseline groundwater monitoring for copper, manganese, silver, zinc, and field temperature in the CCR wells. When eight rounds of these parameters have been collected, the data will be evaluated and used to calculate PALs and ACLs where needed. These ACLs and PALs, as needed, will be provided in an addendum to the February 2023 Plan Modification. Metals concentrations in CCR wells are measured as total recoverable metals (i.e., samples for metals are not field-filtered).

Baseline groundwater quality will be established at new or replacement wells in accordance with ss. NR 507.18(4) and (5), unless the requirement for baseline groundwater quality is waived by the WDNR.

# 3.0 Sample Collection

This section presents specific written procedures for collecting groundwater, surface water, and leachate samples. It includes details on taking field measurements, purging monitoring wells, and obtaining samples in accordance with ss. NR 507.16(1)(c)(d) and (e). Samples will be collected during the months of March and September. The wells will generally be sampled from upgradient to downgradient. If wells are determined to be impacted by regulated or other activities, impacted wells shall be sampled after unimpacted wells have been sampled.

## 3.1 Field Procedures for Groundwater Sampling

Figure 1 shows groundwater sample locations, sampling frequencies, and parameters.

### *3.1.1 Groundwater Monitoring Well Maintenance*

In order to assess problems and possible damage to the monitoring wells, field technicians will visually inspect wells at the time of sampling. Wells will be inspected for the following items:

- Protective casing condition
- Protective casing cap condition
- Casing lock condition
- Well cap condition
- Concrete seal condition
- Visual damage to well

DPC field technicians will provide a written inspection report if repair action is needed.

### *3.1.2 Static Water Level Measurement*

Static water levels will be measured in each well prior to purging each time groundwater is sampled. All groundwater level measurements will be made using a reference point established on the well casing. The reference point will be the highest point of the PVC well casing. A battery-operated water level indicator will be the primary device for water level measurements. The indicator is a self-contained transistorized instrument equipped with a cable and sensor that activates a buzzer and a light when it contacts the water. The depth to water is read from permanent 0.01-foot increment markings on the cable.

In case of instrument failure, depth to groundwater will be measured by a plopper tape that is a bell- or cup-shaped weight attached to a nylon-coated stainless-steel measuring tape. When lowered into the well, a “plopping” or “popping” sound is made when the weight strikes the surface of the water. An accurate reading can be determined by lifting and lowering the weight in short strokes, and reading the tape when the weight just strikes the water. Depth to water will be recorded to the nearest 0.01 foot.

In order to prevent cross-contamination between wells, the water level measuring device will be decontaminated between each well by rinsing first with a soapy water solution and then with distilled water.

In accordance with s. NR 507.15(3)(h), groundwater elevations in wells that monitor the same CCR landfill will be measured within a timeframe short enough to avoid temporal variations in groundwater flow that could preclude accurate determination of groundwater flow rate and direction.

### *3.1.3 Purging of Wells*

The monitoring wells will be purged by removing stagnant water so that the samples collected are fresh formation water. Purging will be accomplished using a QED® MicroPurge pump and controller or similar submersible pump and a YSI® Pro DSS or equivalent multiparameter meter equipped with a flow-through cell. Wells will be purged at a rate of less than a half-liter per minute. Purging will continue until stable conditions are reached, as shown by three consecutive readings taken 2 minutes apart, for the following parameters:

- Dissolved oxygen (± 0.2 mg/L)
- pH (± 0.1 pH unit)
- Conductivity (± 10 percent)
- Temperature (± 0.1°C)

Purging and sampling data will be recorded on a groundwater sampling form (Attachment 2). In accordance with s. NR 507.26, DPC will inform the department of any CCR well that purges dry, is damaged or obstructed, or in any way is rendered such that a sample is unable to be collected from the well during a scheduled sampling event. In such case, DPC will propose actions to correct the problem prior to the next sampling event.

### *3.1.4 Sampling and Data Collection at Each Well*

Samples will be collected immediately after purging. If the well is purged dry, then the sample will be collected when the well has sufficiently recovered (approximately 4 hours). The procedure for sampling the monitoring wells is as follows:

- Prepare bottles by labeling with the well number, the date, the name of the sampler, and the time of day at which the sample is collected.
- Collect samples using the QED® MicroPurge pump and controller or equivalent.
- Collect samples for field measurements.
- Fill unfiltered bottles first.
- After filling unfiltered bottles, collect samples to be filtered, if any, using the filtering device.

A log of meter calibrations and checks will be maintained during each sampling event.

### *3.1.5 Field-filtering*

Samples from the CCR wells collected to meet the requirements of the CCR program will not be field-filtered. If field-filtering is required for samples from non-CCR wells or non-CCR parameters at CCR wells, it will be performed using a vacuum pump (electric or hand-operated), a magnetic filter holder, a 1,000-mL nalgene or polypropylene filter flask, and cellulose nitrate 0.45 micron filter paper.

### 3.1.6 Equipment Cleaning Procedure Between Sampling Events

All equipment used for sampling that is not dedicated or discarded after use (meters, flow cell, and water level measuring devices, etc.) is decontaminated after the sampling event using the following methods:

- Prepare a soapy water bath using laboratory-grade detergent (Alconox).
- Unwind water level measuring devices, soak in soapy water, and wipe clean with a cloth.
- Rinse all equipment with deionized water (ASTM Type II).
- Dry equipment.
- Seal dry equipment in polypropylene plastic to prevent contamination.

### 3.1.7 Equipment Cleaning Procedure Between Monitoring Wells

The procedure to be followed for cleaning water level indicators and nylon-clad steel tapes in the field between wells is as follows:

- Rinse equipment with soapy water.
- Rinse equipment with deionized water (ASTM Type II).

### 3.1.8 Sample Preservation Methods

The preservation methods for the parameters to be analyzed are listed in Table 2 below. Each of the bottles will contain a premeasured volume of preservative, as needed.

Samples will be analyzed at a laboratory certified in Wisconsin in accordance with ch. NR 149.

### 3.1.9 Chain-of-Custody Guidelines

A Chain-of-Custody Record provides a written record of sample bottle possession and transference. The guidelines for the Chain-of-Custody Record to be used by sampling and laboratory personnel to ensure proper tracking are outlined below. An example of a typical Chain-of-Custody Record is included as Attachment 3.

**Table 2: Sample Preservation and Analysis Methods**

| Parameter | Bottle Material | Preservative | Holding Time | Laboratory Methods |
|---|---|---|---|---|
| ***Groundwater, Surface Water, and Leachate*** | | | | |
| Alkalinity | Polyethylene | None | 14 days | SM 2320B |
| Chemical oxygen demand (COD) | Polyethylene | Sulfuric acid | 28 days | EPA 410.4 |
| Chloride, fluoride, and sulfate | Polyethylene | None | 28 days | EPA 300.0 |
| Boron and calcium | Polyethylene | Nitric acid | 6 months | 6020B/6010D |
| Hardness | Polyethylene | Nitric acid | 6 months | 6020B/6010D/ SM 2340B |
| Selenium | Polyethylene | Nitric acid | 6 months | 6020B |
| Total dissolved solids (TDS) | Polyethylene | None | 7 days | SM 2540C |
| ***Leachate Only*** | | | | |
| BOD5 | Polyethylene | None | 48 hours | SM 5210B |
| Total suspended solids (TSS) | Polyethylene | None | 7 days | SM 2540D |
| Cadmium, antimony, and thallium | Polyethylene | Nitric acid | 6 months | 6020B |
| Iron, lead, manganese, beryllium, cobalt, lithium, and molybdenum | Polyethylene | Nitric acid | 6 months | 6020B/6010D |
| Mercury | Polyethylene | Nitric acid | 28 days | 7470/1631E |
| Radium226 + Radium228 | Polyethylene | None/Nitric acid | 5 days/ 6 months | 903.1, 904.0 |
| Semivolatile organic compounds | Glass | None | 7 days | EPA 8270E |

### *3.1.10 Sample Shipment Methods*

#### 3.1.10.1 Time Period

At the completion of the sampling event, DPC personnel will ship samples to the laboratory via commercial shipping service or courier. Sample shipping will be coordinated to ensure that holding times (Table 2) of the analyses are met.

#### 3.1.10.2 Handling

1. Samples will be iced to 4°C and contained in coolers for transport to the laboratory as soon as possible.
2. Transport will be by commercial shipping service or courier service.
3. Samples will be transported in coolers.
4. Sample packaging will include the following:
   - Fill the cooler with ice.
   - Tape the drain on the cooler shut, and wrap the cooler completely with tape in two locations.
   - Place address labels on the cooler.

#### 3.1.10.3 Sample Bottle Labels

Each sample bottle will be labeled so that the analytical laboratory has the following information:

- Collector's name or initials
- Sample date and time
- Sample source/identification
- Sample preservatives
- Whether or not the sample was field-filtered

All labels are color-coded to indicate the type of preservative in the bottle (e.g., red - nitric acid, yellow - sulfuric acid, blue - no preservative).

#### 3.1.10.4 Transport Container Labels

Labels for the transport containers will be addressed to the selected laboratory.

## 3.2 Surface Water Sampling Field Procedures

### *3.2.1 Static Water Level Measurement*

Static water levels will be measured at each sampling point by reading the staff gauge to the nearest 0.05 foot. Surface water sampling points are shown on Figure 1.

### 3.2.2 Sampling and Data Collection

The samples will be collected with a clean, stainless-steel ladle near the outlet of the sedimentation basins with the opening facing upstream (flowing condition). All bottles will be filled prior to taking a sample for performing field measurements. Field measurements will be performed with the YSI® Pro DSS or equivalent measuring equipment. Surface water samples will not be filtered.

### 3.2.3 Sample Preservation

The preservation methods for the parameters to be analyzed are identical to those for groundwater samples (see Table 2).

### 3.2.4 Chain-of-Custody Guidelines

The chain-of-custody procedures are identical to those for groundwater samples (see Subsection 3.1.9).

### 3.2.5 Sample Shipment Method

The sample shipment method for surface water samples is identical to that described for groundwater samples (see Subsection 3.1.10).

## 3.3 Leachate Monitoring

Leachate levels will be measured monthly at the leachate head wells, and leachate samples will be collected semiannually at the leachate tank. Leachate head will be measured in the leachate head wells using a dedicated calibrated transducer. The transducer will be located within the screened interval of the head well and referenced to mean sea level. Leachate samples will be obtained from the leachate tank using a dedicated bailer. The leachate tank will not be purged prior to obtaining samples. The samples will be treated and analyzed as described for groundwater samples. Leachate samples will not be filtered. Collected and recirculated leachate volumes will be recorded monthly using flow meters. The volume of leachate that is recirculated will be recorded separately.

## 3.4 Air Monitoring

In accordance with communication with the WDNR, no air monitoring is required for this site (see Subsection 3.15 of the October 2000 POO).

# 4.0 Quality Assurance/Quality Control Procedures (QA/QC)

Field QA/QC samples are used to evaluate two primary areas of quality control. Sample contamination that may occur in the field and/or during shipping is monitored in the trip blank(s) and the equipment or rinsate blank(s). Field duplicate samples and matrix spike/matrix spike duplicate samples are used to evaluate precision and bias of the sampling and analytical procedures. A general description of each of these follows.

## 4.1 Trip Blanks

Trip blank samples are prepared in the laboratory by filling the appropriate clean sample container(s) with reagent-grade water and adding any applicable chemical preservative. The containers are labeled "Trip Blank." Trip blanks are shipped from the laboratory in the cooler to the field and back to the laboratory along with the other samples for that parameter for a given sampling event. The trip blanks are analyzed to identify contamination that may occur from the containers, coolers, cleaning procedures, or chemical preservatives used. Trip blanks are used and analyzed at a frequency of at least one for each sampling event that includes analysis of samples for VOCs. Because VOCs are not part of the analytical program, trip blanks will not be analyzed.

## 4.2 Equipment (Rinsate) Blank

Equipment or rinsate blanks are prepared in the field immediately following decontamination of nondedicated field equipment used for purging or sampling. Following decontamination, reagent-grade water is passed through the equipment using the same procedures followed in collecting a groundwater sample. The equipment blank confirms proper field decontamination procedures. Therefore, one equipment blank will be collected in association with each surface water sampling event, and one equipment blank will be collected in association with each groundwater sampling event if non-dedicated and/or non-disposal field sampling equipment is used. Sampling typically utilizes dedicated and disposable equipment; therefore equipment blanks will not typically be collected.

## 4.3 Field Duplicate

Field duplicate samples are an extra set of samples collected at a routine monitoring point and labeled as "Duplicate." These are two separate samples collected from the same source, stored in separate containers, and analyzed independently. The samples shall be collected in proper alternating order for the sample point and field duplicate for each parameter (e.g., first collect metals sample, then duplicate metals sample, and so on). Field duplicates document the precision of the sampling and analytical process. Field duplicates may be collected, and analyzed semiannually if data discrepancies or QA/QC issues are occurring.

## 4.4 Matrix Spike / Matrix Spike Duplicate

Matrix spike and matrix spike duplicate samples are collected in the same manner as field duplicates, but a sufficient volume is collected to perform both matrix spike and matrix spike duplicate analyses (triple sample volume total). To conduct a matrix spike analysis, a known amount of a target analyte is added to the sample at the laboratory prior to laboratory sample

preparation and analysis. The matrix spike is used to evaluate the bias of a method in a given sample matrix.

Matrix spike duplicate samples are intra-laboratory split samples spiked with identical concentrations of target analytes. The spiking occurs at the laboratory prior to laboratory sample preparation and analysis. Matrix spike duplicate samples are used to evaluate the precision and bias of a method in a given sample matrix. One matrix spike/matrix spike duplicate for groundwater (all parameters) will be collected during each semiannual monitoring round.

# 5.0 Record Keeping

## 5.1 Field Logs

Field notes must be completely and accurately prepared to become a part of the final report for a monitoring event. Field information will be recorded on groundwater sampling forms (Attachment 2) or equivalent. Field logs will be available to the WDNR upon request.

## 5.2 Chain-of-Custody Procedures

Proper chain-of-custody procedures are necessary to document the integrity of the samples and the condition of the samples upon receipt at the laboratory. The sample collector will fill in all applicable sections of the Chain-of-Custody Record and forward the original, along with the respective sample(s), to the laboratory. Upon receipt at the laboratory, the DPC sampling coordinator will complete the Chain-of-Custody Record, make a copy for his/her records, and make the original form a part of the final analytical report.

## 5.3 Labeling

Sample containers will be labeled to prevent misidentification. The following will be recorded on an adhesive label on each sample container. Data will be recorded using a waterproof pen:

- Collector's name or initials
- Sample date and time
- Sample source/identification
- Sample preservatives
- Whether or not the sample was field-filtered

# 6.0 Sampling, Analysis, and Laboratory Requirements

Samples will be obtained and analyzed in accordance with the approved sampling plan and with the requirements of NR 507.17. Sampling methods are further described in Section 3. All chemical analyses will be conducted by a laboratory certified under s. 144.95, Stats., and NR 149 for that test category, in accordance with NR 507.17(5). Samples will be analyzed for the parameters listed in Table 1.

## 7.0 Reporting

The results of environmental monitoring will be submitted to the WDNR within 60 days of the end of the sampling period, in accordance with NR 507. Sampling data will be submitted in an electronic format, and will include the information required by NR 507.26(3)(b). The WDNR will be notified of values that have attained or exceeded the groundwater standards, in accordance with NR 507.30. The owner or operator of the CCR landfill shall determine the rate and direction of groundwater flow each time groundwater is sampled and include the results in the report to the WDNR within 60 days of the end of the sampling period.

In addition, an annual groundwater monitoring and corrective action report in accordance with NR 507.15(3)(m) will be prepared and submitted by January 31 of the year following the calendar year in which the groundwater monitoring system is approved by the department, and annually thereafter. The annual groundwater monitoring and corrective action report will be placed in the written operating record and posted on a publicly accessible internet site in accordance with NR 506.17 (2) and (3). In accordance with NR 507.15(3)(m) the annual groundwater monitoring and corrective action report will document the status of the groundwater monitoring and any corrective action implemented at the CCR landfill, summarize key actions completed, describe any problems encountered, discuss actions to resolve the problems, and project key activities for the upcoming year. The report will include, at a minimum, the information specified in NR 507.15(3)(m)1. through 5.

# 8.0 Groundwater Standards

## 8.1 Calculation of Groundwater Standards

The site-specific Preventive Action Limits (PALs) and Alternative Concentration Limits (ACLs) have been calculated or will be calculated following completion of remaining baseline sampling. PALs and ACLs were computed in accordance with NR 507.27. PALs and ACLs for any replacement wells will be established following the first eight rounds of detection monitoring after installation.

## 8.2 Evaluation of Groundwater Standard Exceedances

Exceedances of PALs and ACLs will be determined in accordance with NR 507.28. If a false reading is suspected, the WDNR will be notified of the intent to either begin assessment monitoring or determine that a false exceedance has occurred. The statement of intent will be submitted with the notification required in NR 507.30(1). The written demonstration of false exceedance will be included with the next monitoring round.

## 8.3 Exemptions to Groundwater Standards

Any groundwater exemption requests will be made in accordance with NR 507.29, NR 140.28, and NR 500.08(4). Exemption requests will be made in writing to the WDNR. Requests will include a list of the specific wells and parameters for which an exemption is being requested, proposed ACLs, calculations in accordance with NR 507.27, and a discussion of how the criteria listed in NR 140.28(2), (3), or (4) are met.

## 8.4 Notification and Response to Attainment or Exceedance of Standards

In accordance with NR 507.30, the WDNR will be notified in writing if any groundwater monitoring well value exceeds or attains a groundwater standard. Per NR 507.15(3)(L)(4), the horizontal distance for the design management zone for a CCR landfill is zero feet from the waste boundary and may not be expanded by the department. The waste boundary includes the horizontal space taken up by any liner, dike, or barrier designed to contain CCR waste. Therefore, the point of standards application to determine if a value exceeds or attains a standard is any point where groundwater is monitored.

The notification will specify the parameters for which standards have been attained or exceeded and the well(s) at which the standard was attained or exceeded. The written notification will provide a preliminary analysis of the cause and significance of each concentration in accordance with NR 140.24(1)(a) or NR 140.26(1)(a). The sampling results and two copies of the notification will be submitted to the WDNR within 60 days from the end of the sampling period.

Responses to groundwater exceedances will be in accordance with NR 508, including establishment of an assessment monitoring program in accordance with NR 508.06 unless the exceedance is determined by the WDNR to be from a source other than the CCR landfill, the result of a sampling error, or natural variation.

## 9.0 References


RMT, Inc. 1997. Feasibility Report – Dairyland Power Cooperative Phase IV Disposal Area Alma Off-Site Ash Disposal Facility. September 1997.

RMT, Inc. 2000. Plan of Operation – Dairyland Power Cooperative, Phase IV Disposal Area, Alma Off-Site Ash Disposal Facility. October 2000.

RMT, Inc. 2006. Proposed PALs and ACL Values for wells W100AR, W100R, W102AR and W102R, Dairyland Power Cooperative, Phase IV Disposal Area, Alma Off-Site Ash Disposal Facility. May 2006.

WDNR. 2001. Conditional Plan of Operation Approval for Dairyland Power Cooperative Phase IV Disposal Area, Alma Off-Site Ash Disposal Facility, Town of Belvidere, Buffalo County, License #4126. May 2001.

WDNR. 2006. WDNR Approval of proposed PAL/ACL calculations for the Dairyland Power Cooperative Phase IV Ash Disposal Facility, Town of Belvidere, Buffalo County Wisconsin, License No. 4126. September 2006.

# Attachment 1: Well Information Form

State of Wisconsin
Department of Natural Resources

GROUNDWATER WELL INFORMATION FORM
Chapter 281 and 289, Wis. Stats.
Form 4400-89

Rev. 7-98

| Facility Name | Facility ID Number | License, Permit or Monitoring No. | Date | Completed By (Name and Firm) |
|---|---|---|---|---|
| Dairyland Power Cooperative | 606009360 | 4126 | 21-Aug-00 | Craig Bartholomew, 8/00; QC'd by Rob Hafemeister, 8/00; updated by Mike Dickey 6/13/01 |

| WI Unique Well | Well Name | DNR Well ID Numbe | Well Location | Dir. N E | Dir. S W | Date Establishe | Well Casing Diam. | Well Casing Type | Elevation Top of Well Casing | Elevation Ground Surface | Reference MSL (√) | Reference Site Datum (√) | Depths Screen Top (bgs) | Depths Initial Groundwater (btoc) | Depths Well Depth (bgs) | Screen Length | Well Type | Well Status | Enf. Stds. | Grad-ient | Distance to Waste |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Station 1 | 001 | 171440 | X | | 8/24/81 | 4 | PVC | 837.22 | 835.7 | X | | 34 | 31.6 | 44 | 10 | OW | Aband | Y | U | Within[1] |
| | | | 1508460 | X | | | | | | | | | | | | | | | | | |
| | Station 2 | 002 | 170730 | X | | 9/18/81 | 4 | PVC | 827.12 | 825.6 | X | | 37 | 34.1 | 47 | 10 | OW | Aband | Y | U | Within[1] |
| | | | 1508940 | X | | | | | | | | | | | | | | | | | |
| | W42 | 017 | 172168.72 | X | | 10/19/94 | 2 | PVC | 837.93 | 836.0 | X | | 46.5 | 51.5 | 56.5 | 10 | OW | | Y | S | Within[1] |
| | | | 1476924.64 | X | | | | | | | | | | | | | | | | | |
| | P42A | 018 | 172166.81 | X | | 9/10/79 | 2 | PVC | 838.90 | 835.3 | X | | 64.9 | 51.4 | 69.9 | 5 | PZ | | Y | S | Within[1] |
| | | | 1476933.9 | X | | | | | | | | | | | | | | | | | |
| | P42B | 019 | 172159.42 | X | | 9/11/79 | 2 | PVC | 838.30 | 835.1 | X | | 81.8 | 51.4 | 84.8 | 3 | PZ | | Y | S | Within[1] |
| | | | 1476925.25 | X | | | | | | | | | | | | | | | | | |
| | W43 | 020 | 171828.38 | X | | 8/29/79 | 2 | PVC | 817.70 | 814.7 | X | | 54 | 42.8 | 64 | 10 | OW | Aband | Y | D | Within[1] |
| | | | 1477672.25 | X | | | | | | | | | | | | | | | | | |
| | W100 | 021 | 171345.3 | X | | 10/25/94 | 2 | PVC | 794.52 | 792.2 | X | | 60.5 | 65.3 | 70.5 | 10 | OW | Aband | Y | D | 20' S |
| | | | 1477166.2 | X | | | | | | | | | | | | | | | | | |
| | W101 | 023 | 172654.5 | X | | 11/2/94 | 2 | PVC | 925.83 | 923.2 | X | | 107 | 112.5 | 122 | 15 | OW | | Y | U | 200' NE |
| | | | 1477721 | X | | | | | | | | | | | | | | | | | |
| | W101A | 024 | 172652 | X | | 10/27/95 | 2 | PVC | 925.53 | 923.1 | X | | 146 | 112.5 | 151.0 | 5 | PZ | | Y | U | 190' NE |
| | | | 1477729 | X | | | | | | | | | | | | | | | | | |
| | W102 | 025 | 172046.6 | X | | 10/18/94 | 2 | PVC | 838.02 | 836.1 | X | | 25 | 30.2 | 35 | 10 | OW | Aband | Y | S | Within[1] |
| | | | 1478190.2 | X | | | | | | | | | | | | | | | | | |
| | W102A | 026 | 172041.8 | X | | 10/18/96 | 2 | PVC | 837.45 | 835.7 | X | | 50 | 30.4 | 55 | 5 | PZ | Aband | Y | S | Within[1] |
| | | | 1478191.2 | X | | | | | | | | | | | | | | | | | |

Location Coordinates Are:
- [x] State Plane Coordinate
  - [x] Northern
  - [ ] Central
  - [ ] Southern
- [ ] Local Grid System

Grid Origin Location: (Check if estimated: ___ )

Lat. ____ ° _____ ' _____" Long. ____ ° _____ ' ____ __" or

St. Plane _____ ft. N. _____ ft. E. S/C/N Zone

Remarks:

bgs = below ground surface; btoc = below top of casing.

[1] To be abandoned during landfill construction - spring 2000.

Completion of this form is mandatory under s. NR 507.14 and NR 110.25 Wis. Adm. Code. Failure to file this form may result in forfeiture of not less than $10 nor more than $5,000 for each day of violation. Personally identifiable information provided is intended to be used by the Department for the purposes related to the waste management program.

State of Wisconsin
Department of Natural Resources

GROUNDWATER WELL INFORMATION FORM
Chapter 281 and 289, Wis. Stats.
Form 4400-89

Rev. 7-98

| Facility Name | Facility ID Number | License, Permit or Monitoring No. | Date | Completed By (Name and Firm) |
|---|---|---|---|---|
| Dairyland Power Cooperative | 606009360 | 4126 | 21-Aug-00 | Dan Reid - RMT, Inc.; updated by Craig Bartholomew, 8/00; QC'd by Rob Hafemeister, 8/00 |

| WI Unique Well No. | Well Name | DNR Well ID Number | Well Location | Dir. N/E | Dir. S/W | Date Established | Well Casing Diam. | Well Casing Type | Elevation Top of Well Casing | Elevation Ground Surface | Reference MSL (√) | Reference Site Datum (√) | Depths Screen Top (bgs) | Depths Initial Groundwater (btoc) | Depths Well Depth (bgs) | Screen Length | Well Type | Well Status | Enf. Stds. | Grad-ient | Distance to Waste |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | W100A | 022 | 171357 | X | | 10/27/95 | 2 | PVC | 795.31 | 792.9 | X | | 95 | 82.9 | 100 | 5 | PZ | Aband | Y | D | 18' S |
| | | | 1477172 | X | | | | | | | | | | | | | | | | | |
| | W104 | 027 | 171542 | X | | 11/14/95 | 2 | PVC | 845.79 | 843.3 | X | | 75 | 87.2 | 90 | 15 | OW | | Y | S/U | 120' SE |
| | | | 1477713 | X | | | | | | | | | | | | | | | | | |
| | W104A | 028 | 171546 | X | | 11/13/95 | 2 | PVC | 845.14 | 843.1 | X | | 109 | 100.25 | 114 | 5 | PZ | | Y | S/U | 110' SE |
| | | | 1477718 | X | | | | | | | | | | | | | | | | | |
| | W105 | 029 | 171180 | X | | 11/3/95 | 2 | PVC | 821.21 | 818.3 | X | | 79 | 88.45 | 94 | 15 | OW | | Y | S/U | 127' SE |
| | | | 1477404 | X | | | | | | | | | | | | | | | | | |
| | W106 | 030 | 171530 | X | | 11/7/95 | 2 | PVC | 850.84 | 848.3 | X | | 72 | 79.5 | 82 | 10 | OW | | Y | S/U | 80' W |
| | | | 1476837 | X | | | | | | | | | | | | | | | | | |
| | W107 | 031 | 173527.44 | X | | 5/1/97 | 2 | PVC | 908.29 | 906.2 | X | | 69 | 77.4 | 84 | 15 | OW | | Y | U | 190' N |
| | | | 1477214.99 | X | | | | | | | | | | | | | | | | | |
| | PW01 | 032 | 170430 | X | | 8/24/81 | 10 | STL | | | | | | 67 | 410 | NA | Water Supply | Aband | Y | D | 260' SE |
| | | | 1477100 | X | | | | | | | | | | | | | | | | | |
| JQ894 | W100R | 40 | 171197.15 | X | | 5/17/01 | 2 | PVC | 784.38 | 781.4 | X | | | | 75 | 15 | OW | | Y | D | 135' NE |
| | | | 1477195.77 | X | | | | | | | | | | | | | | | | | |
| JQ893 | W100AR | 42 | 171202.48 | X | | 5/17/01 | 2 | PVC | 784.79 | 781.4 | X | | | | 92 | 10 | PZ | | Y | D | 135' NE |
| | | | 1477198.28 | X | | | | | | | | | | | | | | | | | |
| SQ892 | W102R | 44 | 172319.04 | X | | 5/17/01 | 2 | PVC | 876.1 | 873.1 | X | | | | 78 | 5 | OW | | Y | U | 90' W |
| | | | 1478318.01 | X | | | | | | | | | | | | | | | | | |
| SQ891 | W102AR | 46 | 172320.77 | X | | 5/17/01 | 2 | PVC | 876.1 | 873.1 | X | | | | 98 | 10 | PZ | | Y | U | 90' W |
| | | | 1478313.97 | X | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |

Location Coordinates Are:
- [x] State Plane Coordinate
- [ ] Local Grid System
  - [x] Northern
  - [ ] Central
  - [ ] Southern

Grid Origin Location: (Check if estimated: ___ )

Lat. ____ ° _____ ' _____" Long. ____ ° _____ ' _____ __" or

St. Plane _____ ft. N. _____ ft. E. S/C/N Zone

Remarks:

bgs = below ground surface; btoc = below top of casing.

Completion of this form is mandatory under s. NR 507.14 and NR 110.25 Wis. Adm. Code. Failure to file this form may result in forfeiture of not less than $10 nor more than $5,000 for each day of violation. Personally identifiable information provided is intended to be used by the Department for the purposes related to the waste management program.

# Attachment 2: Example Groundwater Sampling Form

# LOW-FLOW GROUNDWATER SAMPLING RECORD

| Well Name |
|---|
| W106 |
| Page 1 of |

| | | |
|---|---|---|
| PROJECT : DAIRYLAND POWER COOPERATIVE | DNR WELL ID No: 30 | DATE: |
| LOCATION: Alma Offsite 04126 | WUWN: | WEATHER: |
| FIELD MONITOR DEVICE: YSI ProDSS | PUMP DEVICE: Dedicated Pump | TEMPERATURE: |
| WELL I.D. (in.): 2-inch | SCREEN LENGTH: 10 | FIELD REPS: |
| WATER LEVEL: | MEASURING POINT: Top of PVC Casing | PUMP INTAKE DEPTH: 62 |
| WELL DEPTH (Log): 64.7 | | Duplicate: W106 |

| TIME (24 HR) | DEPTH (ft) | TEMP (°c) | *DO (mg/L) | COND. (µS/cm) | pH | ORP (mV) | **TURB (NTU) | DRAW DOWN (ft) | FLOW RATE | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|
| Stabilized within > | | N/A | [+/- 10%] | [+/- 3%] | [+/- 0.1] | [+/- 10] | [+/- 10%] | [+/- 0.3] | <700mL/min | (Color, odor, comments) |
| | | | [if > .5 mg/l] | | | | [if > 5 NTU] | | | |
| | | | | | | | | | | |
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NOTES:

2/43 200 Historical Ranges: pH: 7.15 - 7.65 Cond: 560 - 570

* If three DO readings are < 0.5 mg/l, consider value stabilzed ** If three turbidity values are less than 5 NTU, consider values as stablized

[well volume = 3.14 (PI) * radius$^2$ * height of water column] → 2 in well = 0.163 gal/ft 4 in = 0.653 gal/ft 6 in = 1.469 gal/ft 1 ft$^3$ = 7.48 gal 1 gal = 3.785 L 1L = 0.264 gal 0.5L/min = 0.132 gal/min

# Attachment 3: Example Chain of Custody Record

# CHAIN-OF-CUSTODY Analytical Request Document

Pace Analytical®

Submitting a sample via this chain of custody constitutes acknowledgment and acceptance of the Pace Terms and Conditions found at: https://info.pacelabs.com/hubfs/pas-standard-terms.pdf

Chain-of-Custody is a LEGAL DOCUMENT - Complete all relevant fields

**LAB USE ONLY- Affix Workorder/Login Label Here or List Pace Workorder Number or MTJL Log-in Number Here**

**ALL BOLD OUTLINED AREAS are for LAB USE ONLY**

Company: Dairyland Power Cooperative

Address: 3251 East Ave. South, LaCrosse, WI 54601

Billing Information: APInvoices@DairylandPower.com

Report To: Tad.Schwartzhoff@DairylandPower.com

Email To:

Copy To:

Site Collection Info/Address: Alma Off Site

Customer Project Name: **ALMA OFF-SITE GROUNDWATER**

State: WI / County/City: / Time Zone Collected: [ ]PT [ ]MT [X]CT [ ]ET

Phone: 608-787-1441
Email:

Site/Facility ID #: Alma Off-Site

Compliance Monitoring? [ X ] Yes [ ] No

Collected By (print): Tad Schwartzhoff/Brian Kalvelage

Purchase Order # :
Quote #:

DW PWS ID #:
DW Location Code:

Collected By (signature):

Turnaround Date Required: Standard

Immediately Packed on Ice: [ X ] Yes [ ] No

Sample Disposal:
[X] Dispose as appropriate
[ ] Return
[ ] Archive: _____
[ ] Hold: _____

Rush: (Expedite Charges Apply)
[ ] Same Day [ ] Next Day
[ ] 2 Day [ ] 3 Day
[ ] 4 Day [ ] 5 Day

Field Filtered (if applicable):
[ ] Yes **[ X ] No**

**Analysis: All**

* Matrix Codes (Insert in Matrix box below): Drinking Water (DW), Ground Water (GW), Wastewater (WW), Product (P), Soil/Solid (SL), Oil (OL), Wipe (WP), Air (AR), Tissue (TS), Bioassay (B), Vapor (V), Other (OT)

Container Preservative Type **

| U | 2 | 1 | 1 | 1 | 1 | 1 | | | |
|---|---|---|---|---|---|---|---|---|---|

** Preservative Types: (1) nitric acid, (2) sulfuric acid, (3) hydrochloric acid, (4) sodium hydroxide, (5) zinc acetate, (6) methanol, (7) sodium bisulfate, (8) sodium thiosulfate, (9) hexane, (A) ascorbic acid, (B) ammonium sulfate, (C) ammonium hydroxide, (D) TSP, (U) Unpreserved, (O) Other _____

Lab Project Manager:

Analyses

Container Type: Plastic (P) or Glass (G)

| Customer Sample ID | Matrix * | Comp / Grab | Collected (or Composite Start) Date | Collected (or Composite Start) Time | Composite End Date | Composite End Time | Res Cl | # of Ctns |
|---|---|---|---|---|---|---|---|---|
| | GW | Grab | | | | | | |
| | GW | Grab | | | | | | |
| | GW | Grab | | | | | | |
| | GW | Grab | | | | | | |
| | GW | Grab | | | | | | |
| | GW | Grab | | | | | | |
| | GW | Grab | | | | | | |
| | GW | Grab | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

Lab Profile/Line:

Lab Sample Receipt Checklist:
Custody Seals Present/Intact Y N NA
Custody Signatures Present Y N NA
Collector Signature Present Y N NA
Bottles Intact Y N NA
Correct Bottles Y N NA
Sufficient Volume Y N NA
Samples Received on Ice Y N NA
VOA - Headspace Acceptable Y N NA
USDA Regulated Soils Y N NA
Samples in Holding Time Y N NA
Residual Chlorine Present Y N NA
Cl Strips: _____
Sample pH Acceptable Y N NA
pH Strips: _____
Sulfide Present Y N NA
Lead Acetate Strips: _____

LAB USE ONLY:
Lab Sample # / Comments:

Customer Remarks / Special Conditions / Possible Hazards:

Type of Ice Used: Wet Blue Dry None

Packing Material Used:

Radchem sample(s) screened (<500 cpm): Y N NA

SHORT HOLDS PRESENT (<72 hours) : Y N N/A

Lab Tracking #:

Samples received via:
FEDEX UPS Client Courier Pace Courier

LAB Sample Temperature Info:
Temp Blank Received: Y N NA
Therm ID#: _____
Cooler 1 Temp Upon Receipt: __oC
Cooler 1 Therm Corr. Factor:___oC
Cooler 1 Corrected Temp: _____oC
Comments:

| Relinquished by/Company: (Signature) | Date/Time: | Received by/Company: (Signature) | Date/Time: |
|---|---|---|---|
| Relinquished by/Company: (Signature) | Date/Time: | Received by/Company: (Signature) | Date/Time: |
| Relinquished by/Company: (Signature) | Date/Time: | Received by/Company: (Signature) | Date/Time: |

MTJL LAB USE ONLY
Table #:
Acctnum:
Template:
Prelogin:
PM:
PB:

Trip Blank Received: Y N NA
HCL MeOH TSP Other

Non Conformance(s): YES / NO

Page: 1
of: 1

# Appendix O: Fugitive Dust Control Plan

# DUST CONTROL PLAN

# Alma Offsite Landfill – Phase IV
# S2180 State Hwy 35
# Alma, Wisconsin

*Prepared by: Dairyland Power Cooperative*

*Reviewed and Certified by: TRC Environmental Corporation*

December 30, 2022

## REVISION HISTORY

| Revision Number | Revision Date | Section Revised | Summary of Revisions |
|---|---|---|---|
| 00 | 10/14/15 | -- | Initial Fugitive Dust Control Plan |
| 01 | 11/29/16 | 2 | Updated landfill cell status table and text. |
| 01 | 11/29/16 | 3.3 | Added "track out pads" to text in one of the bullets. |
| 01 | 11/29/16 | 6.2 | Updated contact phone number and email address. |
| 01 | 11/30/16 | 3.1 | Updated Dust Control Procedures to reflect engineering evaluation |
| 01 | 11/30/16 | App. D | Added Appendix D – Engineering Control Evaluation |
| 01 | 12/19/16 | 7 | Updated Engineering Certification Statement |
| 02 | 12/13/17 | App. C & D | Updated Appendix C and D |
| 03 | 12/17/18 | App. C & D | Updated Appendix C and D |
| 04 | 12/17/19 | App. C & D | Updated Appendix C and D |
| 05 | 12/16/20 | All | Updated the link in Section 6 to https://www.dairylandpower.com/<br>Updated the dates and revision # on all applicable pages<br>Updated Appendix C and D |
| 06 | 12/29/21 | Section 1, 2, 3, App. C & D | Updated report to account for decommissioning of G-3, upgrades to JPM, and change in use of the ash processing facility to backup status. |
| 07 | 12/30/22 | Section 2, 3, 4, 6, App. C | Updated procedures and inspection description to include the use of leachate wetting inside the limits of the lined active landfill. Incorporated Wisconsin Administrative Code Requirements. |

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Figure 2: Site Layout

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Appendix A: Daily Inspection Checklist

Appendix B: Training Attendance Record

Appendix C: Dust Control Plan Review Documentation

## LIST OF ACRONYMS

| | |
|---|---|
| CCR | Coal Combustion Residuals |
| CFR | Code of Federal Regulations |
| EPRI | Electric Power Research Institute |
| FGD | Flue Gas Desulfurization |

# SECTION 1

# BACKGROUND

The purpose of this Plan is to identify and describe the Coal Combustion Residuals (CCR) fugitive dust control procedures used to reduce the potential for CCR becoming airborne at the Alma Off-Site Landfill. The following sections provide background information on (1) coal combustion residuals and (2) regulatory requirements.

## 1.1 Coal Combustion Residuals

CCR materials are produced at coal-fired power plants when coal is burned to produce electricity. CCR materials are managed by coal-fired power plant sites, including on-site storage, processing (such as dewatering), and final disposal, typically in CCR landfills. Currently, CCR materials produced by Dairyland Power Cooperative's John P. Madgett Station is managed at the Alma Off-Site Landfill. CCR material from Genoa #3 was also managed at the Alma Off-site Landfill prior to decommissioning the unit in 2021. Types of CCRs typically generated include fly ash, bottom ash, and flue gas desulfurization (FGD) materials. General characteristics of these CCR materials are described below.

- **Fly Ash** – Fly ash is captured from exhaust (flue) gases by emissions control equipment including baghouses and electrostatic precipitators. Fly ash is characterized by clay-sized and silt-sized fine grain materials, consisting of silica, calcium, alumina, iron and trace heavy metals. Due to the small particle size and consistency, fly ash can often be mobilized by windy conditions when it is dry. However, the fly ash received at the Alma Off-Site Landfill is typically not dusty during management activities. This material is conditioned by adding water to the fly ash prior to arriving at the landfill or at the conditioning facility located at the landfill. Once this water has been added, it generally forms a crust on the surface of the fly ash, reducing the potential for dust issues.
- **FGD Materials** – FGD materials are produced by FGD emissions control systems, which are designed and operated to remove sulfur dioxide (SO2) from exhaust (flue) gases. FGD materials are produced as a dry fine grained material, similar to fly ash. The material is collected in a baghouse and stored in silos. The material is then conditioned with water and transported by covered trucks to the landfill for disposal. When wetted and rolled out, the material forms a light crust reducing the potential for dust issues. Under certain conditions, FGD materials can form a crust on surfaces, reducing potential for dust issues from FGD storage areas.

- **Bottom Ash** – Bottom ash is characterized by sand-sized and gravel-sized materials, which settle by gravity to the bottom of a coal-fired furnace. Bottom ash from the boiler is directed to bins, where it is dewatered before being removed and transported to the landfill or storage area. Because of the larger particle size than fly ash, bottom ash is generally less susceptible to dust issues.

## 1.2 Regulatory Requirements

This Dust Control Plan has been developed for the Alma Off-Site Landfill in accordance with applicable federal, state, and local regulations discussed below.

### 1.2.1 CCR Rule Requirements

The CCR Rule (40 Code of Federal Regulations [CFR] Part 257, Subpart D) requires preparation of a Dust Control Plan for facilities including CCR landfills, CCR surface impoundments, and any lateral expansion of a CCR unit. Definitions from the CCR Rule are provided below.

> **CCR fugitive dust** means solid airborne particulate matter that contains or is derived from CCR, emitted from any source other than a stack or chimney.
>
> **CCR landfill** means an area of land or an excavation that receives CCR and which is not a surface impoundment, an underground injection well, a salt dome formation, a salt bed formation, an underground or surface coal mine, or a cave. For purposes of this subpart, a CCR landfill also includes sand and gravel pits and quarries that receive CCR, CCR piles, and any practice that does not meet the definition of a beneficial use of CCR.
>
> **CCR unit** means any CCR landfill, CCR surface impoundment, or lateral expansion of a CCR unit, or a combination of more than one of these units, based on the context of the paragraph(s) in which it is used. This term includes both new and existing units, unless otherwise specified. The CCR Rule requires owners or operators of these CCR facilities to adopt and document "measures that will effectively reduce the potential for CCR becoming airborne at the facility, including CCR fugitive dust originating from CCR units, roads, and other CCR management, and material handling activities" (40 CFR 257.80). Existing CCR surface impoundments and existing CCR landfills must prepare a Dust Control Plan "no later than October 19, 2015, or by initial receipt of CCR in any CCR unit at the facility if the owner or operator becomes subject to this subpart after October 19, 2015" (40 CFR 257.80 (b)(5)).

**Facility** means the Alma Off-Site Landfill and consists of contiguous land, and structures, other appurtenances, and improvements on the land, used for treating, storing, disposing, or otherwise conducting solid waste management of CCR. A facility may consist of several treatment, storage, or disposal operational units (e.g., one or more landfills, surface impoundments, or combinations of them).

### 1.2.2 Applicable State and Local Requirements

The Alma Offsite Phase IV Landfill has a State approved operating license and Plan of Operation (POO). The POO includes a Fugitive Dust Control Plan as required by State solid waste rules (e.g., NR 504, 506, and 514). In addition to the State fugitive dust requirements outlined in the POO, Buffalo County does not have specific fugitive dust ordinances.

## SECTION 2

## FACILITY INFORMATION

Name of Facility: Alma Off-Site Landfill

Name of Operator: Dairyland Power Cooperative

Operator Mailing Address: 3200 East Avenue South
La Crosse, WI 54601

Name of Owner: Dairyland Power Cooperative

Owner Mailing Address: 3200 East Avenue South
La Crosse, WI 54601

Location: NE ¼ of the NE ¼ of Section 19 and portions of Section 18 and 20, Township 21N, Range 12W, Town of Belvidere, Buffalo, County, Wisconsin

CCR Description: CCR material consists of the following:

| CCR Material Type | G-3 | JPM |
|---|---|---|
| Fly ash | X | X |
| Bottom ash | X | X |
| Dry Scrubber waste (FGD) | X | |
| Dry Sorbent Injection waste (FGD) | | X |
| Activated carbon waste | X | X |

Facility Description: The Alma Off-Site (AOS) Landfill Facility consists of two licensed landfills. Phase I, II, and III Landfill is closed and capped. Phase IV Landfill is active and is classified as a CCR Landfill. CCR material is delivered by trucks to the Alma Offsite Phase IV Landfill from two off-site generation facilities, Genoa # 3 (G-3) and John P. Madgett Station (JPM). Genoa #3 was decommissioned in 2021 and no additional CCR is received from that facility.

The Phase IV Landfill consists of several cells.

| Cell | Cell Size (acres) | Year Constructed | Year Closed and Capped |
|---|---|---|---|
| 1 | 6 | 2001 | 2009 |
| 2A | 3.8 | 2006 | 2011 |
| 2B | 3.4 | 2007 | Active |
| 3A | 3.9 | 2012 | Active |
| 3B | 3.1 | 2015 | Active |
| 4A | 5.4 | Future | |
| 4B | 6.5 | Future | |

The first cell was constructed in 2001. Constructed cells consist of cells 1, 2A, 2B, 3A, and 3B. Portions of cells 1, 2A and 2B were closed and capped in 2009, 2011 and 2016, respectively. The final two cells, 4A and 4B will be constructed at some future date when appropriate to do so.

The landfill has two sedimentation basins associated with it. Sedimentation Basin No. 1 was constructed with Cell 1 in 2001. Sedimentation Basin No. 2 will be constructed with Cell 4B. The basins are for controlling storm water that drains off of the capped cells.

The landfill has a leachate collection system and leachate storage tank. On-site leachate water is used to condition ash at the adjacent Ash Processing Operation. Leachate water may also be used for dust control within the landfill's active cells, when appropriate site conditions are met.

An Ash Processing Operation (APO) is adjacent to the landfill. The APO consists of CCR storage silos and a system to condition (wet) CCR before being loaded into trucks and placed in the landfill. With the decommissioning of G-3 and system improvements implemented at JPM, the APO is currently acting as a backup storage system that will be used in the event of equipment malfunctions at the JPM facility. The APO has storm water controls and a storm water pond. Pond water, in addition to on-site leachate extracted from the leachate collection system, is used to condition CCR at the facility and for dust control within the landfill's active cells.

# SECTION 3

# DUST CONTROL PROCEDURES

The following sections discuss dust control procedures for (1) CCR short-term storage and management areas, (2) CCR landfill units, and (3) facility roads.

The dust control applications detailed below are typical for the industry and appropriate considering the conditions of the site. The applications are compatible with the current operations or can be initiated quickly to minimize and prevent fugitive dust at the site.

Unless otherwise specified, "water" may include groundwater, on-site leachate, pond water, and/or river water.

## 3.1 CCR Short-Term Storage and Management Areas at the AOS Landfill Facility

Dust control procedures are implemented in CCR short-term storage and management areas, as discussed below.

- Short-term storage consists of CCR silos for backup storage of fly ash from JPM. The material is off-loaded from the trucks pneumatically into the storage silos. Dust is controlled during the off-loading process by a filter system on the silos.
- Prior to loading into dump-trucks from the silos, the CCR material is conditioned (wetted) to reduce dusting and enable the ash to be moved and packed in the landfill. The amount of water added to the ash is dependent on ash quality on any given day. Sometimes more water needs to be added on one day than on another day. The goal is to add enough water to minimize dusting but not so much that the mixers become plugged. During loading activities, drop chutes are utilized to reduce the potential for mobilization of CCR dust. The load-out area is located directly under the conditioning silo, which also has some wind protection built into it. This activity will occur infrequently with the process improvements made at JPM.
- CCR waste is delivered directly to the landfill from the JPM facility. The waste is conditioned at the JPM facility and loaded into trucks. The trucks deploy covers during transport to the landfill to reduce fugitive dust.
- Bottom ash is delivered directly to the landfill from JPM. The bottom ash is dewatered in dewatering bins before being loaded into trucks. The trucks deploy covers during transport to the landfill to reduce the potential for fugitive dust.

## 3.2 AOS Landfill Facility CCR Landfill Units

In accordance with 40 CFR 257.80(a), CCR is conditioned (wetted) before being placed into the active landfill cell(s). As noted in Section 3.1, water is added to the CCR materials to reduce wind dispersal and improve compaction during CCR placement in landfill cells. This process is completed at the APO located adjacent to the landfill.

Additional dust control procedures are implemented for active CCR landfill units, as detailed below.

- The AOS Landfill Facility is located within a narrow valley. The landfill is protected from winds on the east, north, and west sides by steep forested valley slopes that extend well above the landfill. The valley is exposed to the south but lower valley trees provide some limited wind protection.
- Open or active landfill cell areas are reduced to less than 7 acres and the working face will be maintained as small as feasible. Active and closed areas are clearly delineated, and traffic controls implemented to properly direct unloading operations and traffic routing in and out of the landfill.
- When ash is placed in the landfill, it is spread out, wetted, and rolled to create a harder surface to help reduce the ability of the wind to pick up the material. Conditioning (wetting) of the CCR material will be completed as to not result in free liquids. This is done as soon as possible after placement to minimize potential for dust generation.
- Water spray is applied, as needed, to exposed CCR, including on the working face. On-site personnel will monitor the spraying within the active areas to eliminate exposure of leachate outside the lined perimeter.
- During high wind conditions when the facility cannot control visible dust, unloading operations at higher elevations of the working face may be reduced or halted.

When active CCR operations are completed in a given area(s), the area(s) is/are contoured and compacted, as needed, in preparation for final cap and cover installation. The final cap and cover will be installed per the approved Plan of Operation/Plan of Operation Modifications and seeded.

Following the installation of the final cap and cover, the cover system is maintained, including vegetation, to reduce the potential for wind and water erosion of the cover.

## 3.3 AOS Landfill Facility Roads

Dust control procedures for roads in active use for CCR management activities at the landfill, or that are being traveled by construction equipment employed in CCR management activities, are discussed below.

- Enforce reduced vehicle speed limits unpaved surfaces to 15 miles per hour (mph) to reduce dust mobilization. During high wind conditions when the facility cannot control visible dust, operations and related traffic could be reduced or halted.
- During transportation, cover CCR using well-fitted tarps to reduce the potential for CCR becoming airborne during truck transport. If tarps are not practical or dusting is observed, additional water may be added to CCR prior to transportation.
- During non-freezing weather, spray unpaved roads at the landfill daily, as needed, using water trucks. River water or groundwater will be used on the roads outside the landfill. Most of the landfill facility roads are paved, except for sections near the landfill itself. This reduces the water needed for unpaved sections.
- During freezing weather, road salt that is used on the paved roadways on-site, creates a damp condition that is carried over to the unpaved roadways, which helps to eliminate dust emissions from being generated.
- Paved roads at the AOS Landfill Facility will be cleaned by a sweeper/vacuum truck and, during periods of high traffic and/or dry weather, may also be wetted.
- Trucks and vehicles that have the potential to track ash, mud, or dust outside of the CCR management area(s) are cleaned prior to leaving the landfill (use of track out pads added in 2016)
- Trucks and vehicles may also be cleaned as needed using water trucks and portable decontamination areas.

## SECTION 4

## INSPECTIONS

Visual inspections are conducted by Site personnel on a daily basis to observe signs of inadequate dust control, such as significant and visible fugitive dust emissions. Appendix A provides forms for the daily observations. Documentation of daily inspections noting non-conforming items are at the Facility. Inspection records will be maintained at the Facility for five years.

## SECTION 5

## TRAINING

Training sessions are conducted annually to update employees on changes in the regulations, laws, or in-house procedures related to CCR management, including dust control procedures. Training records will be maintained at the Facility for five years. Sign-in sheets and topics of discussion at each briefing are maintained for documentation (Appendix B).

# SECTION 6

# RECORDKEEPING AND REPORTING

The following sections provide details regarding (1) Plan preparation, (2) community involvement, (3) annual reporting, and (4) Dust Control Plan assessment and update process.

## 6.1 Plan Preparation

In accordance with 40 CFR 257.80(a), 257.105(g), and 257.107(g), a complete, updated copy of this Dust Control Plan is maintained in the Phase IV Landfill facility operating record and on the DPC publicly accessible internet site. (CCR Rule Compliance Data and Information at https://www.dairylandpower.com/)

Revision to this Dust Control Plan shall be completed in accordance with s. NR 514.04(6), whenever there is a change that may substantially affect the Landfill Plan of Operation. This includes submitting the revised Dust Control Plan to the WDNR Waste and Materials Management Section as a Plan Modification for review and approval prior to implementation. In accordance with 40 CFR 257.106(g), WDNR Waste and Materials Management Section is notified when this Dust Control Plan, or any subsequent amended version, is placed in the Phase IV Landfill operating record and on the DPC internet site.

## 6.2 Community Involvement

As discussed above, DPC maintains a publicly accessible internet site to provide information to stakeholders. The DPC internet site also provides contact information and requests that stakeholders contact DPC with any questions or concerns regarding dust controls for the AOS Landfill Facility. Additionally, DPC may be contacted directly regarding fugitive dust events by contacting the DPC Manager of Water & Waste Programs as follows:

Phone: (608) 787-1311 (during normal business hours, 8:00 AM - 4:00 PM)
Email: ccrinfo@dairylandpower.com
Mail: Dairyland Power Cooperative, 3200 East Avenue South, La Crosse, WI 54601

For reporting a CCR fugitive dust event, include the following information in your correspondence:

- Name
- Address

- Phone number
- Email address (optional)
- Date of dust event
- Time of dust event
- Location of dust event
- Description of the dust event
- Do they want us to contact them?
- Date and time they can be reached for follow-up by DPC personnel, if wanted.

CCR fugitive dust events will be logged via the Record of External Contact Form and included with the annual report described in Section 6.3 of this plan.

In accordance with 40 CFR 257.80(b), DPC will maintain records of stakeholder correspondence, including any questions or concerns regarding dust controls at the AOS Landfill Facility.

## 6.3 Annual Reporting

In accordance with 40 CFR 257.80(c) and s. NR 506.20(3)(a), DPC prepares annual dust control reporting to document the following information:

- Description of dust control procedures implemented at the Phase IV Landfill facility.
- Summary of any questions of concerns raised by stakeholders
- Description of any corrective actions taken

The first Annual Dust Control Report will be completed on or before December 19, 2016, that is 14 months after the Plan completion date, when the initial CCR fugitive dust control plan is placed in the Phase IV Landfill operating record. Subsequent Annual Dust Control Reports will be completed by December 19 of each calendar year thereafter. Each Annual Dust Control Report is completed and placed in the Phase IV Landfill facility operating record and on the DPC internet site, as required by 40 CFR 257.80(c), 257.105(g), and 257.107(g). In accordance with 40 CFR 257.106(g), WDNR Solid Waste is notified when each Annual Dust Control Report has been placed in the Phase IV Landfill facility operating record and on the DPC internet site.

In accordance with s. NR 506.20(3), each Annual Dust Control Report will be included in the Annual Report required by the WDNR for CCR Landfills. Each annual report will be submitted to the WDNR and placed in the facility's operating record by January 31 of each year.

## 6.4 Plan Assessment and Update Process

In accordance with 40 CFR 257.80(b), DPC periodically assesses the effectiveness of this Dust Control Plan. The Dust Control Plan will be inspected as detailed in Section 4.0. The Dust Control Plan will be reviewed annually when the Dust Control Plan Report is completed for adherence to the requirements of 40 CFR 257. If more effective prevention and control technology has been field-proven at the time of the review and will significantly improve dust controls, the Dust Control Plan will be amended to reflect the changes. The amended Dust Control Plan will be implemented as soon as practicable of its completion. The designated person accountable for dust control at the Phase IV Landfill facility is responsible for documenting completion of each review, signing a statement as to whether the Dust Control Plan is amended, and recording the results in Appendix C. As required by 40 CFR 257.80(b), technical changes made to this Dust Control Plan must be certified by a Professional Engineer.

In accordance with 40 CFR 257.80(b) and s. NR 514.07(10)(a)(4), DPC will also amend this Dust Control Plan whenever there is a change in conditions that would substantially affect the written Dust Control Plan or Plan of Operation in effect, such as the construction and operation of a new CCR unit. The amended Dust Control Plan will be submitted to the WDNR for review and approval prior to being implemented. Implementation will occur before or concurrently with the initial receipt of CCR into any new CCR unit(s) or prior to the technology implementation. As required by 40 CFR 257.80(b), technical changes made to this Dust Control Plan must be certified by a Professional Engineer.

In accordance with 40 CFR 257.106(g), WDNR Solid Waste will be notified when this Dust Control Plan has been amended and placed in the Phase IV Landfill facility operating record and on the DPC internet site.

## SECTION 7

## ENGINEERING CERTIFICATION

Pursuant to 40 CFR 257.80 and by means of this certification I attest that:

(i) I am familiar with the requirements of the CCR rule (40 CFR 257);

(ii) I am familiar with the requirements of the ch. NR 500-520, Wisconsin Administrative Code;

(iii) the Dust Control Plan has been prepared in accordance with the requirements of the CCR rule and Wisconsin Administrative Code; and

(iv) the Dust Control Plan meets the requirements of 40 CFR 257.80 with the following action items:

a. The ash processing operation will be utilized as a backup system used infrequently (quarterly or less) during equipment interruptions at the JPM facility. Dust generated during this infrequent use will be managed by best management practices implemented at the facility. If there is a need for more frequent use, Dairyland Power Cooperative will continue the annual evaluation of dust reduction options and implement recommendations on a minimum annual basis.

BreAnne Kahnk, P.E. – TRC Environmental Corporation

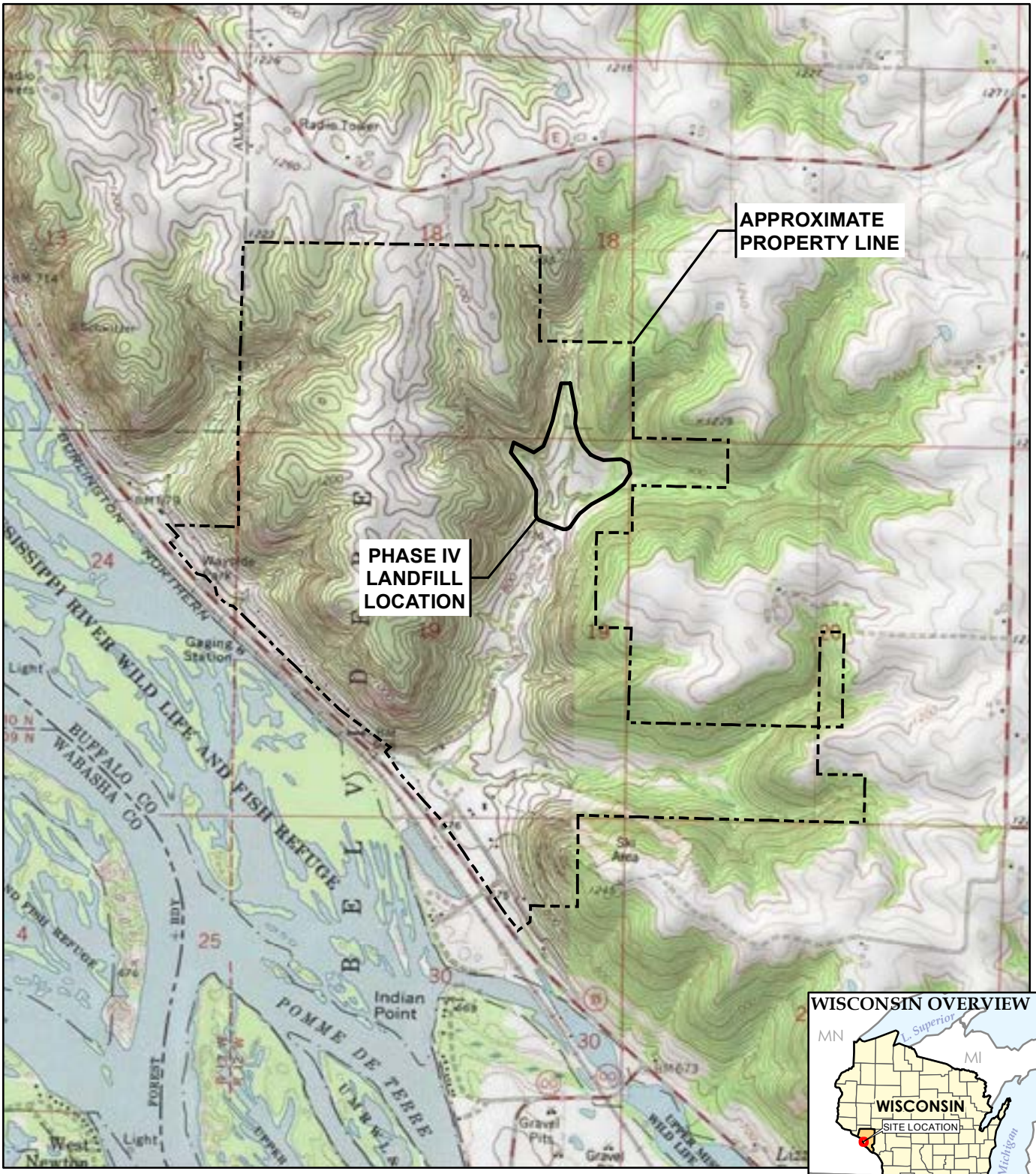
Signature of Registered Professional Engineer

Registration No. E-46825 State: WI

# FIGURES

Saved By: BRHODE on 10/13/2015, 16:30:22 PM

TRC - GIS




BASE MAP FROM USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE SERIES.

N

1 " = 2,000 '
1:24,000

0 2,500 5,000 FEET

TRC

708 Heartland Trail
Suite 3000
Madison, WI 53717
Phone: 608.826.3600

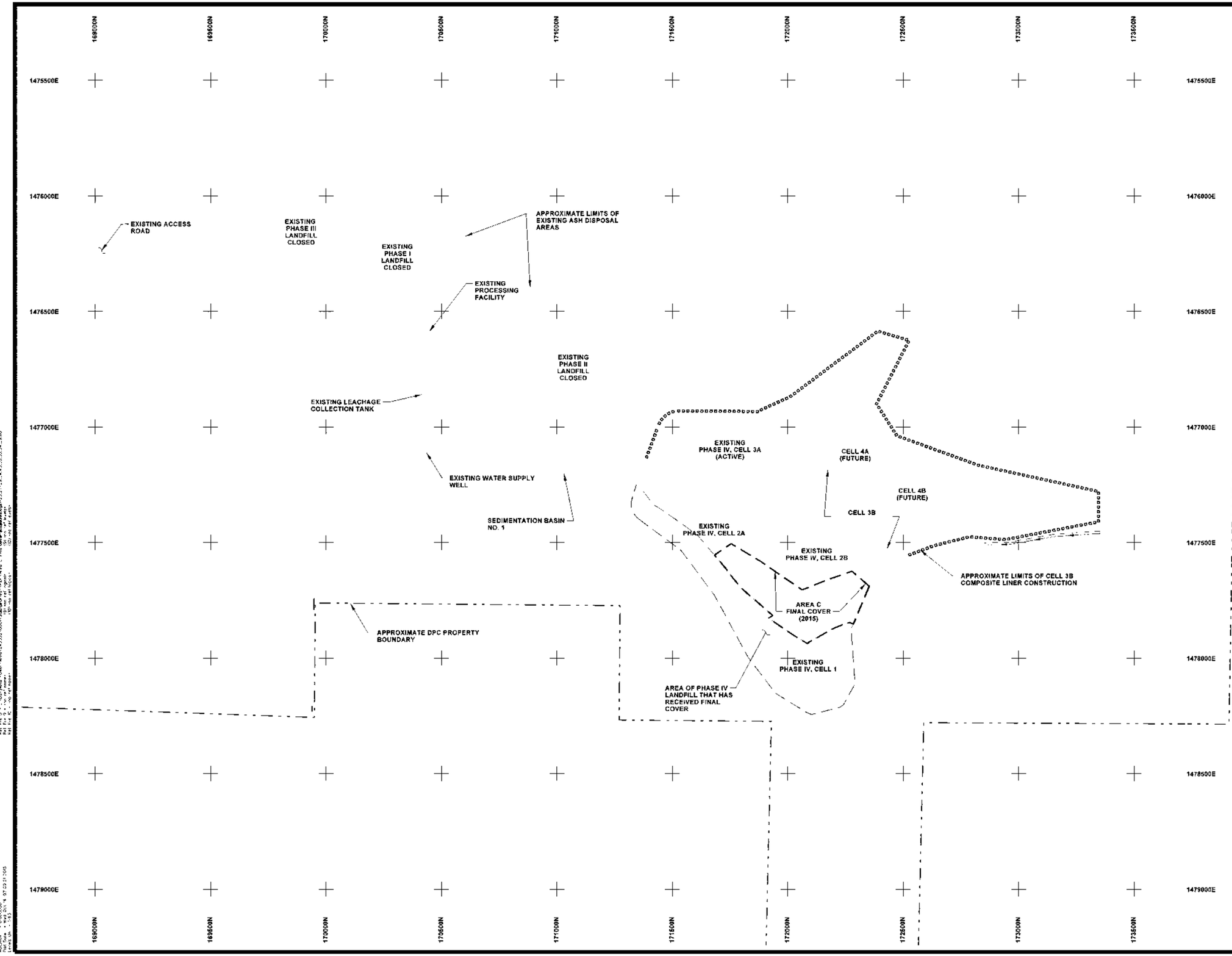
**DAIRYLAND POWER COOPERATIVE**
**ALMA OFF-SITE DISPOSAL FACILITY**
**DUST CONTROL PLAN**
**TOWN OF BELVIDERE, BUFFALO COUNTY, WISCONSIN**

**SITE LOCATION MAP**

| | |
|---|---|
| DRAWN BY: | RHODE B |
| APPROVED BY: | HOTSTREAM J |
| PROJECT NO: | 243332.0001 |
| FILE NO. | 243332-001slm.mxd |
| DATE: | OCTOBER 2015 |

E:\DairylandPower\AlmaWI\2015_243332\243332-001slm.mxd

**FIGURE 1**




## NOTES

1. REFER TO PLAN SHEET 2 FOR STANDARD LEGEND, NOTES, AND BENCHMARK LOCATIONS.

| NO. | BY | DATE | REVISION | APP'D |
|---|---|---|---|---|

PROJECT: DAIRYLAND POWER COOPERATIVE
ALMA OFF-SITE DISPOSAL FACILITY
PHASE IV LANDFILL
BUFFALO COUNTY, WISCONSIN

SHEET TITLE: SITE LAYOUT
DUST CONTROL PLAN

| | | | |
|---|---|---|---|
| DRAWN BY: lstoerner | SCALE: AS SHOWN | PROJ. NO. | 243332.0001 |
| CHECKED BY: JH | | FILE NO. | 243332.0001.01.PLT |
| APPROVED BY: BH | DATE PRINTED: | FIGURE 2 | |
| DATE: OCTOBER 2015 | | | |


TRC
708 Heartland Trail
Suite 3000
Madison, WI 53717
Phone: 608.826.3600

# APPENDIX A

## Daily Inspection Checklist

# AOS Fugitive Dust Plan Inspection Log

The areas to be inspected for fugitive dust are: **These inspections need to be performed anytime these areas are active.**

**A1** Active Landfill Area(s)
**A2** Dozer Operations in active Landfill
**A3** Active landfill roadway
**A4** AOS Ash Load out area
**A5** Auxillary Landfill Roadways

When each affected area is active, fill out the appropriate information below. **Inspections need to be performed prior to and during operations.** Apply dust suppressant anytime dusting is observed. Note the time(s), type(s) and amount of dust suppression applied. If dust suppressant is not applied note why (i.e. raining, no dusting apparent, etc.)

| Date | Time of Day | Weather (rainy, sunny, windy, overcast, etc.) | Active Area | Visible Dust? (yes/no) | Dust Suppression Used? (none, type and amount) | Comments | Signed |
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# APPENDIX B

## Training Attendance Record

| Employee Number | Attendee Name (Print) | Attendee Signature | Cost Center |
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**Topics Discussed Or Reviewed**
(Check All Applicable)

- ☐ Manufacturer Operator Manuals
- ☐ Operator Manual Safety Section
- ☐ Applicable DPC Safety Rules
- ☐ Safety Features/Equipment
- ☐ Safety And Operation Decals
- ☐ Safety Shields And Covers
- ☐ Emergency Systems
- ☐ Stability Requirements
- ☐ Load Charts/Capacities
- ☐ Maintenance Schedules/Procedures
- ☐ Lube Points, Types And Charts
- ☐ Inspections And Operation Tests
- ☐ Operator Qualifications
- ☐ Applicable ANSI\OSHA Standards
- ☐ Operator Controls/Gauges
- ☐ Winch Line Inspection And Capacity
- ☐ Operation/Set Up Demonstration
- ☐ Operation/Set Up Operator Hands-On
- ☐ Personnel Basket And Safety Belts
- ☐ Applicable Standard Hand Signals
- ☐ Road Travel Preparations
- ☐ Trailer Loading And Tieing Down
- ☐ Securing Cargo
- ☐ Travel Height
- ☐ Options/Accessories
- ☐ Chassis/Carrier Inspections
- ☐ Applicable DOT Regulations
- ☐ Chassis/Carrier Engine Checks
- ☐ Applicable Operator And Driver Licenses
- ☐ Chassis/Carrier Options And Accessories
- ☐ Applicable Record Keeping
- ☐ Applicable Written Examinations
- ☐ _____
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- ☐ _____

Note: X - Denotes Assigned Operator

# APPENDIX C

## Dust Control Plan Review Documentation

**APPENDIX C**

**DUST CONTROL PLAN REVIEW DOCUMENTATION**

In accordance with 40 CFR 257.80(b), this Dust Control Plan has been reviewed to assess if more effective control procedures are available to significantly reduce the likelihood of CCR from becoming airborne at the facility.

By means of this certification, I attest that I have completed a review and evaluation of this Plan for the Facility located in Alma, Wisconsin, and as a result

_____ will

_____ will not

amend the Plan. Technical amendments to the Plan have been certified by a Professional Engineer.

_____ _____
Signature Date

Don Loock
Name (Printed)

Mgr. Alma Fuels & Solid Waste
Title

*Leif Tolokken*

_____ 12/27/2022
Signature Date

Leif Tolokken
Name (Printed)

Mgr. Water & Waste Programs
Title

# Appendix P: Closure Plan

# Closure Plan

## Alma Offsite Disposal Facility, Phase IV Landfill Alma, Wisconsin

January 2023

**Prepared For:**

Dairyland Power Cooperative
3200 East Avenue South
La Crosse, Wisconsin 54601

**Prepared By:**

TRC
999 Fourier Drive, Suite 101
Madison, Wisconsin 53717


BreAnne Kahnk, P.E.
Senior Engineer

Todd W. Martin
Principal Project Manager

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Table 1: Schedule Estimate for Completing Closure


## APPENDICES


Appendix A: Engineering Drawings

## Revision History

| Revision Number | Revision Date | Section Revised | Summary of Revisions |
|---|---|---|---|
| 1 | 01/12/2023 | 1-3 | Text updates. |
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# 1.0 Introduction

This Closure Plan (Plan) was prepared by TRC Environmental Corporation (TRC) on behalf of Dairyland Power Cooperative (DPC) for the Alma Off-Site Disposal Facility, Phase IV Landfill (Landfill) where coal combustion residuals (CCR) are disposed. The approximately 32.1 acres Landfill is located in Sections 18 and 19, T21N, R12W, Town of Belvidere, Buffalo County, Wisconsin. DPC owns and operates the Landfill in compliance with the Plan of Operation (RMT 2000) as permitted by the Wisconsin Department of Natural Resources (WDNR).

This Plan meets the closure requirements of the U.S. Environmental Protection Agency's (USEPA) CCR Rule, Title 40 Code of Federal Regulations (40 CFR) Parts 257 and 261 Subpart D - "Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments" as well as ch. NR 500-520, Wisconsin Administrative Code. The Landfill is considered an existing CCR landfill according to the CCR rule (40 CFR 257.53).

DPC plans to close the Landfill by leaving the CCR in-place upon completion of CCR placement. The Landfill is operated by moisture conditioning CCR, placing, and compacting the waste in the active area. Final cover will be installed in phases as portions of the Landfill reach the design top of waste grades. The Landfill has a design waste capacity of 3,011,000 cubic yards. Based on the phasing in the Plan of Operation (RMT, 2000), the largest proposed active area to be closed for the Landfill is approximately 12.4 acres. Based on the available capacity and current filling at the Landfill, it is anticipated that closure will be initiated in 2057. This closure date is subject to change based on potential changes in volume of CCR accepted at the Landfill.

# 2.0 Closure Plan

## 2.1 Initiation of Closure Activities

The owner or operator of the CCR unit shall initiate closure no later than 30 days after the date on which the CCR unit either receives the known final receipt of waste or removes the known final volume of CCR for beneficial use in accordance with 40 CFR 257.102(e) and s. NR 506.083(2). Closure shall also be commenced if the unit has not received waste or is no longer removing CCR for beneficial use within two years of last receipt of waste or last removal for beneficial use. The owner or operator may secure an additional 2 years so long as they are able to demonstrate that there is reasonable likelihood that the unit will accept waste or remove CCR in the foreseeable future. Subsequent 2-year periods may be continued to be requested so long as they are able to continue to demonstrate the reasonable likelihood of CCR waste disposal or removal for beneficial use. Demonstrations must be placed in the operating recorded prior to the end of any two-year period following 40 CFR 257.102(e)(2)(ii and iii). Per s. NR 506.083(2)(b), these delays shall be requested in writing to the WDNR as a modification to the Closure Plan and include the requirements detailed in s. NR 506.083(2)(b)(1-3).

No later than the date of initiating closure, the owner or operator must prepare a notification of intent to close the Landfill including the certification of a qualified professional engineer for the final cover system design as required by 40 CFR 257.102(d)(3)(iii).

Closure activities have been initiated if the owner or operator has ceased placing waste and completes one of the following activities:

- Taken steps necessary to implement the written closure plan,
- Submitted a completed application for required state or agency permit or modification, or
- Taken steps necessary to comply with state or other agency standards that are pre-requisite to initiating or completing closure.

## 2.2 Closure Performance Standard

The owner or operator of the Landfill will close the CCR unit in a manner that controls post-closure infiltration of liquids into the waste, releases of waste, and leachate or contaminated run-off to groundwater or surface water and preclude the probability of impoundment of water, sediment, or slurry. Measures will be included that provide slope stability which will prevent movement of the final cover system during closure and post-closure. Need for further maintenance of the CCR unit will be minimized. The CCR unit closure should be completed in the shortest amount of time consistent with recognized and generally accepted engineering practices and be done in accordance with 40 CFR 257.102 and s. NR 506.083.

## 2.3 Final Cover System

Closure of the Landfill will occur by leaving the CCR in-place, which requires the construction of a final cover system compliant with 40 CFR 257.102(d) and s. NR 504.12(4). The final cover system shall meet the following requirements:

- Designed to be compliant with s. NR 504.07, or

- The hydraulic conductivity of the final cover must be less than or equal to 1 x $10^{-5}$ centimeters per second (cm/s), or less than or equal to the hydraulic conductivity of the bottom liner system or natural subsoils present, whichever is less.
- An infiltration layer of at least 18 inches of earthen material that meets the requirements of s. NR 504.12(4)(b)(2).
- An erosion layer of at least six inches of earthen material that is capable of sustaining native plant growth that meets the requirements of s. NR 504.12(4)(b)(3).
- The final cover system must be designed to minimize impacts due to settling and subsidence.

The Landfill will be closed using a composite final cover system. Two final cover system options have been previously approved for the Landfill. These consist of the WDNR design presented in the Plan of Operation Conditional Approval (from bottom to top):

- a 24-inch compacted soil barrier (barrier layer),
- GCL (barrier layer),
- a 40-mil textured linear low density polyethylene (LLDPE) geomembrane (barrier layer),
- a 12-inch–thick select granular fill drainage layer (infiltration layer),
- an 18-inch–thick general fill rooting layer (infiltration layer), and
- a 6-inch–thick topsoil layer (erosion layer).

The 2004 Plan of Operation Modification presented a modified final cover system, which has been used in the previous three final cover construction events. This modified final cover system consists of the following components (from bottom to top):

- 2-foot (24 inches) moisture-conditioned and compacted “select” fly ash (i.e. mixture containing a minimum of 40 percent of the more reactive J.P. Madgett fly ash) (barrier layer),
- 40-mil geomembrane (barrier layer),
- 1-foot-thick (12 inches) sand drainage layer (infiltration layer),
- 1.5-foot-thick (18 inches) general soil cover layer (infiltration layer), and
- 6-inch-thick topsoil layer (erosion layer).

The modified final cover system provides a total of 3 feet of soil above the geosynthetics. The general function of each component of the final cover system is provided in parentheses above. The barrier layer consists of 2 feet of compacted select CCR and a 40-mil geomembrane which exceeds the hydraulic conductivity criteria of 1x$10^{-5}$ cm/s. The landfill was constructed with a composite liner system; therefore, a composite final cover system provides an equivalent hydraulic conductivity. The granular fill drainage layer removes water that infiltrates through the erosion and infiltration layers. The infiltration layer and erosion layer meet the requirements of

the CCR rule and s. NR 504.07(6) and (7). This final cover system meets the requirements of 40 CFR 257.102(d)(3)(i) and s. NR 504.12(4).

Following placement of final cover and the surface water control features, the area will be fertilized, seeded, and mulched in order to establish vegetation.

The final cover system has design slopes of 25 percent, refer to Sheet 12 from the Plan of Operation in Appendix A. Because the waste is placed and compacted with control of the moisture conditions and the stability of CCR, significant settlement is not anticipated. Global stability of the Landfill and interface stability of the final cover system were evaluated in the Plan of Operation (RMT 2000) with resulting factors of safety that meet the CCR rule. Based on these considerations, the Landfill closure has been designed in a manner to minimize or eliminate infiltration into the waste, preclude the probability of future impoundment of water, provide stable slopes, and minimize future maintenance.

### *2.3.1 Final Cover Construction*

The final cover system will be constructed in phases as the top-of-waste grades are achieved to minimize the active area of the Landfill and leachate generation. After final CCR placement in the Landfill, the remaining portion of the final cover system will be constructed. Surface water control features on this segment of the final cover will be constructed and connected with the existing surface water control features.

The final cover will be constructed by fine grading the waste subbase, placing the soil barrier layer and GCL or placing and compacting the 2 foot thick select CCR material, deploying and installing the 40-mil thick textured geomembrane, placing the granular drainage layer, placing the general fill rooting layer, and placing the topsoil layer. A schedule estimate of closure activities is presented in Table 1. It is anticipated that closure construction can be completed within the 6-month required timeframe.

#### 2.3.1.1 Fine Grading the Waste Subbase

The waste subbase will be fine graded and leveled using heavy equipment to provide a surface for the placement of the grading layer and GCL.

#### 2.3.1.2 Soil Barrier Layer and GCL

The soil barrier layer material, if used, will meet the requirements specified in Condition 11b of the Plan of Operation Conditional Approval. The soil barrier layer will have a minimum thickness of 24 inches measured vertically from the top of the ash waste.

The GCL will be deployed above the soil barrier layer such that there is a minimum of 6 inches of overlap on longitudinal seams and a minimum of 24 inches overlap on end seams or as recommended by the manufacturer, whichever is greater. The panels will be placed with the overlap on both longitudinal and end seams shingled down-slope. If the GCL requires granular bentonite to be placed along the seam, the overlapping panel edge will be pulled back and granular sodium bentonite will be poured continuously along all seams, at an application rate of ¼ pound per linear foot.

The GCL will be tested during manufacturing, and prior to installation. The results of manufacturer's testing will be submitted to the engineer for review and approval prior to the acceptance of GCL. Samples from selected rolls delivered to the site will also be collected for conformance testing prior to acceptance and installation.

#### 2.3.1.3 Select CCR Layer

The select CCR layer will be moisture conditioned and compacted according to the construction specifications. The compaction of the select CCR material will be observed by the engineer's representative that is documenting construction. The select CCR layer will have a minimum thickness of two feet measured vertically from the cover surface.

#### 2.3.1.4 40-mil LLDPE Geomembrane

If GCL is used, the LLDPE geomembrane will be deployed at a rate equivalent to that of the GCL deployment rate such that the GCL panels will be covered daily to prevent against physical damage and/or hydration of the GCL. The geomembrane will be fabricated from a polyethylene resin, which will have a density range of 0.939 g/cc or less for LLDPE. The nominal geomembrane thickness will be 40 mils for LLDPE, with no thickness measurements falling below the minimum industry-accepted manufacturing tolerance.

The geomembrane will be installed with the panels orientated perpendicular to the contours (i.e., running up and down the slope). The geomembrane will be deployed in a manner that does not adversely impact the barrier material below the geomembrane.

Geomembrane panels will be seamed in the field. Production seaming (linear seams) will be performed using the dual hot wedge (fusion type) seam method. Non-production seams (detail work and repairs) will be performed using the extrusion fillet weld process. Corners, butt seams, and long repairs will be fusion-welded where possible. The geomembrane component of the adjacent cell will be welded together for a continuous membrane surface.

The geomembrane will be tested during manufacturing, and prior to and during installation. The results of the manufacturer's testing will be submitted for review and approval prior to the acceptance of geomembrane rolls delivered to the site. Samples from selected rolls delivered to the site will also be collected for conformance testing by a third-party laboratory prior to acceptance and installation. Finally, during placement, both nondestructive and destructive testing of the geomembrane seams will be performed. Nondestructive testing will be performed by the installation contractor and observed by a third party. Destructive testing will consist of both field and third-party laboratory testing of the samples collected

#### 2.3.1.5 Granular Drainage Layer

After placement and testing of the geomembrane, or portions thereof, a 12-inch–thick select granular fill drainage layer will be placed as soon as practicable to protect the geomembrane and to provide a confining pressure for the underlying GCL, if used. At a minimum, the select granular fill will be placed within 30 days of completing the membrane installation and quality assurance testing.

To minimize the potential for large wrinkles in the geomembrane, the drainage layer will be placed during cooler temperatures when possible. Wrinkles in the geomembrane that are higher than they are wide, will be smoothed or cut out and repaired prior to placing the drainage layer.

The initial lift of select granular fill will be 2 to 3 feet thick, depending on the type of equipment being used, to provide an access ramp. A minimum of 2 feet of material will be placed prior to operating tracked vehicles and flotation tire–equipped vehicles, while a minimum of 3 feet of material will be placed prior to operating trucks and other wheeled hauling equipment. The initial lifts of select granular fill will eventually be graded to the designed 1-foot–thick layer with a low ground pressure (< 5 psi) tracked vehicle. The procedure for deployment of the granular drainage blanket will be established at the preconstruction meeting.

#### 2.3.1.6 General Fill Rooting Layer

An 18-inch–thick uncompacted general fill rooting layer will be placed above the drainage layer in a single lift. The general fill rooting layer will provide a rooting zone for vegetation and will protect the cap from damage due to freeze-thaw and desiccation.

#### 2.3.1.7 Topsoil and Vegetation

The top layer of the final cover system will be a 6-inch–thick layer of topsoil. Topsoil stripped from the landfill and perimeter areas during site preparation will be stockpiled and reused in the final cover. After topsoil is placed, the area will be seeded, mulched, and fertilized. Prior to seeding, the topsoil layer will be prepared for seeding by disking and pulverizing soil within 2 inches of the surface.

DPC has established prairie vegetation on previously constructed phases of final cover with good performance. The prairie vegetation is suitable to soil quality/thickness, and slopes and moisture conditions, with minimal need for continuous maintenance. This prairie vegetation is planned for use in future final cover construction events. Erosion control measures will be installed as needed across the site to limit erosion prior to establishing vegetation.

### *2.3.2 Storm Water Control Features*

Storm water control features will be constructed and/or completed for each phase of final cover construction. Storm water control features consist of diversion berms, a downslope flumes, and energy dissipaters. These storm water control features on the final cover deliver water to perimeter ditches, sedimentation basins, and sediment traps that were constructed during liner construction of the various cells. The storm water control features will be constructed in accordance with the specifications and details presented in the Plan of Operation (RMT 2000), refer to Appendix A for relevant plan sheets from the Plan of Operation. These features are designed to manage runoff from 100-year 24-hour storm events and minimizing scour and erosion of the final cover. Additional details on the storm water control features are provided in the Run-On and Run-Off Control Systems Plan.

## 2.4 Completion of Closure Activities

Within 30 days of completion of closure activities the owner or operator shall prepare a notification of closure of a CCR unit with a certification from a qualified professional engineer that the closure has been performed in accordance with this Plan.

Per 40 CFR 257.102(i) the owner or operator must record a notation on the deed to the property, or some other instrument that is normally examined during title search, that the land has been used for a CCR unit and that it is restricted under the post-closure care requirements as provided in 40 CFR 257.104(d)(1)(iii). Per s. NR 506.083(4)(a), the deed notation (affidavit) is to be recorded within 60 days after closure is complete. A copy of the affidavit is required to be submitted to the WDNR and placed in the facility's operating record within 30 days of recordation.

## 2.5 Amendment of a Written Closure Plan

The owner or operator will amend the written closure plan in accordance with s. NR 514.04(6) whenever:

- There is a change in the operation of the Landfill that would substantially affect the plan in effect, or
- Before or after closure activities have commenced, unanticipated events necessitate a revision.

The closure plan must be amended and submitted in writing to the WDNR at least 60 days prior to a planned change in operation of the Landfill, or no later than 60 days after an unanticipated event occurs that requires the need to revise an existing closure plan. If a written closure plan is revised after closure activities have commenced for the Landfill, the current closure plan must be amended and submitted to the WDNR no later than 30 days following the triggering event.

# 3.0 Notification

## 3.1 Operating Record

The following items will be maintained in the operating record for a minimum of five years:

- 40 CFR 257.105(i)(4): the most recent written closure plan or amendment of the Plan must be maintained for the life of the operating record
- 40 CFR 257.105(i)(7): the notification of intent to close a CCR unit
- 40 CFR 257.105(i)(8): the notification of completion of closure of a CCR unit
- 40 CFR 257.105(i)(9): the notification of recording a notation on the deed

## 3.2 Notification Requirements

The following required notifications will be provided before the close of business on the day the notification is required to be completed:

- 40 CFR 257.106(i)(4)/s. NR 506.17(4)(c): a notification of the available written closure plan or amendment of the Plan
- 40 CFR 257.106(i)(7)/s. NR 506.083(1)(a): the notification of intent to close a CCR unit
- 40 CFR 257.106(i)(8) /s. NR 506.083(1)(b): the notification of completion of closure of a CCR unit
- 40 CFR 257.106(i)(9) /s. NR 506.083(4)(a): the notification of recording a notation on the deed

## 3.3 Publicly Accessible Internet Site

The following required items will be posted on the publicly accessible internet site within 30 days of placing the information in the operating record:

- 40 CFR 257.105(i)(4): the most recent written closure plan or amendment of the Plan must be maintained for the life of the operating record
- 40 CFR 257.107(i)(7): the notification of intent to close a CCR unit
- 40 CFR 257.107(i)(8): the notification of completion of closure of a CCR unit
- 40 CFR 257.106(i)(9): the notification of recording a notation on the deed

Information should be posted within 30 days of placing the pertinent information required by 40 CFR 257.105/NR 506.17(3)(c) in the operating record. Records will be made available to the public for at least five years following the date on which the information was posted to the internet site.

Additional postings to the operating record, notifications, and postings to the publicly accessible internet site may be needed if extensions under 40 CFR 257.102e(2)(ii) or 40 CFR 257.102(f)(2) are pursued.

## 4.0 References

RMT, Inc. 2000. Plan of Operation: Phase IV Disposal Area, Alma Off-site Ash Disposal Facility, Town of Belvidere, Buffalo County, Wisconsin. October 2000.

RMT, Inc. 2004. Plan of Operation Modification: Phase IV Disposal Area, Alma Off-site Disposal Facility, Town of Belvidere, Buffalo County, Wisconsin.

TRC Environmental Corporation. 2021. Run-On and Run-Off Control Systems Plan. October 2021.

## 5.0 Engineer's Certifications

Pursuant to 40 CFR 257.102 and by means of this certification I attest that:

(i) I am familiar with the requirements of the CCR rule (40 CFR 257);

(ii) I am familiar with the requirements of the ch. NR 500-520, Wisconsin Administrative Code;

(iii) this Closure Plan has been prepared in accordance with good engineering practice;

(iv) the design of the final cover system meets the requirements of 40 CFR 257.102(d)(3) and s. NR 504.12(4); and

(v) this Closure Plan meets the requirements of 40 CFR 257.102 and s. NR 514.07(10)(c).

For the purpose of this document, "certify" and "certification" shall be interpreted and construed to be a "statement of professional opinion." The certification is understood and intended to be an expression of my professional opinion as a Wisconsin licensed professional engineer, based upon knowledge, information, and belief. The statement(s) of professional opinion are not and shall not be interpreted or construed to be a guarantee or a warranty of the analysis herein.

Breanne N. Kahnk

Signature of Registered Professional Engineer

Registration No. E-46825 State: Wisconsin

WISCONSIN
BREANNE N. KAHNK
E-46825
MIDDLETON, WI
01/26/23
PROFESSIONAL ENGINEER

**Table 1: Schedule Estimate for Completing Closure**
**Closure Plan – Alma Offsite Disposal Facility, Phase IV Landfill**

| Closure Area: 12.4 Acres - Remaining Portion of Final Cover on Plan of Operation Phasing Plans | | | |
|---|---|---|---|
| **Task/Milestone** | **Start Date[1]** | **Duration** | **Estimated End Date** |
| Ash Filling Ceases | 2/1/2057 | -- | 2/1/2057 |
| Notification to Initiate Closure | 3/2/2057 | -- | 3/2/2057 |
| Fine Grading Waste | 3/5/2057 | 22 days | 3/26/2057 |
| Select CCR Placement and Compaction[2] | 3/27/2057 | 31 days | 4/26/2057 |
| Geomembrane Deployment and Installation | 4/27/2057 | 21 days | 5/17/2057 |
| Granular Drainage Layer Placement | 5/18/2057 | 18 days | 6/4/2057 |
| General Fill Rooting Zone Placement | 6/5/2057 | 21 days | 6/25/2057 |
| Topsoil Placement and Seeding | 6/26/2057 | 11 days | 7/6/2057 |
| Notification of Completion of Closure | 7/9/2057 | 31 days | 8/8/2057 |
| Deed Notation and Notification | 7/9/2057 | 61 days | 9/7/2057 |
| | **Total Duration:** | **124 days[3]** | |

Footnotes:

(1) Start date based on assumed beginning of 2057 construction season. Closure construction may be shifted to different years based on rate of filling.

(2) Previous final cover construction has utilized the modified final cover design. Timeframes associated for this modified final cover design will be used.

(3) Total duration provided in time to substantial completion of final cover placement. At this point, the CCR has been covered and the vegetation seed and temporary erosion control has been applied. Emergence and establishment of vegetation may require additional time.

Created By: J. Hotstream
Checked By: S. Sellner

Revised by: B. Kahnk
Checked By: Z. Bauman

# Appendix A: Engineering Drawings

- Plan of Operation – Title Sheet (Sheet 1)
- Plan of Operation – Final Grades (Sheet 12)
- Plan of Operation – Details – Final Cover (Sheet 19)
- Cell 3B Liner Construction and Area C (Over Cells 1 and 2) Final Cover Construction – Details (Sheets 12 and 13)

# DAIRYLAND POWER COOPERATIVE

DAIRYLAND Power
COOPERATIVE – LACROSSE, WISCONSIN

## PLAN OF OPERATION
## PHASE IV DISPOSAL AREA
## ALMA OFF-SITE ASH DISPOSAL FACILITY

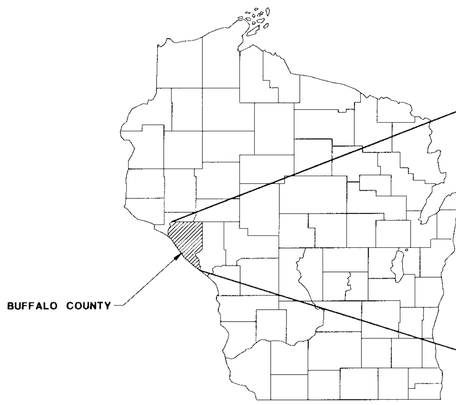
**PREPARED FOR:** DAIRYLAND POWER COOPERATIVE
LACROSSE, WISCONSIN

**PREPARED BY:** RMT, INC.
MADISON, WISCONSIN

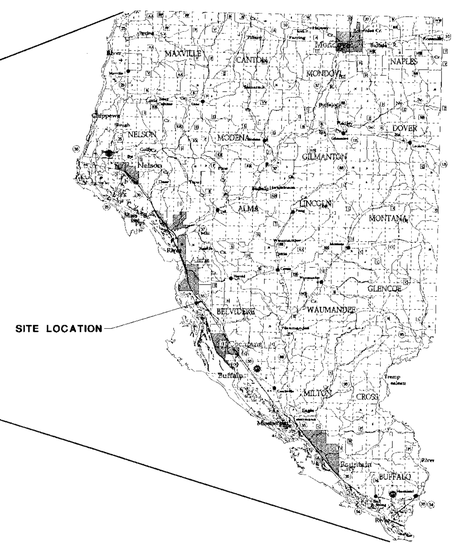
**DATE:** OCTOBER 2000

## INDEX

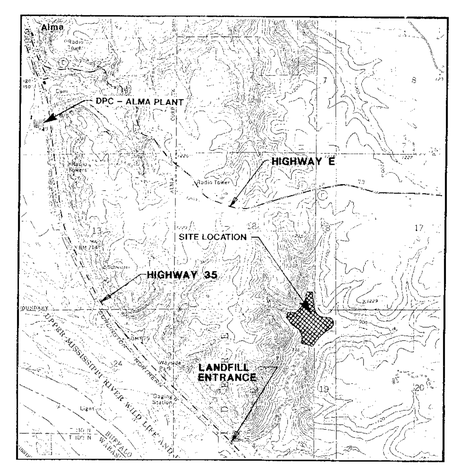

| SHEET NUMBER | SHEET TITLE |
|---|---|
| 1 | TITLE SHEET/INDEX |
| 2 | STANDARD LEGEND AND NOTES |
| 3 | EXISTING CONDITIONS MAP |
| 4 | PROPOSED SUBBASE GRADES |
| 5 | PROPOSED BASE GRADES |
| 6 | PHASING PLAN- CELL I ACTIVE |
| 7 | PHASING PLAN- CELL I CLOSED<br>CELL 2A ACTIVE |
| 8 | PHASING PLAN- CELL 1 AND 2A CLOSED<br>CELL 2B ACTIVE |
| 9 | PHASING PLAN- CELL 1, 2A, AND 2B CLOSED<br>CELL 3 ACTIVE |
| 10 | PHASING PLAN- CELL 1, 2A, 2B AND 3 CLOSED<br>CELL 4A ACTIVE |
| 11 | PHASING PLAN- CELL 1, 2A, 2B, 3 AND 4A CLOSED<br>CELL 4B ACTIVE |
| 12 | PROPOSED FINAL GRADES |
| 13 | PROPOSED ENVIRONMENTAL MONITORING PLAN |
| 14 | LONG TERM CARE PLAN |
| 15 | ENGINEERING CROSS SECTIONS 171700N AND 172200N |
| 16 | ENGINEERING CROSS SECTIONS 1477340E AND 1477710E |
| 17 | DETAILS- LINER AND COLLETION PIPES |
| 18 | DETAILS- LEACHATE STORAGE TANK AND MANHOLE |
| 19 | DETAILS- FINAL COVER |
| 20 | DETAILS- DOWNSLOPE FLUMES |
| 21 | DETAILS- DOWNSLOPE FLUMES |
| 22 | DETAILS- SEDIMENTATION BASINS |
| 23 | DETAILS- MISCELLANEOUS |


WISCONSIN




BUFFALO COUNTY




SCALE: 1"=2000'

MAP SOURCE: U.S.G.S. CREAM AND ALMA 7.5' QUADRANGLES, DATE 1974.

SITE LOCATION

NOTE: THESE PLANS ARE ACCOMPANIED BY A REPORT OF THE SAME TITLE. THESE DOCUMENTS ARE INTERRELATED AND ARE INTENDED TO BE USED AND REVIEWED TOGETHER. (NOT FOR CONSTRUCTION)


RMT
744 Heartland Trail
Madison, WI 53717-1934
P.O. Box 8923
Madison, WI 53708-8923
Phone: 608-831-4444



Plot Date
Design File : J:\0208-40\TITLE.dgn
Date : 10/13/2000
Plot File : J:\0208\40\TITLE.plt
Plot Scale : 1.0000 x 1.0000 Y= 1.0000
Plotter : 6630,24x36
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Rotation : 0.0000
Time : 14:07:07 @ October 2000
User Id : JPL
Levels : 1-62
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Ref File 9 : \MO_ref\comm
Ref File 10 : \MO_ref\home
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(2) \MO_ref\bgdgn
(3) \MO_ref\bgdgn
(4) \MO_ref\bgdgn
(5) \MO_ref\bgdgn
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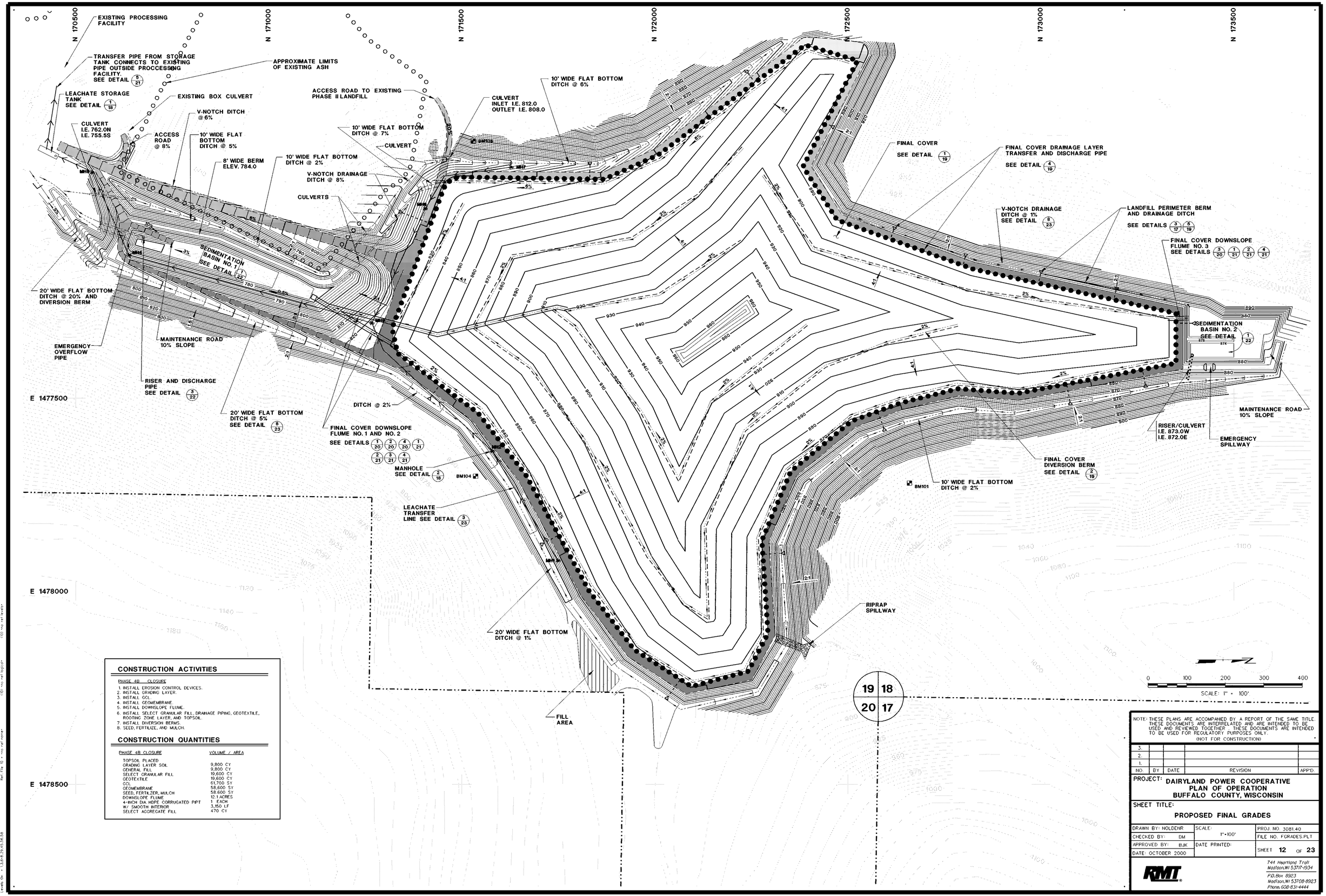


## CONSTRUCTION ACTIVITIES

PHASE 4B CLOSURE

1. INSTALL EROSION CONTROL DEVICES.
2. INSTALL GRADING LAYER.
3. INSTALL GCL.
4. INSTALL GEOMEMBRANE.
5. INSTALL DOWNSLOPE FLUME.
6. INSTALL SELECT GRANULAR FILL, DRAINAGE PIPING, GEOTEXTILE, ROOTING ZONE LAYER, AND TOPSOIL.
7. INSTALL DIVERSION BERMS.
8. SEED, FERTILIZE, AND MULCH.

## CONSTRUCTION QUANTITIES

| PHASE 4B CLOSURE | VOLUME / AREA |
|---|---|
| TOPSOIL PLACED | |
| GRADING LAYER SOIL | 9,800 CY |
| GENERAL FILL | 9,800 CY |
| SELECT GRANULAR FILL | 19,600 CY |
| GEOTEXTILE | 19,600 CY |
| GCL | 61,700 SY |
| GEOMEMBRANE | 58,600 SY |
| SEED, FERTILIZER, MULCH | 58,600 SY |
| DOWNSLOPE FLUME | 12.1 ACRES |
| 4-INCH DIA. HDPE CORRUGATED PIPT W/ SMOOTH INTERIOR | 1 EACH 3,150 LF |
| SELECT AGGREGATE FILL | 470 CY |

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PROJECT: DAIRYLAND POWER COOPERATIVE
PLAN OF OPERATION
BUFFALO COUNTY, WISCONSIN

SHEET TITLE:
PROPOSED FINAL GRADES

| | | |
|---|---|---|
| DRAWN BY: NOLDENR | SCALE: 1"=100' | PROJ. NO. 3081.40 |
| CHECKED BY: DM | | FILE NO. FGRADES.PLT |
| APPROVED BY: BJK | DATE PRINTED: | SHEET 12 OF 23 |
| DATE: OCTOBER 2000 | | |

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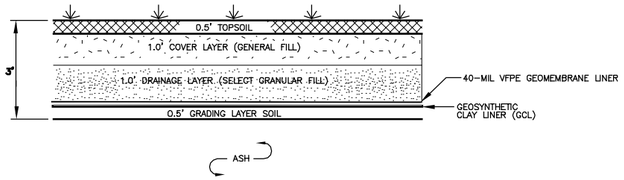
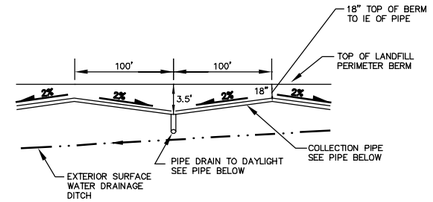


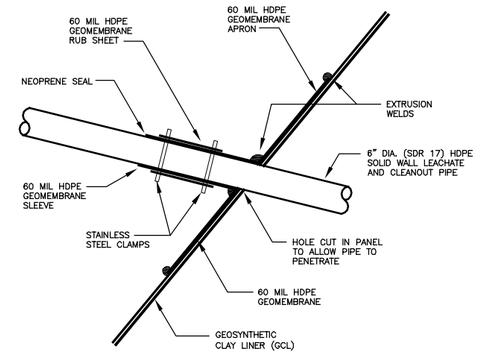

1/19 **FINAL COVER**

(NOT TO SCALE)



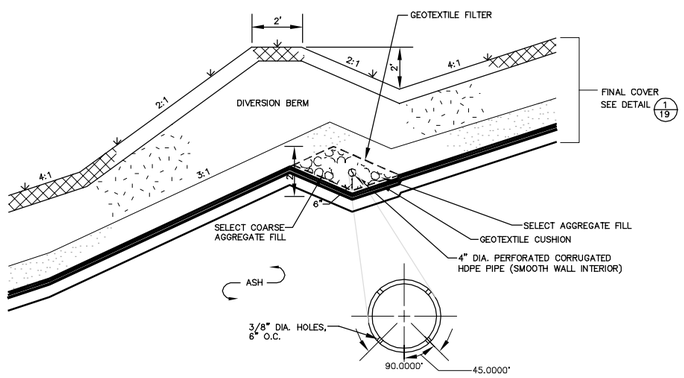

**NOTE: IN AREAS WHERE THE TOP OF BERM SLOPES, THE COLLECTION PIPE WILL FOLLOW THE SAME SLOPE AS THE TOP OF BERM AND WILL OUTLET THROUGH DISCHARGE PIPES LOCATED AT SPECIFIED INTERVALS. REFER TO PLAN SHEET 12.**

**SECTION A-A' OF FINAL COVER DRAINAGE LAYER**




6/19 **PIPE BOOT- PIPES PENETRATING THROUGH FINAL COVER AND LOW PERMEABILITY LAYER (TYPICAL)**

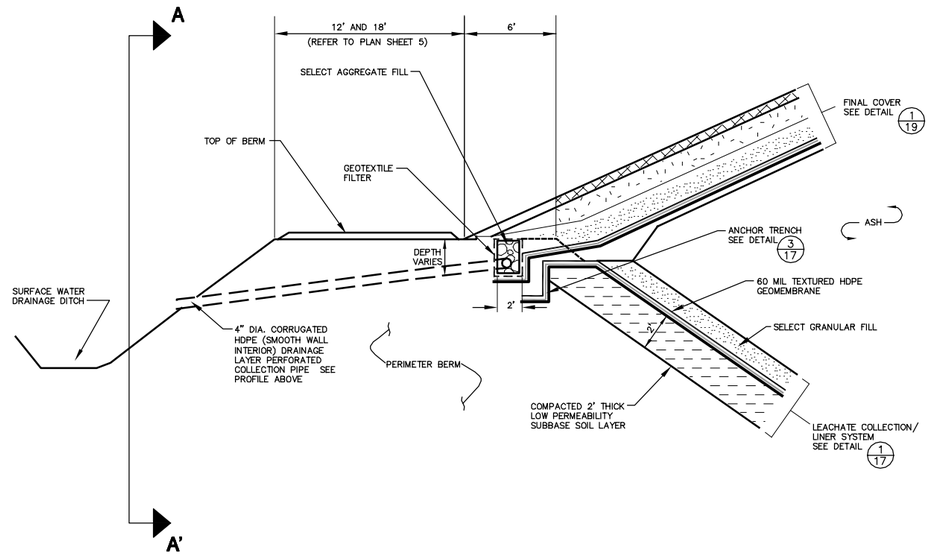
(NOT TO SCALE)




**NOTE:**
**A 4" DIA. PERFORATED CORRUGATED HDPE PIPE WILL BE LOCATED BELOW EVERY DIVERSION BERM ABOVE THE FINAL COVER EXCEPT THE LOWEST BERM LOCATED NEXT TO THE LANDFILL PERIMETER BERM. TO COLLECT WATER IN THE DRAINAGE LAYER ALONG THE PERIMETER BERM PIPES WILL BE CONSTRUCTED IN THE BERM AS SHOWN ON DETAIL 4 OF 19.**

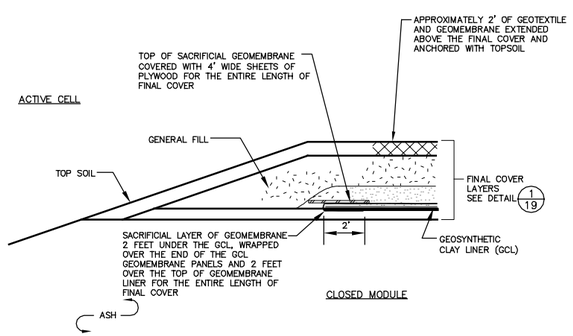
2/19 **SURFACE WATER DIVERSION BERM ON FINAL COVER (TYPICAL)**

(NOT TO SCALE)



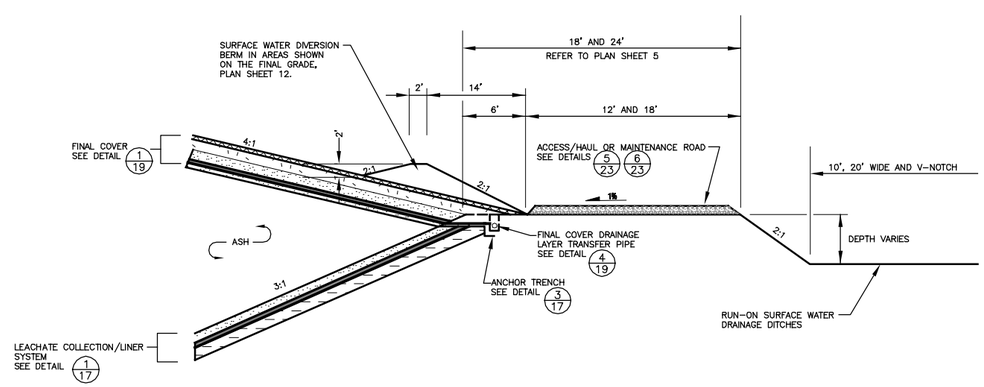

4/19 **PERIMETER BERM FINAL COVER DRAINAGE LAYER DISCHARGE PIPE (TYPICAL)**

(NOT TO SCALE)




3/19 **CONSTRUCTION OF FINAL COVER FOR SPLICING FUTURE FINAL COVER**

(NOT TO SCALE)




5/19 **LANDFILL PERIMETER BERM AND SURFACE WATER DRAINAGE DITCHES (TYPICAL)**

(NOT TO SCALE)

**LINE AND SHADING LEGEND**

| | |
|---|---|
| GEOTEXTILE | GEOMEMBRANE |
| GEOCOMPOSITE | GEOSYNTHETIC CLAY LINER (GCL) |
| TOPSOIL | NATIVE SOIL |
| SELECT GRANULAR FILL DRAINAGE LAYER | CONCRETE |
| PIPE BEDDING MATERIAL | RIPRAP |
| SELECT AGGREGATE FILL | GRAVEL |
| COMPACTED SELECT LOW PERMEABILITY SOIL | GENERAL FILL |

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| 2. | | | | |
| 1. | | | | |

PROJECT: **DAIRYLAND POWER COOPERATIVE PLAN OF OPERATION BUFFALO COUNTY, WISCONSIN**

SHEET TITLE: **DETAILS- FINAL COVER**

| | | |
|---|---|---|
| DRAWN BY: DEFOEJ | SCALE: | PROJ. NO. 3081.40 |
| CHECKED BY: DM | NOT TO SCALE | FILE NO. 30814004.dwg |
| APPROVED BY: BJK | DATE PRINTED: | SHEET 19 OF 23 |
| DATE: OCTOBER 2000 | | |


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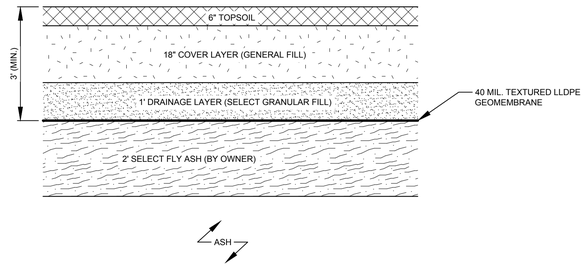
NOT FOR CONSTRUCTION



$$SCALE$$
$$ROTT$$
$$DATE$$
$$USER$$
Attached Xref's: No xref's Attached.
DATE: 06/04
$$DWG$$
$$USER$$
$$PRFN$$
$$DATE$$
$$PLOTTER$$
RMT COMPUTER AIDED DESIGN & DRAFTING




1/12 **FINAL COVER**
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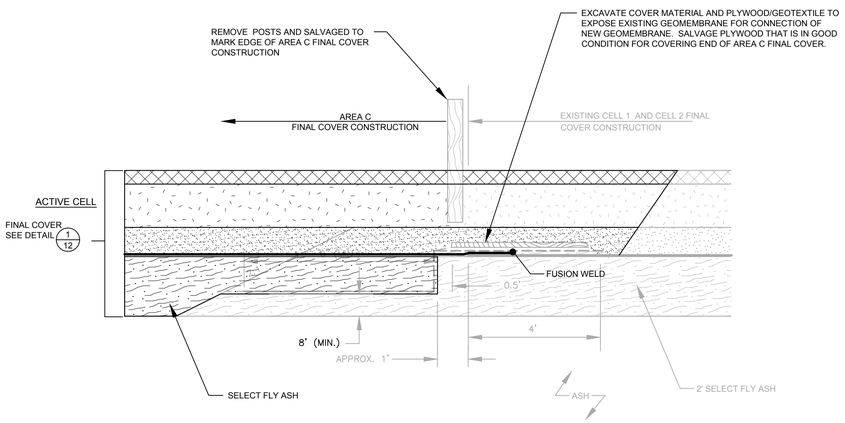
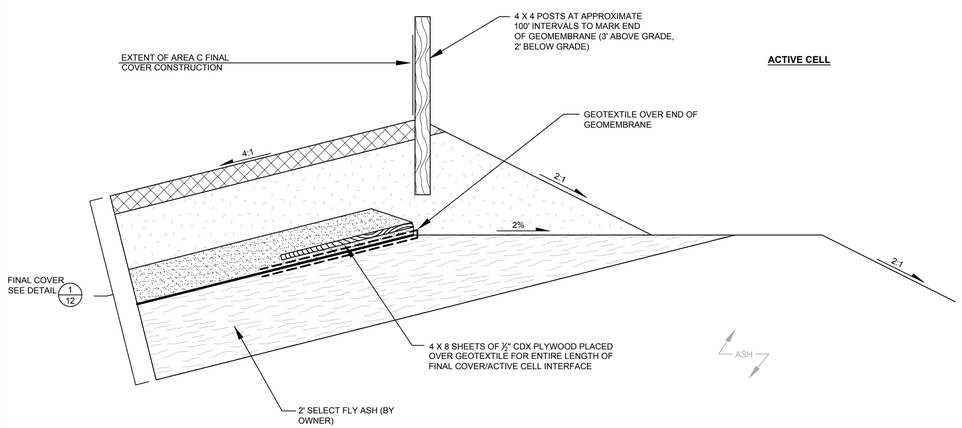
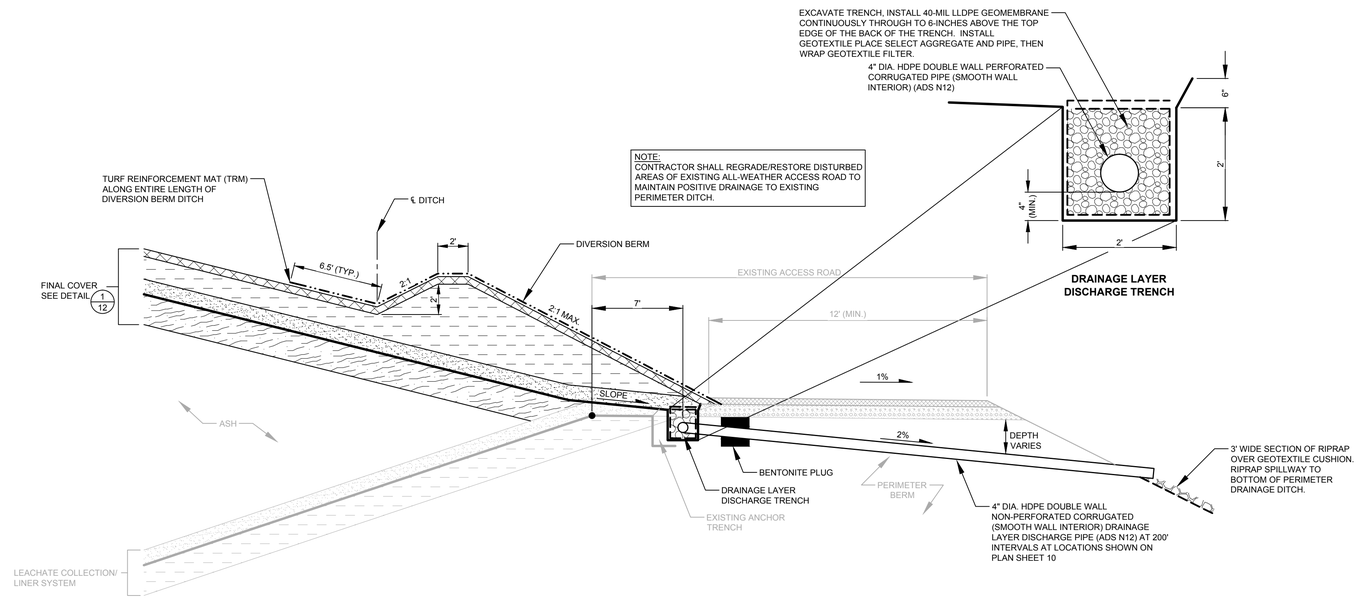


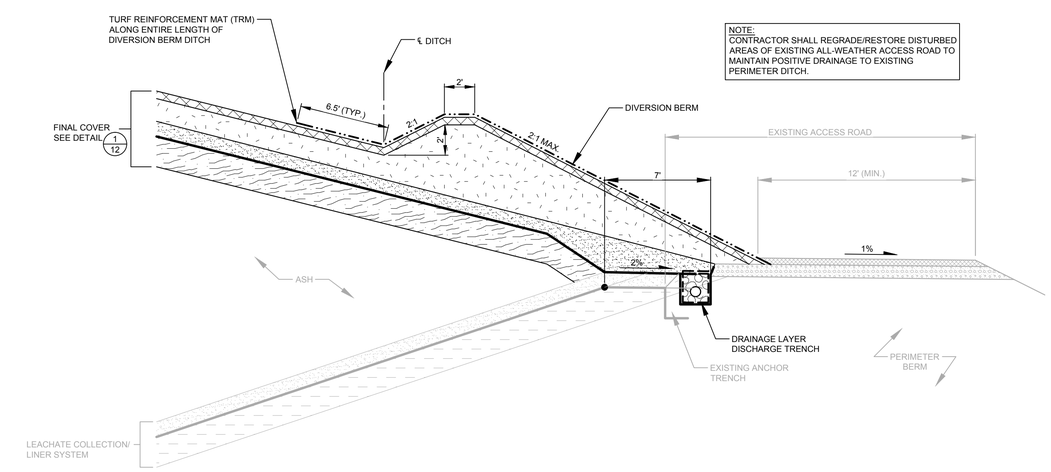

2/12 **FINAL COVER CONNECTION**
(NOT TO SCALE)




3/12 **FINAL COVER TRANSITION**
(NOT TO SCALE)




4/12 **FINAL COVER TERMINATION WITH TOE DRAIN DISCHARGE PIPE**
(NOT TO SCALE)




5/12 **FINAL COVER TERMINATION (OVER CELL 1 LINER CONSTRUCTION)**
(NOT TO SCALE)

NOTE: THE CONTRACTOR SHALL NOTIFY ALL AREA UTILITY COMPANIES PRIOR TO COMMENCING WORK ON THIS CONTRACT, IN ACCORDANCE WITH STATE AND LOCAL REQUIREMENTS.

NOTE: THESE PLANS ARE ACCOMPANIED BY A PROJECT MANUAL OF THE SAME TITLE. THESE DOCUMENTS ARE INTERRELATED AND ARE INTENDED TO BE USED TOGETHER.

| NO. | BY | DATE | REVISION | APP'D. |
|---|---|---|---|---|
| | | | | |

PROJECT:
**DAIRYLAND POWER COOPERATIVE**
**PHASE IV, CELL 3B LINER CONSTRUCTION & AREA C (OVER CELLS 1 & 2) FINAL COVER CONSTRUCTION**
**BUFFALO COUNTY, WISCONSIN**

SHEET TITLE:
**DETAILS**

| | | | |
|---|---|---|---|
| DRAWN BY: LSTORMER | SCALE: AS SHOWN | PROJ. NO. 216851.0005 | |
| CHECKED BY: DM | | FILE N0216851.0004.SHT12-DT.dwg | |
| APPROVED BY: TWM | DATE PRINTED: | **SHEET 12 OF 13** | |
| DATE: MARCH 2015 | | | |

TRC
708 Heartland Trail
Suite 3000
Madison, WI 53717
Phone: 608.826.3600

PLOT DATA
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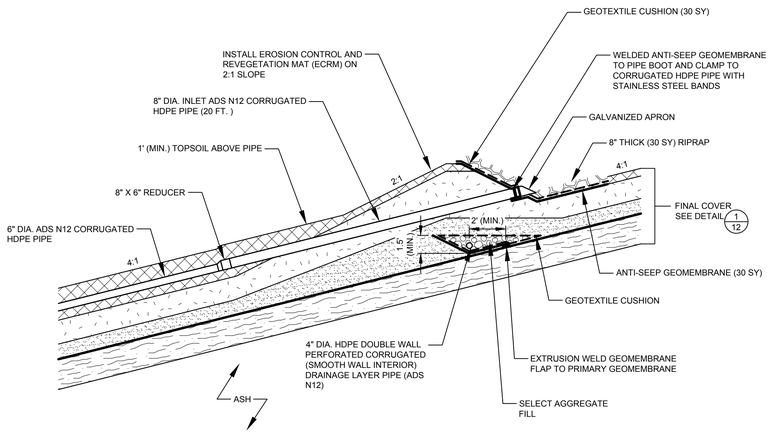
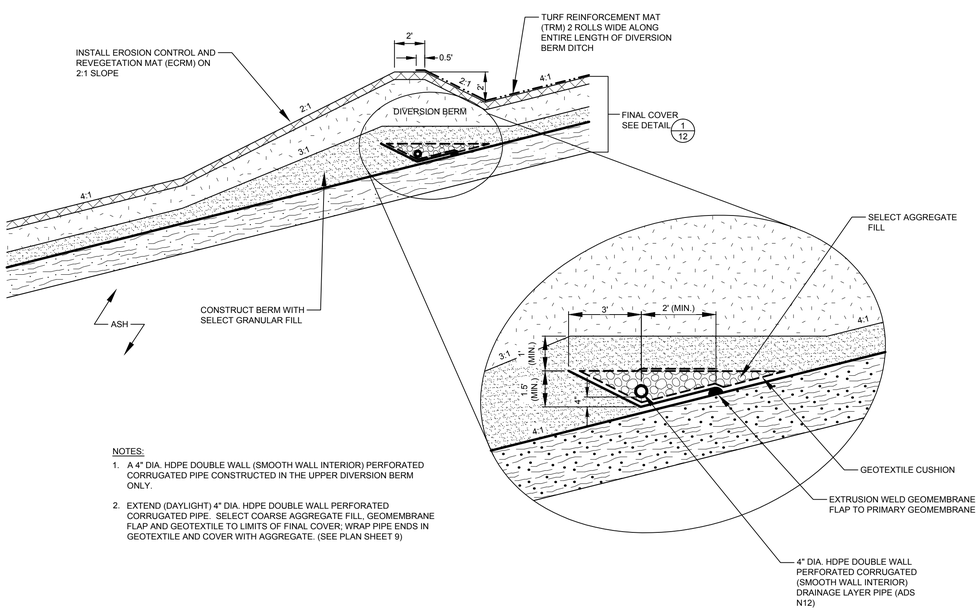
Attached Images:




1/13 **8" DIA. INLET STRUCTURE**

(NOT TO SCALE)

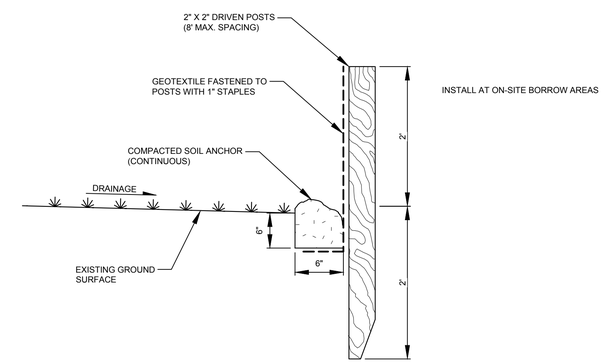



NOTES:

1. A 4" DIA. HDPE DOUBLE WALL (SMOOTH WALL INTERIOR) PERFORATED CORRUGATED PIPE CONSTRUCTED IN THE UPPER DIVERSION BERM ONLY.
2. EXTEND (DAYLIGHT) 4" DIA. HDPE DOUBLE WALL PERFORATED CORRUGATED PIPE. SELECT COARSE AGGREGATE FILL, GEOMEMBRANE FLAP AND GEOTEXTILE TO LIMITS OF FINAL COVER; WRAP PIPE ENDS IN GEOTEXTILE AND COVER WITH AGGREGATE. (SEE PLAN SHEET 9)

2/13 **DIVERSION BERM**

(NOT TO SCALE)




3/13 **SEDIMENT CONTROL FENCE**

(NOT TO SCALE)

NOTE: THE CONTRACTOR SHALL NOTIFY ALL AREA UTILITY COMPANIES PRIOR TO COMMENCING WORK ON THIS CONTRACT, IN ACCORDANCE WITH STATE AND LOCAL REQUIREMENTS.

NOTE: THESE PLANS ARE ACCOMPANIED BY A PROJECT MANUAL OF THE SAME TITLE. THESE DOCUMENTS ARE INTERRELATED AND ARE INTENDED TO BE USED TOGETHER.

| NO. | BY | DATE | REVISION | APP'D. |
|---|---|---|---|---|
| | | | | |

PROJECT: **DAIRYLAND POWER COOPERATIVE**
**PHASE IV, CELL 3B LINER CONSTRUCTION & AREA C (OVER CELLS 1 & 2)**
**FINAL COVER CONSTRUCTION**
**BUFFALO COUNTY, WISCONSIN**

SHEET TITLE: **DETAILS**

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|---|---|---|---|
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| CHECKED BY: DM | | FILE NO. 216851.0004.SHT13-DT.dwg | |
| APPROVED BY: TWM | DATE PRINTED: | SHEET 13 OF 13 | |
| DATE: MARCH 2015 | | | |

TRC
708 Heartland Trail
Suite 3000
Madison, WI 53717
Phone: 608.826.3600

PLOT DATA
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File Size: 0.62 Mb
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Attached Xref's:
Attached Images:

# Appendix Q: Post-Closure Plan

# Post-Closure Plan

## Alma Offsite Disposal Facility, Phase IV Landfill Alma, Wisconsin

January 2023

**Prepared For:**

Dairyland Power Cooperative
3200 East Avenue South
La Crosse, Wisconsin 54601

**Prepared By:**

TRC
999 Fourier Drive, Suite 101
Madison, Wisconsin 53717


BreAnne Kahnk, P.E.
Project Engineer

Todd W. Martin
Principal Project Manager

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## Revision History

| Revision Number | Revision Date | Section Revised | Summary of Revisions |
|---|---|---|---|
| 01 | 01/12/2023 | 1-3 | Updated text per WDNR regulations. |
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# 1.0 Introduction

This Post-Closure Care Plan (Plan) was prepared by TRC Environmental Corporation (TRC) on behalf of Dairyland Power Cooperative (DPC) for the Alma Offsite Disposal Facility, Phase IV Landfill (Landfill) where coal combustion residuals (CCR) are disposed. The approximately 32.1 acre Landfill is located in Sections 18 and 19, T21N, R12W, Town of Belvidere, Buffalo County, Wisconsin. DPC owns and operates the landfill in compliance with the Plan of Operation as permitted by the Wisconsin Department of Natural Resources (WDNR).

This Plan meets the post-closure (long-term) care requirements of the United States Environmental Protection Agency's (USEPA) CCR Rule, Title 40 Code of Federal Regulations (40 CFR) Parts 257 and 261 Subpart D - "Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments" and s. NR 506.084. Post-closure care requirements apply to the owners or operators of CCR landfills subject to closure criteria under 40 CFR 257.102. Because DPC plans to conduct closure of the Landfill through leaving the CCR material in-place, post-closure/long-term care requirements are necessary. Following closure of the CCR landfill (placement of final cover), the owner or operator shall begin to conduct long-term care for the Landfill in accordance with this Plan.

# 2.0 Post-Closure Care

## 2.1 Post-Closure Period

Following closure of the CCR landfill, the site owner is required to maintain and monitor the closed site for a minimum of 40 years. The post-closure period begins on the date identified in the notification of closure of the CCR unit as required by 40 CFR 257.102(h) and s. NR 506.084(1). Post-closure care will be provided to maintain integrity and effectiveness of the final cover system, the leachate collection system in accordance with 40 CFR 257.70(d), and groundwater monitoring system in accordance with 40 CFR 257.90 through 40 CFR 257.98. These goals are consistent with those detailed in s. NR 514.07(10)(d)(1)(b),(c), and (d).

## 2.2 Post-Closure Contact

The post-closure contact for this facility will be:

Manager, Water and Waste Programs
Dairyland Power Cooperative
3200 East Avenue South
La Crosse, WI 54601
Phone: 608-787-1311
ccrinfodesk@dairylandpower.com

## 2.3 Inspection, Monitoring and Maintenance

The site will be inspected annually during the post-closure care period. The Landfill post-closure/long-term monitoring program was initially outlined in the 2000 Plan of Operation. A written record of the inspection(s) will be made and retained in the operating record. The inspector will assess the condition and need for repair of the final cover, vegetation, monitoring points, and storm water control features.

Minor repairs may be required to maintain the integrity and functionality of the drainage structures, roads, monitoring points, etc. Repairs will be made as warranted.

### *2.3.1 Final Cover Maintenance*

Because the CCR is handled dry, moisture conditioned, and compacted in the Landfill, settlement of the final cover system is not anticipated. However, erosion may require minor final cover repairs. Areas of the final cover where ponding or erosion are observed will be repaired to maintain the integrity of the final cover system. Minor repairs may be required to maintain the integrity and functionality of the drainage structures, storm water controls, roads, monitoring points, etc.

### *2.3.2 Vegetation Maintenance*

During inspections, areas lacking vegetation where it is required will be noted. Reworked surfaces, areas of failed or eroded vegetation, and repaired surfaces will be revegetated appropriately. Vegetation maintenance includes mowing. Mowing will be conducted as needed or on a semi-annual basis, whichever is more frequent. Mowing is not required where native prairie grass vegetative cover has been installed as previously approved by the WDNR.

### *2.3.3 Storm Water Runoff Management System Maintenance*

Erosion controls and avoiding ponding of water are addressed by the design, grading, construction, and establishing vegetation on the landfill final cover to ensure proper run-on and run-off of storm water. During site inspections, diversion berms, perimeter dikes, roads, slopes, and storm water sedimentation basins will be inspected for erosion, seeps, depressions, obstructions to flow, vegetation cover, and other maintenance concerns. Maintenance associated with sediment accumulations and erosion will be performed as needed.

### *2.3.4 Leachate Collection System Maintenance and Monitoring*

The leachate collection system will be maintained as needed during the post-closure care period. Features of the system that will be inspected annually include manholes, surface features, transfer piping, controls, the storage tank, and leachate collection volumes. Leachate lines will be cleaned and televised on an annual basis at a minimum. Miscellaneous repairs will be performed on an as-needed basis. The leachate storage tank will be replaced as necessary.

The leachate monitoring program will continue to be conducted during the post-closure period. At a minimum, leachate sampling from the storage tank will occur on a bi-annual basis and leachate head wells will be recorded annually, as presented in the 2000 Plan of Operation and the Environmental Sampling Plan.

Leachate collected in the leachate collection tanks will be utilized on-site for approved activities or hauled to the DPC wastewater treatment plant (WWTP), located in Alma, Wisconsin or the La Crosse Waste Water Utility WWTP location in La Crosse, Wisconsin for treatment and disposal. Miscellaneous repairs will be performed on an as-needed basis to maintain the integrity and effectiveness of the system.

### *2.3.5 Groundwater Monitoring Well Maintenance and Monitoring*

Groundwater monitoring wells will be sampled as outlined in the Environmental Sampling Plan during the post-closure care period. Results associated with CCR wells will be presented in the annual Groundwater Monitoring and Corrective Action Report submitted to the WDNR and posted to the publicly accessible website. The remainder of the results will be submitted to the WDNR as required. Groundwater monitoring records will be maintained in the operating record. The groundwater monitoring system will be maintained throughout the post-closure care period.

Sampling procedures and the groundwater monitoring program, as described in the Environmental Sampling Plan, will be followed throughout the post-closure care period. The parameters, frequency, and monitoring locations are summarized within the Environmental Sampling Plan.

If adverse trends develop, then the WDNR will be notified and further evaluation will be performed. If corrective action becomes necessary, then a plan will be developed and submitted to the WDNR for approval.

## 2.4 Post-Closure Uses

After the Landfill is closed, the site will be secured and maintained by the owner as open green space and recreation. These uses do not conflict with long-term care plans for the area. The

final use is intended to prohibit agricultural uses, building construction, and excavation of the final cover or CCR. These uses are protective of the final cover system and do not increase the potential threat to human health or the environment.

## 2.5 Post-Closure Care Termination

Post-closure care termination may be considered after a period of 40 years from the notification of closure. In the event that the Landfill is operating under assessment groundwater monitoring in accordance with 40 CFR 257.95, the Owner will continue to perform post-closure care and groundwater monitoring in accordance with 40 CFR 257.95 until the Landfill returns to detection monitoring.

No later than 60 days following completion of the post-closure care period, the owner or operator of the CCR landfill shall post the notification of completion of post-closure care period to the operating record in accordance with 40 CFR 257.104(e) and s. NR 506.084(2)(b). Section 3 provides details on notification requirements.

## 2.6 Revision of the Post-Closure Plan

This Post-Closure Plan should be amended and submitted to the WDNR at least 60 days prior to a planned change that will substantially affect this plan or within 60 days of an unanticipated event after post-closure activities have commenced. If the Post-Closure Care Plan is revised after long-term care activities have commenced, the owner or operator shall submit the modification request to the WDNR no later than 30 days following the triggering event. Modifications to the Post-Closure Care Plan shall be completed in accordance with s. NR 514.04(6).

# 3.0 Notifications

## 3.1 Operating Record

The following items will be maintained in the operating record for a minimum of five years:

- 40 CFR 257.105(h): applicable requirements for groundwater monitoring
- 40 CFR 257.105(i)(12): the current post-closure plan and any amendment of the plan; the current version of the post-closure plan will be maintained in the facility's operating record irrespective of time,
- 40 CFR 257.105(i)(13): the notification of completing post-closure care
- Inspection reports

## 3.2 Notification Requirements

The following required notifications will be provided before the close of business on the day the notification is required to be completed:

- 40 CFR 257.106(h): *applicable* requirements for groundwater monitoring
- 40 CFR 257.106(i)(12): the availability of the written post-closure plan and any amendment of the plan
- 40 CFR 257.106(i)(13): the availability of completion of post-closure care

## 3.3 Publicly Accessible Internet Site

The following required items will be posted on the publicly accessible internet site:

- 40 CFR 257.107(h): *applicable* requirements for groundwater monitoring
- 40 CFR 257.107(i)(12): the written post-closure plan and any amendment of the plan
- 40 CFR 257.107(i)(13): the notification of completion of post-closure care

Information should be posted within 30 days of placing the pertinent information in the operating record. Records will be made available to the public for at least five years following the date on which the information was posted on the internet site.

## 4.0 Engineer's Certification

Pursuant to 40 CFR 257.104 and by means of this certification I attest that:

(i) I am familiar with the requirements of the federal CCR rule (40 CFR 257);

(ii) this Post-Closure Plan has been prepared in accordance with good engineering practice; and

(iii) this Post-Closure Plan meets the requirements of 40 CFR 257.104(d).

For the purpose of this document, "certify" and "certification" shall be interpreted and construed to be a "statement of professional opinion." The certification is understood and intended to be an expression of my professional opinion as a Wisconsin licensed professional engineer, based upon knowledge, information, and belief. The statement(s) of professional opinion are not and shall not be interpreted or construed to be a guarantee or a warranty of the analysis herein.

Breanne N. Kahnk

Signature of Registered Professional Engineer

Registration No. E-46825 State: Wisconsin

WISCONSIN
BREANNE N. KAHNK
E-46825
MIDDLETON, WI
01/26/23
PROFESSIONAL ENGINEER

# Appendix R: Long-Term (Post-Closure) Care Costs

**Table 2: Opinion of Probable Cost**
**Long-term Care, Phase IV Landfill**
**Dairyland Power Cooperative, Alma Off-Site Disposal Facility**
**Plan Modification - February 2023**

| Major Cost Item | Unit | Unit Cost 2019 (Submitted August 27, 2019) | Unit Cost 2022 (Adjusted for Inflation) (1) | Quantity | Average Cost Per Year |
|---|---|---|---|---|---|
| Cover Vegetation | | | | | |
| Reseed/Erosion Damage | Acre | $ 738.60 | $ 774.80 | 32 | $ 25,000.00 |
| Lawn Mowing | Event | $ 4,727.04 | $ 4,958.72 | 1 | $ 5,000.00 |
| O&M | | | | | |
| Storm Water Control Structures | LS | $ 7,386.00 | $ 7,748.00 | 1 | $ 7,800.00 |
| Settlement/Siltation | | | | | |
| Repair Cover | Acre | $ 295.44 | $ 309.92 | 32 | $ 10,000.00 |
| Sedimentation Basin Cleaning | LS | $ 738.60 | $ 774.80 | 1 | $ 800.00 |
| Leachate Control Features | | | | | |
| Leachate Collection Line Cleaning | LS | $ 2,954.40 | $ 3,099.20 | 1 | $ 3,100.00 |
| Operation and Maintenance | LS | $ 4,431.60 | $ 4,648.80 | 1 | $ 4,700.00 |
| Leachate Disposal | Gallon | $ 0.04 | $ 0.04 | 876,000 | $ 34,000.00 |
| Environmental Monitoring | LS | $ 9,601.80 | $ 10,072.40 | 1 | $ 10,100.00 |
| Inspections | LS | $ 2,954.40 | $ 3,099.20 | 1 | $ 3,100.00 |
| Reporting | LS | $ 4,431.60 | $ 4,648.80 | 1 | $ 4,700.00 |
| | | | | Long-term Care Subtotal: | $ 108,300.00 |
| | | | | Contingency (10%): | $ 10,900.00 |
| | | | | Yearly Grand Total: | $ 119,200.00 |
| | | | | **40-year Long-term Care Cost:** | **$ 4,768,000.00** |

Note:
(1) Costs are in 2022 dollars according to Wisconsin DNR Owner Financial Responsibility Inflation Factor Table. Some totals may not agree due to rounding.

Update By: Z. Bauman 12/21/2022
Checked By: