Addendum no. 6. 1999

Foth and Van Dyke and Associates, Inc.
Green Bay, Wisconsin: Foth and Van Dyke, 1999

Nicolet Minerals
C O M P A N Y

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November 24, 1999

Mr. Bill Tans
Wisconsin Department of Natural Resources
Bureau of Integrated Science Services
101 South Webster Street
P.O. Box 7921
Madison, WI 53707-7921

Ms. Char Hauger
U.S. Army Corps of Engineers
St. Paul District
190 Fifth Street East
St. Paul, MN 55101

Dear Mr. Tans and Ms. Hauger:

Re: Crandon Project - Addendum No. 6 to the May 1995 *Crandon Project Tailings Management Area Feasibility Report/Plan of Operation*

Nicolet Minerals Company (NMC) is pleased to submit the report titled *Addendum No. 6 to the May 1995 Crandon Project Tailings Management Area Feasibility Report/Plan of Operation* (Addendum No. 6).

Addendum No. 6 has been prepared on behalf of NMC by Foth & Van Dyke and Associates, Inc. As noted on the attached distribution list, NMC has distributed the information to appropriate state and federal agencies, to local officials, and to various interested parties. It is our understanding that the Wisconsin Department of Natural Resources (WDNR) and the U.S. Army Corps of Engineers (USCOE) will be responsible for distribution of the document to their appropriate staff members.

The primary purpose of Addendum No. 6 is to present TMA design changes made as a result of NMC's decision to temporarily stockpile Type II waste rock in the TMA construction staging area within the footprint proposed for future TMA development. This location for the Type II stockpile has been selected to allow for the segregation and storage of Type I and Type II waste rock on separate composite lined pads, placement of Type II waste rock into the TMA at a rate that will maintain the TMA's net neutrality, and to minimize impacts associated with the storage facility by locating it in an area proposed for future TMA cell development.

This Addendum also incorporates NMC's response to the WDNR's October 12, 1999 Additional Information Request letter regarding the May 1995 *Crandon Project Tailings Management Area Feasibility Report/Plan of Operation*.

Nicolet Minerals Company has now responded to all additional information requests on feasibility completeness determination as itemized in WDNR letters dated January 4, 1996, September 26, 1997, November 17, 1998, April 2, 1999, and October 12, 1999. Any future work by NMC should be considered confirmatory in nature, and not required to determine TMA facility feasibility or impacts. After review of Addendum No. 6, Nicolet Minerals Company requests that the Wisconsin Department of Natural Resources provide NMC with a confirmation letter acknowledging TMA feasibility completeness.

If you or your staff have any questions regarding Addendum No. 6, please contact either Ken Black or myself at (715) 478-3393.

Sincerely,

Gordon Reid
Manager of Engineering
Nicolet Minerals Company

GR:cer1

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Addendum No. 6 to the May 1995 Crandon Project Tailings Management Area Feasibility Report/Plan of Operation

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November 1999

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Addendum No. 6 to the May 1995 Crandon Project Tailings Management Area Feasibility Report/Plan of Operation

Contents

Page

Contents *(continued)*

Page

Tables

Figures

(Note: Figures for Addendum No. 6 to the May 1995 Tailings Management Area Feasibility Report/Plan of Operation are located at the end of the text, following page 33.)

Drawings

(Note: Drawings for Addendum No. 6 to the May 1995 Tailings Management Area Feasibility Report/Plan of Operation are located following the Figures.)

Appendices

1 Introduction

Through its predecessor company, Nicolet Minerals Company (NMC) submitted its *Crandon Project Tailings Management Area* (TMA) *Feasibility Report/Plan of Operation* (Feasibility Report) (Foth & Van Dyke, 1995) to the Wisconsin Department of Natural Resources (WDNR) and the U.S. Army Corps of Engineers (USCOE) in May 1995. On February 21, 1996, the document titled *Addendum No. 1 to the May 1995 Crandon Project Tailings Management Area Feasibility Report/Plan of Operation* (Addendum No. 1) (Foth & Van Dyke, 1996a), was submitted to the WDNR and USCOE. Addendum No. 1 presented responses to a portion of the comments raised in the WDNR's January 4, 1996, TMA Completeness Determination Letter (WDNR, 1996). The addendum was provided to the WDNR at a February 22, 1996, TMA meeting with the WDNR, the USCOE, and others. At this meeting, WDNR requested clarification of and additional information for some of the responses contained in Addendum No. 1.

The document titled *Addendum No. 2 to the May 1995 Crandon Project Tailings Management Area Feasibility Report/Plan of Operation* (Addendum No. 2) (Foth & Van Dyke, 1996b), was submitted to the WDNR and USCOE on April 4, 1996. Addendum No. 2 was prepared both to clarify responses to the additional information requested at the February 22, 1996 TMA meeting, and to respond to the remaining comments contained within the WDNR's January 4, 1996 TMA Completeness Determination Letter (WDNR, 1996).

Addendum No. 3 to the May 1995 Crandon Project Tailings Management Area Feasibility Report/Plan of Operation (Addendum No. 3) (Foth & Van Dyke, 1997), was submitted to the WDNR on January 30, 1997. Addendum No. 3 was prepared to document modifications to the facility's footprint in the vicinity of the Bur Oak Swamp, to consolidate modifications made to the facility's proposed liner, final cover, and leachate management system design, and to address the remaining issues raised at a May 28, 1996 TMA meeting.

Addendum No. 4 to the May 1995 Crandon Project Tailings Management Area Feasibility Report/Plan of Operation (Addendum No. 4) (Foth & Van Dyke, 1998a), submitted to the WDNR and USCOE on June 17, 1998, presented design changes to the TMA liner system made as a result of GCL compatibility tests. Addendum No. 4 also updated estimates of percolation through the liner and cover system during TMA operation, closure, and post-closure periods due to the proposed design changes, namely, the addition of a sidewall drainage layer on the upper stages of the TMA cells.

The document titled *Addendum No. 5 to the May 1995 Crandon Project Tailings Management Area Feasibility Report/Plan of Operation* (Addendum No. 5) (Foth & Van Dyke, 1998b), submitted to the WDNR and the USCOE on December 24, 1998, presented the reduction in the footprint of the TMA resulting from a tailings volume reduction as a result of NMC's plan to remove pyrite from the tailings prior to deposition in the TMA, with the placement of pyritic tailings underground as paste backfill. The P40 filter layer between the tailings and the till protective layer above the drainage layer was also replaced by six inches of till to enhance liner performance in association with changed characteristics of the depyritized tailings. The project's Geosynthetic Materials Decision Matrix (GMDM) (Foth & Van Dyke, 1997/1998a) was also updated to respond to regulatory agencies' comments, and included as Appendix D to Addendum No. 5.

Finally, this document, titled *Addendum No. 6 to the May 1995 Crandon Project Tailings Management Area Feasibility Report/Plan of Operation* (Addendum No. 6), has been prepared to propose using a portion of the 18-acre construction staging area located within the proposed TMA 3 footprint for temporary storage of Type II waste rock during the initial stages of mine development and operation. Details of design and operation of the Type II waste rock storage area, as well as responses to the WDNR's October 12, 1999 comment letter (WDNR, 1999a), are also included in this addendum.

This proposal to relocate the Type II stockpile to the TMA area is necessary to accommodate the volume of hoisted Type I and Type II waste rock on composite lined pads, keep the two materials separated due to differences in end use, and to provide adequate storage area to allow co-mingling of Type II waste rock with the tailings at a rate that will conservatively maintain the net neutrality of the TMA.

NMC intends to consolidate relevant portions of the original Feasibility Report (Foth & Van Dyke, 1995), addenda and responses to pertinent regulatory agency comments into a consolidated Feasibility Report that will be submitted at the time the WDNR releases its Draft Environmental Impact Statement.

2 Purpose and Scope

The primary purpose of this addendum to the Feasibility Report (Foth & Van Dyke, 1995) is to provide information required by Chapter NR 182, Wis. Admin. Code (NR 182), for construction of the Type II waste rock storage area. Where applicable, this document also incorporates responses to requests for specific additional information required for the WDNR to make a completeness and feasibility determination (e.g., WDNR, 1996; WDNR, 1999a) for the TMA and appurtenant facilities.

Specifically, Addendum No. 6 contains the following:

- Proposal to relocate the Type II waste rock storage area to within the 18-acre construction staging area located within the proposed TMA 3 footprint.
- Redesign of the Type II waste rock stockpile to include a composite liner, leachate collection system and leachate evacuation sump.
- HELP model results of the Type II storage facility.
- Storm water management design features to eliminate run-on and provide storage for the 100 year, 24 hour storm event.
- Modification of the site development and phasing plans to reflect the changes.
- Discussion of the earthwork balance to show that an adequate volume of soils exist to construct and close the TMA cells, and construct the Type II waste rock storage area.
- Reassessment of the adequacy of the runoff basins, given the design modifications listed above.
- Incorporation of relevant responses to the WDNR's October 12, 1999 letter to NMC (WDNR, 1999a) requesting additional information for TMA feasibility report review (see Section 6).

3 Background Information/General Requirements

3.1 Project Description

Several modifications to the project have been made since the original May 1995 Feasibility Report (Foth & Van Dyke, 1995) submittal. A complete summary of the proposed project is contained in the *Mine Permit Application* (MPA) (Foth & Van Dyke, 1995/1998a). The major modifications to the project since submittal of the original MPA which are part of the current project include:

- Removal of pyrite from the tailings prior to deposition in the TMA, thereby significantly reducing long term environmental risk.
- Placement of pyritic tailings underground as mine backfill, using paste technology.
- Reduction of the volume of tailings to be deposited and a subsequent reduction in the footprint of the TMA as a result of the pyrite removal and paste backfill processes.
- Implementation of grouting techniques and/or other suitable technologies to control water inflow.
- Modification to the water management facilities to allow the discharge of treated wastewater to an adjacent soil absorption system. The proposed advanced treatment technology involving reverse osmosis and evaporation is described in the updated *Preliminary Engineering Report for Wastewater Treatment Facilities* (Foth & Van Dyke, 1995/1998b).
- Proposing a lined storage area for the Type I waste rock construction material located north of the headframe at the plant site.
- Proposing a lined Type II waste rock storage area within the 18-acre construction staging area located within the proposed TMA 3 footprint.

The above project modifications significantly reduce project impacts. With the exception of impacts associated with the proposed change in location of the Type II waste rock storage area, project impacts are detailed in the updated *Environmental Impact Report* (EIR) (Foth & Van Dyke, 1995/1998c). Specific impact reductions relative to the TMA are described in detail in Section 4 of that report. Changes in impacts resulting from development of the proposed Type II waste rock storage area are discussed later in this document.

3.2 Overview of the Waste Rock Management Plan

During the various stages of mine development, waste rock and ore will be produced. Waste rock will consist predominantly of quartz and other silicate minerals (chlorite, sericite, plagioclase) and small, but varying amounts of sulfide minerals.

During the pre-production stage, ore and waste rock will be hoisted to the surface. The materials will be loaded into trucks by chute from the headframe bins and hauled and stockpiled on one of three composite lined pads designated for storage of ore, Type I waste rock, or Type II waste rock.

During the production period, waste rock, generated on an ongoing basis, will be hoisted to the surface, and temporarily stockpiled on composite lined storage pads, or be co-mingled with the tailings. Some waste rock will be retained underground in the construction of stope bulkheads.

Section 3.5.5 and Appendices 4.2-12 and 4.2-15 through 4.2-17 of the Crandon Project EIR (Foth & Van Dyke, 1995/1998c) pertain to characterization of the materials to be placed in the TMA. Those sections of the EIR include information concerning the characteristics of waste rock to be produced during the pre-production and production phases of mining and its behavior in the TMA. The MPA (Foth & Van Dyke, 1995/1998a) provides details of the waste rock management plan (WRMP). The WRMP will be used to classify and manage waste rock during mining.

NMC has made the decision to further reduce long term environmental risk by removing pyritic tailings from the TMA and thereby reduce the potential for the tailings to produce acidic conditions. NMC's WRMP is consistent with the objective to maintain a net neutral TMA, and at the same time beneficially uses waste rock (inside of TMA containment areas), so as to minimize the volume of additional borrow required for construction of the TMA.

The WRMP stipulates that pre-production ore and Type I waste rock will be stored in an approximate 10 acre area located north of the headframe. This composite lined storage area will be used to store approximately 240,000 tons of pre-production ore and approximately 692,000 tons of Type I waste rock in two separate piles [see Figures 4-10 and 4-10A of the update to Section 4.8.9.3 of the MPA (Foth & Van Dyke, 1995/1998a), to be submitted shortly]. In addition, approximately 431,000 tons of Type II waste rock will be temporarily stockpiled on an approximate 6.7-acre composite lined pad within the 18-acre construction staging area of the TMA (see Figure 3.2-1).

3.3 Waste Rock Generation, Storage, and Use

3.3.1 General

Table 3-1 was prepared based on the current mine plan as the best estimate of the amount of waste rock which will be hoisted to the surface from the formations expected to be encountered during the pre-production and production mining years. A detailed discussion of waste rock generation can be found in Section 4.8 of the MPA (Foth & Van Dyke, 1995/1998a).

Table 3-1

Estimated Waste Rock to be Hoisted to the Surface[1,2] (Tons)

	Type I			Type II			Total
Year[3]	Rice Lake	Upper Mole Lake	Subtotal Type I	Skunk Lake	Lower Mole Lake	Subtotal Type II	Type I & II
1	5,000	—	5,000	37,000		37,000	42,000
2	221,000	—	221,000	27,000	42,000	69,000	290,000
3	132,000	180,000[4]	312,000	—	367,000	367,000	679,000
4	154,000	—	154,000	—	66,000	66,000	220,000
5	—	—	—	—	37,000	37,000	37,000
6	—	—	—	—	25,000	25,000	25,000
7	—	—	—	—	30,000	30,000	30,000
8	—	—	—	—	21,000	21,000	21,000
9	—	—	—	—	12,000	12,000	12,000
10	—	—	—	—	6,000	6,000	6,000
11	—	—	—	—	6,000	6,000	6,000
12 thru 17	—	—	—	—	—	—	—
18 thru 25[5]	—	—	—	—	220,000	220,000	220,000
Totals[6]	512,000	180,000	692,000	64,000	832,000	896,000	1,588,000

[1] Based on NMC's mine plan and best estimate of mine waste rock production. Production in tons is calculated assuming an in-situ rock density of 177.3 lbs/cf and a blasted rock density of 111.1 lbs/cf.
[2] Tons rounded to the nearest thousand.
[3] Years 1 through 3 represent the pre-production period, years 4 and on represent the mine production period.
[4] Includes 130,000 tons from a Type I waste rock stope.
[5] A total of approximately 220,000 tons of waste rock will be hoisted to the surface during years 18 through 25.
[6] Rounded to the nearest thousand tons.
Note: Table 3-1 reproduced from Table 4-6 of the MPA (Foth & Van Dyke, 1995/1998a).

Prepared by: SAD2
Checked by: KPB

Table 3-1 divides the mined rock into Type I and Type II by formation, based on estimated sulfide mineral content and the results of the project's waste characterization work (Foth & Van Dyke, 1995/1998a, NMC, 1999a). This work showed that most waste rock from the Rice Lake and Upper Mole Lake formations would be non acid generating. The table shows that approximately 692,000 tons of Type I waste rock (with approximately 130,000 tons coming from a waste stope) and approximately 896,000 tons of Type II waste rock will be generated during the life of the project. Estimates of the volume of waste rock to be hoisted have been calculated using a hoisted broken bulk density of 111.1 pounds per cubic foot (Hansen, 1984). The estimated volume of Type I waste rock is approximately 461,000 cubic yards. The estimated volume of Type II waste rock is approximately 600,000 cubic yards, but only 315,000 cubic yards will be produced during the pre-production period.

3.3.2 Type I Waste Rock

Type I waste rock will be classified and segregated underground, and then hoisted to the surface for storage on a composite lined area, as discussed in Section 4.8 of the MPA (Foth & Van Dyke, 1995/1998a). The Type I waste rock will be used for the grading layer in between TMA final tailings surface and the final cover. Smaller amounts of Type I waste rock may be used as aggregate for the concrete required for surface and subsurface construction, as riprap for the reclaim pond or wastewater storage basins, or for construction of access ramps internal to the TMA.

In the event that some of the Type I material is, through underground assessment, determined to be Type II, it will be relocated to the Type II stockpile area or placed directly in the TMA. The TMA has been sized with an adequate contingency to accept all waste rock generated from the project. A buffer area south of the Type II stockpile area (see Figure 3.2-1) will also be available for storage of additional Type II waste rock, if necessary. The liner system proposed for the Type II stockpile would be extended into the buffer area if needed.

3.3.3 Type II Waste Rock

NMC has used the following principles as guidelines in developing its surface management plan for Type II waste rock.

- Type II waste rock will be hauled directly to an approximate 6.7-acre composite lined pad sited in the north end of the 18-acre construction staging area, located east of TMA 1 (see Figure 3.2-1). Surface water management features will be designed to collect contact water that will be routed to the TMA or reclaim pond and recycled back to the mill, or be treated and discharged to the soil absorption system (SAS). Non contact runoff water will be routed around the perimeter of the storage pad to one of the proposed runoff basins, as discussed in Section 5.7.

- Type II waste rock will only be placed within composite lined facilities, either as a construction material (riprap in the TMA) or co-mingled with tailings in the TMA.

Type II waste rock will be restricted to use within the containment area of the TMA facilities. The containment area is defined as the composite lined portion of the TMA which is below the grading layer. The potential construction use of Type II waste rock and the estimated quantities for each use are provided in Table 3-2. It is anticipated that Type II waste rock will be used as riprap on the base and sideslopes of the TMA cells, or will be co-mingled with the depyritized tailings within the TMA cells in appropriate proportion with the tailings so as to maintain the net neutrality of the TMA.

Table 3-2

Potential Type II Waste Rock Construction Uses

Year[1]	Description of Use		Tons[2]
3	TMA 1 Stage I Base Riprap		42,000
6	TMA 1 Stage II Base Riprap		41,000
19	TMA 2 Stage IV Base Riprap		76,000
25	TMA 3 Stage VI Base Riprap		76,000
		Total	235,000

[1] Years 1 through 3 represent the pre-production period, years 4 and on represent the mine production period.
[2] Calculated assuming an in-place density of 125 pcf.

Prepared by: DMR
Checked by: KPB

Table 3-3 compares an estimate of the yearly amount of Type II waste rock that will be hoisted to the surface and the quantity of Type II waste rock that could be used per year in TMA construction. This comparison shows that the production of Type II waste rock is greater than the potential use, especially during the first half of the project's life. The proposed Type II waste rock storage during the pre-production period on a composite lined storage pad in the 18-acre construction staging area of the TMA will meet NMC's intent of maximizing the use of this material as riprap. In the production period, during those times when Type II waste rock is hoisted to the surface at a rate greater than it can be used for TMA riprap, the excess Type II waste rock will be co-mingled with depyritized tailings in the TMA at a weight-to-weight ratio no greater than two parts tailings to one part waste rock. This ratio will be maintained so as to maintain the net neutrality of the TMA (see memo from SRK in Appendix A). Table 3-3 also contains a material balance that shows the approximate amount of Type II waste rock that will be placed in and taken out of storage on an annual basis and how much will be co-mingled with the tailings. A review of Table 3-3 shows:

Table 3-3

Type II Waste Rock Hoisted to the Surface and Estimated Use

Year[1]	Type II Production (tons)	TMA Use[2] (tons)	Temporary Storage[3] (tons)		Deposition in TMA (tons)	
			Year	Cumulative	Year	Cumulative
1	37,000	—	37,000	37,000	—	—
2	69,000	—	69,000	106,000	—	—
3	367,000	42,000	325,000	431,000	—	—
4	66,000	—	—	303,000	194,000[5]	194,000
5	37,000	—	—	146,000	194,000	388,000
6	25,000	41,000	—	—	130,000	518,000
7	30,000	—	—	—	30,000	548,000
8	21,000	—	—	—	21,000	569,000
9	12,000	—	—	—	12,000	581,000
10	6,000	—	—	—	6,000	587,000
11	6,000	—	—	—	6,000	593,000
12 thru 18	—	—	—	—	—	593,000
19	22,000	22,000[4]	—	—	—	593,000
20	22,000	—	—	—	22,000	615,000
21	22,000	—	—	—	22,000	637,000
22	22,000	—	—	—	22,000	659,000
23	22,000	—	—	—	22,000	681,000
24	22,000	—	—	—	22,000	703,000
25	22,000	22,000[4]	—	—	—	703,000
26	22,000	—	—	—	22,000	725,000
27	22,000	—	—	—	22,000	747,000
28	22,000	—	—	—	22,000	769,000
Totals	896,000	127,000	—	—	769,000	—

[1] Years 1 through 3 represent the pre-production period, years 4 and on represent the mine production period.
[2] Type II waste rock uses from Table 3-2.
[3] Type II waste rock temporary storage will be on a composite lined pad locate in the 18-acre construction staging area of the TMA.
[4] Stage IV and Stage VI base riprap each require 76,000 tons; however, only 22,000 tons will be available.
[5] The annual tailings delivery rate to the TMA is approximately 388,000 tons/year; therefore, a ratio of 2 parts tailings to 1 part Type II waste rock will be maintained.
Note: Table 3-3 reproduced from Table 4-10 of the MPA (Foth & Van Dyke, 1995/1998a).

Prepared by: DMR
Checked by: KPB

- It is planned to use approximately 127,000 tons of Type II waste rock as riprap within the TMA cells.

- Surface storage of Type II waste rock on a lined pad is limited to approximately 6 years, with the average time of storage being considerably less than 6 years.

- The tonnage contained in the Type II waste rock storage stockpile at any given time will range from approximately 0 to 431,000 tons (0 - 300,000 cubic yards).

- The maximum amount of waste rock to be co-mingled with depyritized tailings in any year is 194,000 tons.

- Of the total quantity of Type II waste rock, approximately 75 percent will be generated during the zinc phase of mining (i.e., during the first 16 years of production). Therefore, approximately 75 percent (672,000 tons, or 448,000 cubic yards) of the Type II waste rock will be placed in TMA 1.

- Of the total quantity of Type II waste rock, approximately 25 percent will be generated during the copper phase of mining (i.e., years 17-28 of production). Therefore, approximately 25 percent (224,000 tons, or 149,000 cubic yards) of the Type II waste rock will be placed in TMA cells 2 and 3.

3.4 Regulatory Requirements

Since the Type II waste rock storage area will be located within the area proposed for TMA 3 development, the existing conditions and satisfaction of facility location criteria have been previously documented through information provided in the Feasibility Report (Foth & Van Dyke, 1995), subsequent addenda, and other pertinent correspondence. Therefore, additional characterization of the site is not necessary nor provided as part of this addendum.

The remainder of Addendum No. 6 is organized to closely follow the order of regulatory requirements contained in "Feasibility report", Chapter NR 182.08, Wis. Admin. Code. Where appropriate, the code references are included in the section or subsection headings.

3.4.1 General Submittal Requirements (NR 182.06)

The general submittal requirements are contained in Section 1.1 of the TMA Feasibility Report (Foth & Van Dyke, 1995) and supplemental data submitted to the WDNR in response to their letter of April 2, 1999 (NMC, 1999b). The preparation and format of Addendum No. 6 follows the procedures in Chapter NR 182.06, Wis. Admin. Code.

3.4.2 Location Criteria (NR 182.07)

The location and sizing of the TMA cells was modified in Addendum No. 5 (Foth & Van Dyke, 1998b). Section 4.4 of Addendum No. 5 provides a description of the revised TMA footprint and compares the impacts of the revised footprint to those of the previous footprint. As stated earlier, the composite lined Type II waste rock storage area proposed in this Addendum will cover approximately 6.7 acres within the 18-acre construction staging area located within the proposed TMA 3 footprint. As a result, the potential impacts as related to proximity to existing resources, will be the same as for TMA 3. Section 4.4 of Addendum No. 5 provides additional details on the TMA facility description.

3.4.3 Groundwater Standards (NR 182.075)

Groundwater standards for the TMA have been codified in Chapter NR 182.075, Wis. Admin. Code. Per NR 182.075(1), the TMA shall comply with Chapter NR 140, Wis. Admin. Code, groundwater quality standards. NR 182.075 also specifies the location of the design management zone and mandatory intervention boundary for mining waste facilities.

The Type II waste rock storage area is an integral part of the TMA operations, as it will be used for the temporary storage of Type II waste rock that will ultimately be placed in the TMA cells. Since the waste rock storage area is part of the TMA facility operations used for the storage of mining wastes, it will be regulated, with respect to NR 140, as part of the TMA facility. A groundwater quality performance evaluation (GWQPE) (Foth & Van Dyke, 1999) was completed to assess the performance of the TMA with respect to compliance with NR 140 groundwater quality standards. The GWQPE is provided in Appendix 4.2-12 of the EIR (Foth & Van Dyke, 1995/1998c). Section 5.12 of this report addresses the performance evaluation and the potential impacts of the Type II waste rock storage area on the GWQPE.

4 Feasibility Report (NR 182.08)

4.1 General Facility Information [NR 182.08(2)(a)]

- Project: Nicolet Minerals Company, Temporary Type II Waste Rock Storage Area.
- Primary Contact: Gordon Reid
Nicolet Minerals Company
104 West Madison Street
Crandon, WI 54520-0336
Phone: (715) 478-1511
- Owner: Nicolet Minerals Company
7 North Brown Street, Third Floor
Rhinelander, WI 54501-3161
- Site Location: The TMA is located primarily in Section 32, T35N, R13E, Town of Lincoln, Forest County, Wisconsin. The Type II waste rock storage area is located in the Northeast ¼ of Section 32, in the area that will be occupied by TMA 3 at a later date in the TMA construction and development process.
- Proposed Licensed Acreage: The Type II waste rock storage area is approximately 6.7 acres, located in areas which will be occupied by TMA 3 in the future.
- Proposed Facility Site Life: Estimated to be 6 years.
- Estimated Waste Types: Type II waste rock, which is described in Section 4.2.
- Storage Capacity: The planned storage capacity is approximately 302,500 cy. The quantity of Type II waste rock in storage at any given time will vary, since the waste rock will be used for riprap in the TMA cells, or be continually co-mingled with tailings in the active TMA cell during the approximate 6-year life of the Type II storage facility.

4.2 Waste Characterization and Analysis [NR 182.08(2)(b)]

4.2.1 General

A detailed discussion of the bedrock and ore body geology is included in Section 3.5 of the project's EIR (Foth & Van Dyke, 1995/1998c).

Type II waste rock will be generated during the pre-production and operation periods during advancement of lateral hanging wall drifts, crosscuts, and other ancillary areas. These development drifts will be mined adjacent to the Crandon formation in the Lower Mole Lake formation and will provide a means of access to the ore body. Type II waste rock will be temporarily stockpiled on a composite lined pad in the TMA area and will either be beneficially used as riprap within the lined area of the TMA cells, or be co-mingled with the tailings.

4.2.2 Type I and Type II Waste Rock Segregation Criteria

Access to the mine will be through a main production/service shaft located north of the ore body in the Skunk Lake, Rice Lake, and Upper Mole Lake hanging wall formations. Ancillary facilities like the crusher, ramp, crosscuts to the ore body, garage, etc. will also be sited in these formations. Underground lateral development drifts will be located in the Lower Mole Lake formation and will access the ore body from the main production shaft at 200 foot vertical intervals. The lateral extent of mine level development at any given time will depend upon the need for access to mining blocks, internal ore and waste passes and ventilation raises. During the first year of pre-production, a grout drift will also be constructed along the strike of the crown pillar in the Crandon formation to facilitate grouting to control groundwater inflow.

Section 3.5 of the EIR (Foth & Van Dyke, 1995/1998c) shows that the four hanging wall rock formations that will be encountered during the construction of the pre-production underground facilities at the Crandon mine have differing geochemical and leaching characteristics. Based upon this data, the Skunk Lake and Lower Mole Lake formations will be classified as Type II waste rock, and the Rice Lake and Upper Mole Lake formations are anticipated to be primarily Type I waste rock.

Section 4.8.9.3 and Appendix D of the MPA (Foth & Van Dyke, 1995/1998a) contain a detailed description of procedures which will be used to segregate the Type I and Type II waste rock.

4.2.3 Type II Waste Rock: Physical Characteristics

Type II waste rock will be drilled, blasted, and hoisted to the surface. NMC expects that the hoisted rock will vary from approximately 24-inch size to sand-sized particles, with the gradation depending to a large degree on the rock type. As stated earlier, the as-hoisted density of the waste rock is estimated to be approximately 111.1 pounds per cubic foot (Hansen, 1984).

4.2.4 Type II Waste Rock: Chemical Characteristics

Calculations reported in Appendix A2 of the *Groundwater Quality Performance Evaluation* (Foth & Van Dyke, 1999) address the potential of waste rock to alter the overall acid generating potential of the TMA. The calculations conservatively assume that all of the sulfide minerals in the waste rock will generate acid, but only 20 percent of the carbonate materials will consume acid. Even with those very conservative assumptions, the waste rock has little effect on the overall balance of the TMA, which remains clearly net neutral. Appendix A of this report contains additional calculations by SRK demonstrating that if the tailings to Type II waste rock ratio in the TMA is conservatively maintained at a minimum of 2 parts tailings to 1 part waste rock by weight, the neutrality of the TMA will be preserved. Calculations provided in

Section 4.8.9.3 of the MPA (Foth & Van Dyke, 1995/1998a) show that the waste rock will have a similarly insignificant effect on water quality within the TMA.

Type II waste rock which is not used for construction within the TMA cells will be stored temporarily on a composite lined pad located within the TMA 3 footprint. The maximum storage time is estimated to be 6 years. Oxidation of the available sulfides in this waste rock material is expected to be low, as not all sulfide minerals will be exposed. The potential for significant acid generation is very unlikely in that short period, regardless of the carbonate mineralogy or the net neutral balance. Furthermore, the tailings which are co-mingled with the waste rock will overwhelm the potential acid generation characteristics of the waste rock.

4.3 Regional Information [NR 182.08(2)(c)]

Section 5.1 of the Feasibility Report (Foth & Van Dyke, 1995) contains a description of the regional topography, hydrology, geology, hydrogeology, climatology, and biology of the proposed project area.

4.4 Site Specific Information [NR 182.08(2)(d)]

Section 5.2 of the Feasibility Report (Foth & Van Dyke, 1995) contains a description of the geotechnical information collected in conjunction with the siting of the TMA. Sections 5.3 and 5.4 of the Feasibility Report contain groundwater quality validation information and other required site specific environmental information, respectively. In addition, Addendum No. 2 (Foth & Van Dyke, 1996b) contains responses to WDNR completeness comments concerning the geotechnical and groundwater data in the Feasibility Report.

5 Proposed Facility Design [NR 182.08(2)(e)]

5.1 General

The Type II waste rock storage area is designed using the same principles and philosophy as for the TMA cells, and is located in the area which will be occupied by the future TMA cell 3. This section provides the information which is required in Chapter NR 182.08(2)(e), Wis. Admin. Code, "Proposed Facility Design", for the feasibility level design of the Type II waste rock storage area. The design for the various components of the liner and leachate collection system are explained in the information which follows. The major components of the Type II waste rock storage area liner and leachate collection system, from bottom to top, are as follows:

- Prepared subgrade;
- 12 inches of low permeability soil;
- Geosynthetic clay liner (GCL);
- Geomembrane;
- Geocomposite drainage layer;
- 24 inch protective till layer.

The liner and leachate collection system design features are described in more detail in Section 5.9.3 and 5.9.4 of this report.

5.2 Drawings [NR 182.08(2)(e)1 and 2]

The feasibility level design of the Type II waste rock storage area is shown on the set of drawings attached to this report. The drawings include:

- Drawing No. 1, Addendum No. 6 Title Sheet: identifies the drawings revised and added for this Addendum

- Drawing No. 3, Existing Conditions - TMA: identifies the location of the Type II waste rock storage area within the TMA footprint

- Drawing No. 32, Waste Rock Storage Area - Subbase Grades: shows the facility grades prior to construction of any liners

- Drawing No. 33, Waste Rock Storage Area - Base Grades and Leachate Collection System: shows the top of the liner grades and the leachate collection system

- Drawing No. 34, Waste Rock Storage Area - Leachate and Surface Water Management System: presents the leachate transfer piping to the reclaim pond and the surface water management system

- Drawing No. 35, Waste Rock Storage Area - Maximum Waste Rock Grades: shows maximum possible grades of the Type II waste rock

- Drawing No. 36, Waste Rock Storage Area - Engineering Cross Sections: includes one east/west and one north/south section through the Type II Waste rock storage area

- Drawing Nos. 37 and 38, Waste Rock Storage Area - Details: include details of the engineering design features of the storage area

5.3 Earthwork Balance [NR 182.08(2)(e)3]

The Type II waste rock storage area is a temporary facility. NMC is proposing to salvage and reuse the soil materials used in its construction, as follows:

- Subbase grade cut/fill – The subbase of the facility will be prepared by removing the topsoil and excavating only the quantity of soil necessary to construct the exterior berms and grade the base of the facility to design grades (Drawing No. 32). This has been estimated to involve approximately 24,700 in-place cubic yards of cut and 32,600 in-place cubic yards of fill. Required fill material will be obtained from the TMA 1A construction area. The overall soil material balance for the TMA will not be impacted.

- 12 inch low permeability soil (LPS) – The LPS will be prepared in accordance with the TMA design requirements, and will require approximately 10,800 cubic yards for Type II storage area construction. NMC estimates that 100 percent of this material can be salvaged: 60 percent salvaged for reuse as LPS, and the remaining 40 percent used in either the final cover grading layer or rooting zone in TMA cell closure construction.

- 24-inch protective till layer and drainage layer material – The 24-inch protective till layer will cover the geosynthetics of the liner and the leachate collection system. Drainage layer material will be in contact with the protective till and surround the leachate collection piping. These materials will be exposed to the waste rock or leachate, and may be mixed with fines from the waste rock. NMC proposes that 100 percent of these materials (approximately 22,000 cubic yards) will be salvaged for reuse as protective till layer within a TMA cell.

Therefore, the earthwork balance presented in Addendum No. 5 (Foth & Van Dyke, 1998) is not impacted by the construction of the Type II waste rock storage area, since all the on-site soil materials used for the construction can be reused in construction or closure of future TMA cells.

5.4 Leachate Collection System [NR 182.08(2)(e)4]

The leachate collection system (LCS) consists of a geocomposite drain overlain by 24 inches of till as a protective layer. This is the same design as proposed for the sideslopes of the TMA cells, except that the protective till layer in the TMA cells is 18 inches thick. The geocomposite will direct leachate to a collection pipe, which is surrounded by drainage layer material, which in turn will transfer the leachate to an extraction sump for removal. The geocomposite will be as proposed in Addendum No. 3 (Foth & Van Dyke,1997), an HDPE geonet with polypropylene non-woven geotextiles heat bonded to its top and bottom surfaces. Details of this geocomposite are provided in Section 5.3 of Addendum No. 3 (Foth & Van Dyke, 1997). Details of the liner and leachate collection system are provided on Drawing Nos. 37 and 38. Details concerning the LCS design are provided in Section 5.9.4 of this report.

5.5 Operating Procedures, Methods of Development, and Phasing [NR 182.08(2)(e)5]

Waste rock will be inspected and visually classified underground by a qualified geologist. The Type I and Type II waste rock segregated underground will then be handled separately and hoisted to the surface. Waste rock hoisted during the pre-production and production periods will be loaded into trucks by chute from the head frame bins and hauled to the appropriate Type I or Type II storage area. The Type I material will be stored north of the head frame, as detailed in Section 4 of the MPA (Foth & Van Dyke, 1995/1998a).

The Type II waste rock will be hauled via the route described in Section 5.9.1 to the Type II waste rock storage area. Waste filling will begin in the southwest corner of the storage area, utilizing the access road shown on Drawing No. 34. A minimum 3 feet of protective till will be maintained between the road surface and the geocomposite of the liner system, as shown on Detail No. 7/37. The filling will proceed toward the east by dumping the rock in piles. When sufficient waste rock has been dumped in the storage area, a bulldozer will be used to grade the piles in an approximate 4-foot thick lift. The waste rock will be graded and sloped with a high point in the center to maintain drainage toward the outside of the facility. Once the bottom of the storage pad is covered, the next lift will be placed in the same manner. As filling progresses, an access ramp to the top of the pile will be maintained at an approximate 10 percent slope. The average exterior slopes of the pile are expected to be at 1½ to 1 (H to V). Drawing No. 35 shows the maximum grades which the waste rock pile would reach if the waste rock storage area was filled to its maximum capacity of approximately 302,500 cy. The maximum height of the pile (approximately 1750 feet MSL) has been selected so as not to exceed the height of the completed TMA cells.

5.6 Screening and Access Control [NR 182.08(2)(e)5]

Since the Type II waste rock storage facility is temporary (i.e., being in operation for only approximately 6 years), will not have a height exceeding the height of the finished TMA, and is located within the proposed footprint of the TMA, screening of the facility relating to aesthetics, as described in previous documents, will not change. The aesthetics for the TMA are described in Section 4.2.12 of the EIR (Foth & Van Dyke, 1995/1998b), and the impacts of the TMA footprint are described in Section 4.5 of Addendum No. 5 (Foth & Van Dyke, 1998b).

The waste rock storage area is within the existing TMA footprint; therefore, there will be no change in access control from that proposed in the Feasibility Report (Foth & Van Dyke, 1995).

5.7 Surface Water Management [NR 182.02(2)(e)5]

The design of the surface water management system for the TMA was updated in Section 9 of Addendum No. 5 (Foth & Van Dyke, 1995/1998b) to reflect changes in the TMA configuration discussed in Section 4 of Addendum No. 5.

The Type II waste rock storage area will be contained within the 18-acre area designated in Addendum No. 5 as the TMA soil stockpile, processing, and construction staging area.

Surface water runoff and run-on will be controlled by a perimeter diversion ditch which will direct surface water to Runoff Basin 9. The surface water management system is shown on Drawing No. 34. The diversion ditches and culverts will be sized to handle a 100-year, 24-hour rainfall event. The runoff basins presented in Addendum No. 5 (Foth & Van Dyke, 1995/1998b) were designed for the largest drainage area, which occurs following completion of the TMA. The construction of the waste rock storage area will result in a temporary reduction in drainage area because all the surface water from the approximate 6.7-acre lined area will be collected and treated as leachate. Runoff Basin 9 was designed for a total watershed area of 110.8 acres. The watershed area for Runoff Basin 9 following construction of the Type II waste rock storage area will be approximately 94.1 acres. Therefore, Runoff Basin 9 is adequately designed to handle the surface water during the operation of the Type II waste rock storage area. Surface water control practices during construction and operation will be consistent with the procedures outlined in Section 4 of the MPA (Foth & Van Dyke, 1995/1998a) and Section 9 of Addendum No. 5 (Foth & Van Dyke, 1995/1998b).

Section 4.2.7 of the updated EIR (Foth & Van Dyke, 1995/1998c) presented an analysis of the impacts to existing wetlands caused by the proposed mine facilities. Construction and operation of the waste rock storage area will temporarily reduce the drainage area of the Duck Lake watershed by approximately 6.7 acres. The effect that this change has on reported impacts in the EIR will be addressed in forthcoming correspondence to be submitted to the WDNR and USCOE.

5.8 Waste Materials Balance [NR 182.08(2)(e)6]

Table 3-1 shows estimates of the total quantity of waste rock to be hoisted to the surface during the mine life, of approximately 1.588 million tons. Of that total, 896,000 tons is expected to be Type II waste rock. Section 3.3.3 and Table 3-3 of this report contain information on the Type II waste rock production rates, stored volumes, use in the TMA, etc., on an annual basis during its approximate 6-year life. As stated in Section 3.3.3, any Type II waste rock which is not beneficially used within the TMA containment area will be co-mingled with the tailings.

5.9 Type II Storage Area Design [NR 182.08(2)(e)7]

5.9.1 Traffic Routing

The Type II waste rock hoisted from the mine will be transported to the composite lined storage area within the 18-acre TMA construction staging area east of TMA 1B. A temporary road located along the north berm of TMA 1A (Figure 5.9-1) will be used to move waste rock to and from the waste rock storage area during the initial 2-3 years of the pre-production period when TMA 1A is under construction and the waste rock storage area is being filled. Prior to TMA 1A liner placement and the start of TMA 1B construction, traffic will be re-routed to a road along the toe of the south berm of TMA 1A, then east of the TMA 1A area to the waste rock storage area, as shown on Figure 5.9-2. Waste rock will be hauled from the storage area to TMA 1A or 1B using either of the roads. A typical haul road detail is shown on Drawing No. 37, Detail 4/37.

5.9.2 Subbase and Base Grades for the Type II Waste Rock Storage Area

Drawing No. 32 (Subbase Grades) shows the subbase grades for the waste rock storage area with slopes at 2 percent toward the leachate collection system (LCS) pipe and 0.5 percent along the LCS pipe toward the collection sump. Drawing No. 33 (Base Grades) shows grades of the same configuration for the top of the liner (geomembrane). The low point for collecting leachate is located along the west berm where a collection sump is located.

5.9.3 Liner Design

The Type II waste rock storage area in general consists of a composite lined containment area with a leachate collection system, having a design which has the same general components as those of the TMA cell liners. The liner design, from bottom to top, is as follows:

- Prepared Subgrade, which will be constructed as described in Section 6.3.2 of the Feasibility Report (Foth & Van Dyke,1995). This includes proof rolling the subbase grade, removing deleterious soils, and compacting of the subbase grade to a minimum of 95 percent compaction (ASTM D-698).

- Low Permeability Soil (LPS) Layer, 1 foot thick, designed and constructed as proposed in Section 4.3 of Addendum No. 3 (Foth & Van Dyke, 1997).

- Geosynthetic Clay Liner (GCL), designed and constructed as proposed in Section 4.4 of Addendum No. 3 (Foth & Van Dyke, 1997) and Section 5 of Addendum No. 5 (Foth & Van Dyke, 1998b).

- Geomembrane, consisting of a 60 mil HDPE, as proposed in the Feasibility Report (Foth & Van Dyke, 1995). Alternative geomembrane selection, if necessary, would be made using criteria developed in the GMDM (Foth & Van Dyke, 1997/1998a), as presented in Appendix D of Addendum No. 5 (Foth & Van Dyke, 1998b).

- Geocomposite, consisting of an HPPE geonet with a non-woven polypropylene geotextile heat bonded to both sides for the facility base and interior sideslopes, which will be designed and constructed as proposed for the geocomposite on the interior sideslopes of the TMA cells. This geocomposite is described in Section 5 of Addendum No. 3 (Foth & Van Dyke, 1997) and Section 2 of Addendum No. 4 (Foth & Van Dyke, 1998a). Alternative geocomposite selection, if necessary, would be made using criteria developed in the GMDM (Foth & Van Dyke, 1997/1998a).

- A protective till soil cover, which will be constructed, as proposed in Section 6.3.5 of the Feasibility Report (Foth & Van Dyke, 1995), except that the thickness of the protective till layer will be 24 inches rather than the 18 inches proposed for the TMA side wall. The additional thickness is provided for extra protection of the geomembrane, given the coarser size of the waste rock as compared to the tailings.

Typical details of the liner and leachate collection system are provided on Drawing No. 37, Details 1/37 and 2/37, respectively.

5.9.4 Leachate Management System Design

The leachate management system for the Type II waste rock storage area is similar to that proposed for the TMA cells, and consists of the following components:

- Leachate drainage layer consisting of a geocomposite, as described in Section 5.9.3.

- Leachate collection system piping consisting of a 6-inch diameter polyethylene (PE) pipe with a standard dimension ratio (SDR) of 17. The leachate collection system piping is located along the valley formed by the 2 percent slopes of the base, as shown on Drawing No. 33 and Drawing No. 37, Details 2/37 and 5/37. Detail 2/37 shows a section view of the leachate collection pipe and drainage layer material bedding, while Detail 5/37 shows the geometry of the cell bottom around the collection pipe. The leachate collection system piping will drain to the west at a 0.5 percent slope to a leachate collection sump located on the west berm of the containment area. The layout of the leachate collection system is shown on Drawing No. 33. The single leachate collection pipe for the system allows cleaning from both ends. The details for the cleanout are shown on Drawing No. 38, Detail 6/38. An analysis of the compatibility of the components of the leachate management system is provided in Appendix B.

- Leachate removal system designed with similar components as the TMA sideslope risers, described in Section 6.4.6 of the Feasibility Report (Foth & Van Dyke, 1995).

As in the TMA design, the pump is designed for use in adverse environments. The storage area is designed using the100-year, 24-hour rainfall event to determine the required storage capacity. The leachate extraction system is designed for the peak average monthly leachate generation predicted by the HELP model. Design calculations for the leachate extraction system are included in Appendix C. The pump is designed to discharge collected contact water to the reclaim pond or an active TMA cell (TMA 1A or 1B), with pump curve numbers based on the total dynamic head loss, as follows:

- design flow: 27 gpm
- static head: 14 feet
- total dynamic head: 54.0 feet

- The pump proposed is rated at 0 to 74 gpm, with a maximum total head of 60 feet. The pump will be actuated by a submersible liquid level transducer mounted over the submersible pump. The transducer will be programed to provide an automatic pump response and an alarm system, as follows:

- pump on - water level 4.0 feet above the SSR invert (refer to Drawing No. 38, Detail 3/38)
- pump off - water level 1.5 feet above the SSR invert (Detail 3/38); and
- pump alarm - water level greater than 5.0 feet above the SSR invert on the upslope edge of the SSR sump (Detail 3/38).

The leachate will be pumped via a force main to TMA cell 1A or 1B, or to the reclaim pond distribution manhole, as shown on Drawing No. 34. Leachate pumped to the TMA cells will be discharged through spigots directly onto the tailings surface using the same procedures as for tailings placement in the TMA, as described in Section 6.2 of the Feasibility Report (Foth & Van Dyke, 1995). The force main will be double encased, as shown on Drawing No. 38, Detail 4/38.

5.10 Environmental Monitoring Program [NR 182.08(2)(e)8]

The Type II waste rock storage pad is part of the TMA facility operations, and is located within the proposed footprint of TMA 3. Specifically, the temporary storage of Type II waste rock will not alter the horizontal extent of mining waste placement. Accordingly, monitoring of the Type II waste rock storage area, a temporary feature of TMA operations, will be encompassed within the scope of the monitoring plan proposed for the TMA. The Environmental Monitoring Plan is located in the MPA (Foth & Van Dyke, 1995/1998a).

5.11 Water Budget [NR 182.08(2)(f)]

5.11.1 Background

In order to estimate the quantity of percolation through the liner system of the waste rock storage area, HELP model analyses were used. An overview of HELP model and weather data for the site (precipitation, evapotranspiration, temperature, and solar radiation) have been included in Section 6.7.2 of the Feasibility Report (Foth & Van Dyke, 1995). The remaining data for completing the HELP model runs for the Type II waste rock storage area are described below.

5.11.2 Model Layers

The waste rock storage area will essentially consist of waste rock placed over a liner system constructed over native soils. The liner system consists of, from bottom to top:

- Prepared subgrade;
- 12 inches of low permeability soil;
- Geosynthetic clay liner (GCL);
- Geomembrane;
- Geocomposite drainage layer;
- 24 inch protective till layer.

Each component of the liner system has been modeled as separate layers. The waste rock itself has been modeled as a single layer with a thickness equal to the average thickness of the stored waste rock.

5.11.3 Material Properties

The physical properties of each material of the liner system are the same as used for the liner system of the TMA [Addendum No 5 (Foth & Van Dyke, 1998b)]. The properties of the waste rock have been taken as that of gravel per Table 4, User's Guide for Version 3 of HELP Model (HELP Class 21), except for the hydraulic conductivity, which has been increased from the default value of 0.3 cm/sec to 1.0 cm/sec to obtain a conservative value of percolation through the liner. (Higher waste rock permeability will result in higher leachate quantities, and the resulting higher leachate head and percolation through the liner.)

5.11.4 Results

The results of HELP model runs (including the predicted percolation through the Type II waste rock storage area liner) have been discussed in detail in previous submittals to the WDNR (NMC, 1999a). Therefore, only the tabulated results are presented in this section in Table 5-1. The percolation rates for the Type II storage area liner are extremely small, and are between 2 and 4 orders of magnitude less than those predicted for the TMA.

Table 5-1

Percolation from TMA During Operation of Second Stages vs. Percolation From Type II Waste Rock Stockpile

Year	TMA Base[1]	Type II Waste Rock Stockpile[2]
1	0.034353	0.000001
2	0.016261	0.000005
3	0.005851	0.000007
4	0.004205	0.000006
5	0.007981	0.000007
6	0.003110	0.000007
7	0.004669	NA
8	0.004549	NA
9	0.001967	NA
10	0.001725	NA
Average	0.008470	0.000006

Note: HELP model output rounds off to six digits. All values in inches/year.

[1] TMA Help model results from TMA Addendum No. 5 (Foth & Van Dyke, 1998b) based on double precipitation values.

[2] Type II stockpile HELP model results from Appendix C.

NA = Not applicable, since stockpile is no longer used after year 6.

Prepared by: DMR
Checked by: MRS

5.12 Groundwater Modeling [NR 182.08(2)(e)9]

The GWQPE (Foth & Van Dyke, 1999) addresses the compliance of the TMA with NR 140 groundwater quality standards at the design management zone (DMZ). The GWQPE incorporated percolation rates from the TMA and reclaim pond. From a compliance demonstration perspective, the reclaim pond was shown to be controlling due to the higher percolation rates from the reclaim pond relative to the TMA. Table 5-1 shows that the percolation rate from the waste rock storage area, as calculated and described in Section 5.11, will be several orders of magnitude less than the TMA percolation rates. Consequently, the Type II waste rock storage area will be an insignificant source to the aquifer and does not affect the conclusions of the GWQPE (Foth & Van Dyke, 1999).

5.13 Impacts [NR 182.08(2)(g)]

Changes in aesthetics [NR 182.08(2)(g)] as a result of proposed Type II storage area development are insignificant, since the duration of stockpiling is approximately 6 years and the stockpile height will not exceed the height of the finished TMA cells.

Changes in surface water and groundwater impacts resulting from development of the Type II storage area are discussed in Sections 5.7 and 5.12, respectively.

Air quality impacts resulting from the transportation and stockpiling of Type II waste rock will not change the worst case assessment used in the Ambient Air Quality Impacts Analysis, Appendix 4.2-2 of the EIR (Foth & Van Dyke, 1995/1998c). Therefore, activities associated with the Type II storage area development do not change the air impacts associated with the TMA area.

5.14 Other Design Issues [NR 182.08(2)(h)]

The requirements of Chapter NR 182.08(2)(h) dam safety factors, Wis. Admin. Code, do not apply to the temporary waste rock storage area, because the storage area does not use a dam to contain the waste rock. However, the stability of the waste rock piles themselves are discussed in this section. The waste rock consists of fairly well graded rock fragments from a maximum size of approximately 24 inches down to sand sizes, with an expected D_{80} of 8 inches. This material will be cohesionless, and its shear strength will be characterized by a friction parameter. Based on NAVFAC DM7.2 (Table 1, page 7.2-3a), the shear strength is >38°. According to Marachi, et. al (as quoted by Singh and Sharma, 1976), the strength of rock fill with a maximum size of 24 inches and confining pressure(σ_3) of less than 30 psi (at approximately 70+ foot depth of fill) is represented by a friction angle of 45+°. Thus, the shear strength of waste rock materials, as placed in the storage area, may be considered as 40-45°. For a 1.5 (H):1 (V) slope with a friction angle of 40-45°, the factor of safety against slope failure is given by

$$\frac{\tan 40}{0.667} \text{ to } \frac{\tan 45}{0.667} \text{ i.e., } 1.25 \text{ to } 1.5$$

The above range of factor of safety against slope failure is acceptable, and a 1.5 (H) to 1.0 (V) slope for the waste rock is appropriate.

5.15 Contingency Plan [NR 182.08(2)(i)]

NMC has prepared a contingency plan to avoid, minimize, or mitigate human health or environmental damage in the unlikely event of an accidental or emergency discharge from the TMA (including the Type II waste rock storage area). This contingency plan specifies the remedial actions which will be taken in the case of an accidental or emergency discharge, including remedial actions or interventions which will be taken if an analysis of groundwater indicates with a reasonable probability that any applicable standard will not be met. The contingency plan for the risks associated with the TMA is discussed in Section 8 of the MPA

(Foth & Van Dyke, 1995/1998a). Section 8 includes an evaluation of the probability of a release occurring, a description of possible contingency measure which can be implemented, and an assessment of the risk for each hazard.

5.16 Closure and Long-Term Care [NR 182.08(2)(j)] (Liner Decommissioning)

When the waste rock has been completely removed from the Type II storage area, the storage area liner system will be decommissioned and the area reclaimed using the following procedures:

- Removal of remaining waste rock from the protective till surface and placement in the active TMA cell.

- Removal of protective till and re-use as protective till in a TMA cell.

- Collection of geosynthetics samples for forensics testing. Typical examples of forensics testing may include:

  Geocomposite
  - visual observation for damage to geotextile, crushing of geonet, clogging (physical or chemical)
  - transmissivity (ASTM D-4716)
  - compressive strength (ASTM D-1621)

  Geomembrane
  - visual damage
  - tensile properties (ASTM D-638)
  - vapor transmission (ASTM E-96)
  - multiaxial test

  GCL
  - visual damage
  - flux (ASTM D-5887)

- Removal of GCL and geosynthetics. These materials will be cut or ripped into manageable sized pieces and placed in the active TMA cell.

- Removal of low permeability soil and re-use as low permeability soil, grading layer, or rooting zone in future TMA cell construction.

- Regrading of the subbase to provide positive drainage to the perimeter drainage system, which will drain to Runoff Basin 9.

The purpose of the geosynthetics forensic work will be to gain information that could be used to enhance material selection or construction means and methods for future TMA cell construction. A more detailed scope of work for forensic analyses will be provided in the Plan of Operation.

5.17 Alternative Design, Location, and Operational Submittals [NR 182.08(2)(k)]

Section 10 of the Feasibility Report (Foth & Van Dyke, 1995) includes a detailed discussion of project alternatives. Subsequent addenda to the Feasibility Report address specific design alternatives. In Addendum No. 5 (Foth & Van Dyke, 1998b), NMC proposed to remove pyrite from the tailings to reduce the long-term environmental risk of the TMA. As a consequence of the pyrite removal process, the overall size of the TMA cells was reduced, with the reduced size resulting in a reduction in the overall impacts of the TMA. As stated earlier, the proposed Type II waste rock storage area is located within the footprint proposed for TMA 3 and, as a consequence, no significant changes to the impacts identified in Addendum No. 5 (Foth & Van Dyke, 1998b) are anticipated.

Section 4.4 of Addendum No. 5 (Foth & Van Dyke, 1998b) characterized the reduction of impacts resulting from the downsizing of the TMA cells and the relocation of the footprint to minimize potential impacts to wetlands. Some of the significant reductions in potential impacts can be summarized as follows:

- The total disturbance from the TMA footprint has been reduced from 345 acres to 282 acres.
- The total direct wetlands disturbance has been reduced from 22.8 acres to 19.9 acres.
- The setback from wetland F15 (Bur Oak Swamp) and the distance between runoff basin discharge points and the wetlands have been increased.
- TMA surface water management design has been modified by relocating the runoff basins and redirecting surface water flow during certain periods of time to minimize the impacts of the TMA on local drainage basins. Diversion berms were also added to the outboard embankment sideslopes to minimize uninterrupted flow distance (thereby reducing sediment loss), and more efficiently route surface water to the sedimentation basins. In addition, the runoff basin discharge design has been modified to better mimic natural conditions. Refer to Section 9 of Addendum No. 5 (Foth & Van Dyke, 1998b) for details.

NMC believes that an economic analysis of the proposed Type II waste rock storage area, as compared to other locations, is not necessary due to the advantages of locating the facility in an area slated for future development as a waste containment facility. Some of these economic advantages include:

- Cost savings resulting from eliminating the need to clear and grub additional lands.

- Cost savings resulting from reuse of soils used to construct the waste rock storage area in future TMA construction (refer to Section 5.3).

- Cost savings resulting from the elimination of extensive reclamation activities and long-term care costs, since the Type II area will be occupied by TMA 3 in the future.

Locating the Type II waste rock storage area within the TMA footprint results in less disturbance and potential impacts than alternative locations outside of areas proposed for future development. NMC believes that locating the facility within the area proposed for future TMA development results in the least total overall environmental impact.

6 Responses to the Additional Information Requested for the Proposed Crandon Mine Tailings Management Area, Town of Lincoln, Forest County, ID #02977, Dated October 12, 1999

6.1 General

The information which follows contains responses to the additional information requested by the WDNR in their letter dated October 12,1999 (WDNR, 1999a). These responses will follow the same format as previous responses in which the WDNR's comment is listed first, followed by NMC's response.

6.2 WDNR October 12, 1999 Letter: Comments and Responses

Comment 1: In a letter to the COE dated 9/2/99, NMC's response to COE Comment 20 states that, based on the current design, the TMA final cover minimum slope following settlement will be 1.5%. That statement suggests that based on current information about expected material properties and settlement, the final cover is being designed with a final minimum slope of 1.5%. According to s. NR 182.11(1)(m), Wis. Adm. Code, "the final slopes of a completed waste site shall be no less than 2% . . ." In a letter to the COE dated 10/4/99, NMC revised the response to COE Comment 20 indicating that the minimum final cover slope at the time of cover construction will be 2.5% in order to ensure that the final minimum cover slope will be 2%. Please revise the FR to account for the revised final cover slopes indicated in the letter to COE.

Response 1: *After further review of Chapter NR 182.11(1)(m) Wis. Admin. Code, NMC agrees that the final slopes for each TMA cell will be 2 percent or greater after all primary and secondary settlement has occurred. NMC therefore proposes to initially construct the TMA slopes to a minimum of 2.5 percent, anticipating that the final cover will experience approximately 0.4 percent loss in slope following final cover placement. NMC has redesigned the final grades of the TMA cells to reflect this change in slope, as shown in Drawing No. 39. The change in final cover slope does not affect operation of the TMA facility. Following is a description of how this slope will be formed.*

Following final tailings deposition in each TMA cell, the tailings will be allowed to consolidate for approximately one year prior to placement of the grading layer. Consolidation of the tailings under their own weight is expected to be completed during this time frame [Section 4.2.1 of Addendum No. 5 (Foth & Van Dyke, 1998b)]. Consolidation of the tailings under the loads imposed by the grading layer will also be similarly completed during the time period between grading layer and final cover placement. The final cover system will be installed during the construction season following grading layer placement. The only additional settlement expected after final cover placement is that induced by the weight of the 5.5-foot thick final cover system itself.

Revised settlement calculations are included in Appendix D, using the calculation format presented in NMC's May 12, 1998 (NMC, 1998) letter to USCOE as the basis. The calculations *show that the maximum anticipated change in slope as a result of settlements caused by the weight of the cover system will be approximately 0.4 percent. Therefore, to achieve a final slope of 2 percent after all anticipated consolidation, a constructed slope of 2.4 percent would be required.*

As an added conservatism to the project, NMC proposes to construct the TMA final cover slopes (Drawing No. 39) at a minimum of 2.5 percent so that the final slope after all anticipated consolidation will be greater than or equal to 2 percent. The approximate 300,000 cubic yards of material required to attain the steeper slopes of 2.5 percent will be obtained from on-site soil or Type I waste rock. This additional quantity is adequately covered by the contingencies built into the project's soil balance.

Comment 2: The Department has identified a concern with possible short-circuiting in the proposed design of TMA Runoff Basin #14. Please provide additional detail illustrating how the design will avoid short-circuiting or a redesign accounting for the possibility of short-circuiting.

Response 2: *NMC does not necessarily agree that short circuiting will occur in runoff basin No. 14 as currently designed. If short circuiting becomes problematic, a baffle design could be employed to eliminate the potential for short circuiting. NMC will provide greater detail on baffle structure contingencies in the Plan of Operation.*

Comment 3: The Department has identified a concern with runoff from the TMA access road based on the information provided in Detail 1 of Drawing 1 in Attachment 3 to NMC's 6/9/99, response to the completeness determination. Please provide additional detail illustrating how the runoff from the road will be managed.

Response 3: *As shown on Figures 9.1-1 through 9.1-5 of Addendum No. 5 (Foth & Van Dyke, 1998b), diversion berms will be constructed sequentially with TMA cell development along the lower reaches of the perimeter berm of each TMA cell. As a result, the only potential runoff reaching the perimeter access roads will be that from the areas downslope of the perimeter diversion berms and that from the road itself. The outboard slopes of the perimeter access road will be seeded immediately following construction. As vegetation develops on the outboard slopes of the perimeter access road, it will act as a bio-filter to aid in suspended particle removal from potential runoff waters.*

If, upon inspection, direct runoff from the access road to small areas of adjacent wetland is found to have become problematic, silt screens or other sediment controls will be deployed in the affected areas.

Comment 4: The response to the Department's 4/2/99 Comment 2 in NMC's 6/9/99 letter did not completely address the issue. Please provide additional information regarding traffic routing (both construction and otherwise) from the TMA access road to the area making up Cells 2 and 3 and the soil borrow area following the construction of Cell 1.

Response 4: *The traffic routing to TMA 2 and TMA 3 and the soil borrow area after the construction of TMA 1 is described in the narrative which follows, and the various traffic routes are shown on Figures 6.2-1 and 6.2-2. A typical haul road detail is provided on Drawing No. 37, Detail 4/37.*

After the construction of TMA 1A and 1B is completed, the traffic during operation and construction will follow the TMA access road to the TMA 1 access ramp, then proceed around the southern toe of the TMA 1A berm on the perimeter access road to the construction staging, soil processing, and TMA 2 area, as shown on Figure 6.2-1. Upon completion of the construction of TMA 2, the route will be modified, as shown on Figure 6.2-2, from the route described above, in that the route to TMA 3 will follow the perimeter access road east around the south berm of TMA 2 and then proceed north along the east berm of TMA 2 to the TMA 3 construction area. The routes to and from the soil borrow area are also shown on Figure 6.2-2.

Comment 5: Please revise the cover termination design presented in Figure 1 of NMC's 6/9/99 letter to include the following:

a. Termination of the cover geosynthetics in a trench outboard of the termination trench for the liner geosynthetics.
b. A graded soil filter at the exit of the cover drain to prevent washout of the drain layer sand should geotextile filter be used and then degrade over time.

Response 5: *(a) The changes made to the final cover detail in Figure 1, as discussed in Response 15 (NMC, 1999b), provide a full thickness of the final cover soils over the geosynthetics for a distance of approximately 13 feet beyond the limits of tailings placement, prior to tapering out and blending in with the perimeter drainage system. While anchoring the geosynthetics in a trench may provide some cosmetic advantages, from a technical perspective it is not required to resist pull-out forces (NMC, 1999b).*

Several alternatives to the current proposed final cover termination detail are available, including:

- *Cutting a final cover anchor trench in the same alignment as the base liner anchor trench.*
- *Welding the final cover geomembrane to the base liner geomembrane.*
- *Placing a final cover geosynthetics anchor trench outboard of the base liner anchor trench.*

The final selection of the cover termination detail will be included in the pre-construction report for TMA 1 closure, which will be submitted to the WDNR for approval prior to commencing cover system construction.

(b) WDNR has expressed concern that if the geotextile wrap around the cobbles at the final cover drainage layer exit area were to deteriorate, sand from the drainage layer may move into the cobbles and inhibit subsurface drainage from exiting the system.

The cobble outlet as designed will be adjacent to the drainage layer at one end, potentially adjacent to topsoil and rooting layer at the upper surface, and adjacent to geotextile and geomembrane at the lower surface. The biggest concern with these contacts is the potential for the topsoil placed on the upper surface of the cobble outlet to migrate downward before the vegetation takes root. To counter this, a geotextile separation layer between the cobble outlet and the adjacent materials has been provided in the form of a wrap. By the time the geotextile deteriorates, vegetation will have taken root, preventing migration of topsoil into the cobble outlet.

NMC believes that the drainage layer materials and cobbles available will create a natural filter in the event that the geotextile were to deteriorate. NMC proposes to do filter calculations of the cobbles and drainage material when more specific grain size curves are available, and to provide specifications in the Plan of Operation for the two materials such that a natural filter will exist when constructed.

7 References

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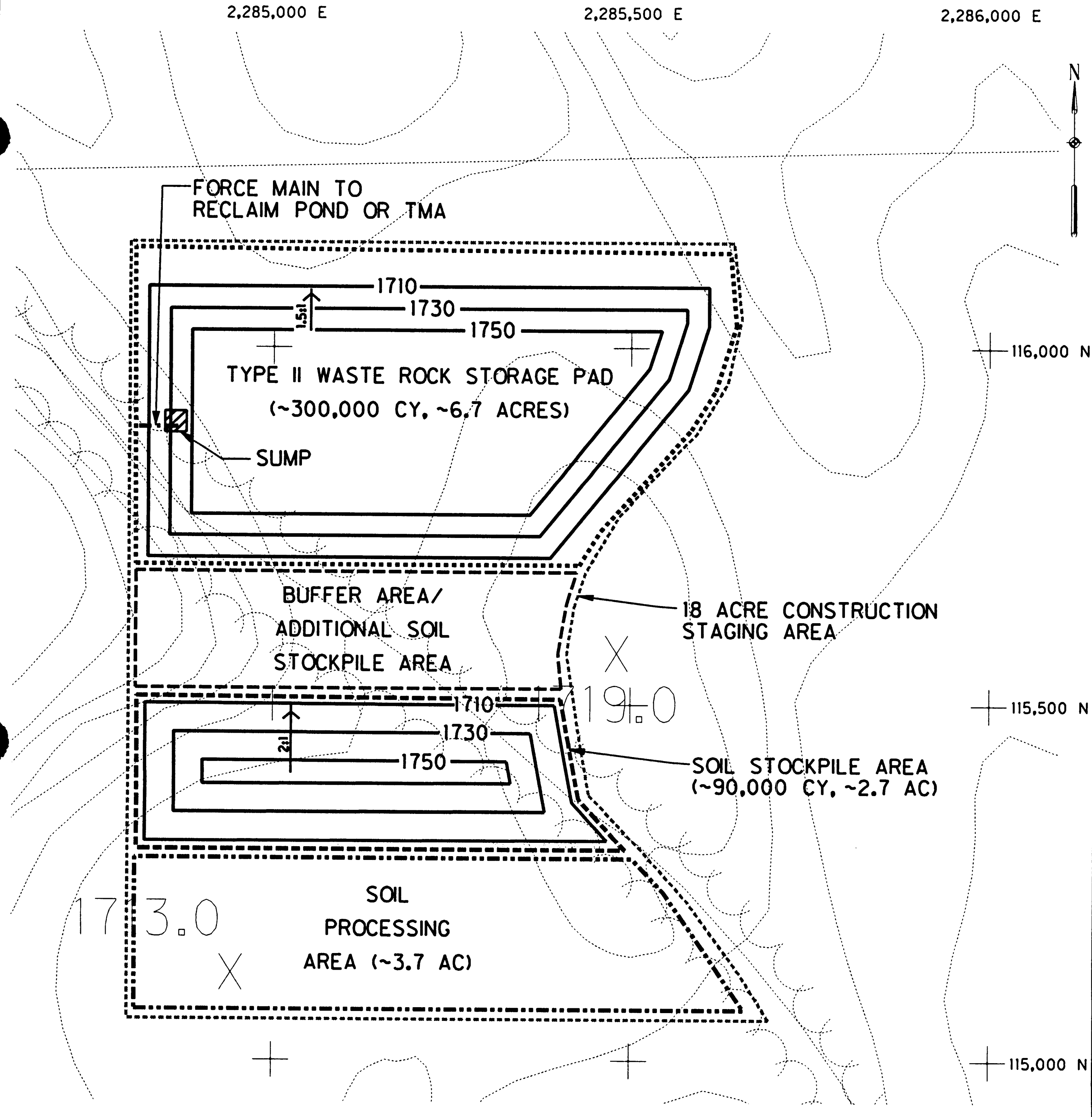
Wisconsin Department of Natural Resources, 1999b. Completeness Determination on the Feasibility Report for the Proposed Crandon Mine Tailings Management Area, Town of Lincoln, Forest County, Reflecting Changes in the Feasibility Report as Submitted in Addendum No. 5. Letter to Gordon Reid, Nicolet Minerals Company, dated April 2, 1999.

FIGURES FOR ADDENDUM NO. 6 TO THE MAY 1995 TAILINGS MANAGEMENT AREA FEASIBILITY REPORT/PLAN OF OPERATION



TYPICAL REPRESENTATION:
REFINEMENTS MAY BE MADE
PRIOR TO CONSTRUCTION

Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

CHECKED BY: DMR	DATE: NOV. '99	
APPROVED BY: NXP	DATE: NOV. '99	
APPROVED BY: GWS	DATE: NOV. '99	

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FIGURE 3.2-1

TYPE II WASTE ROCK
STORAGE AREA LAYOUT

Scale: 0 100' 200'	Date: NOVEMBER, 1999
Prepared By: Foth & Van Dyke	By: MRS	93C049

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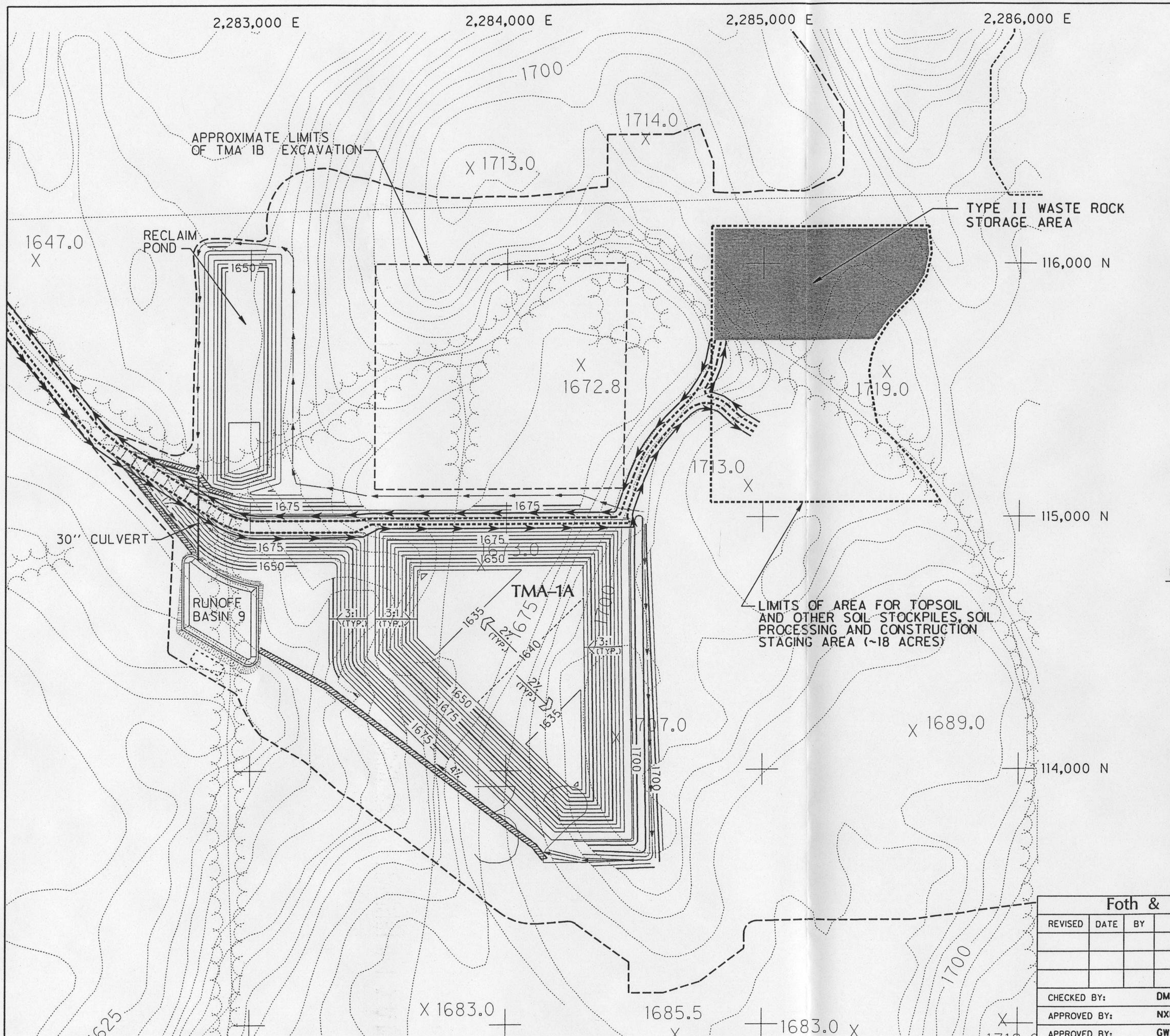

LEGEND

- EXISTING ROAD
- 1675 EXISTING CONTOUR
- x 1726.5 SPOT ELEVATION
- SECTION LINE
- 1700 PROPOSED CONTOUR
- PROPOSED TEMPORARY DRAINAGE FLOW
- 2% PROPOSED DRAINAGE DIVERSION BERM
- 2% PROPOSED SLOPE DIRECTION
- 3:1 PROPOSED SLOPE RATIO
- PROPOSED CULVERT
- TYPE II WASTE ROCK STORAGE AREA
- TRAFFIC FLOW DIRECTION
- HAUL ROAD

N

NOTES:

1. TOPOGRAPHIC BASE MAP DIGITIZED FROM 1"=1000' SCALE, 5' CONTOUR INTERVAL MAP PREPARED BY AERO-METRIC ENGINEERING, INC., SHEBOYGAN, WISCONSIN. DATE OF PHOTOGRAPHY APRIL 28, 1976.
2. HORIZONTAL DATUM BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM - NORTH ZONE.
3. VERTICAL DATUM BASED ON MEAN SEA LEVEL DATUM. CONTOUR INTERVAL IS FIVE FEET.
4. COUNTY AND TOWNSHIP LINES DIGITIZED FROM 7.5' SERIES USGS MAPS.
5. STOCKPILE AREAS SIZE AND LOCATION ARE APPROXIMATE. THE CONTRACTOR MAY VARY LOCATION AND SIZE BASED ON LOGISTICS, CONSTRUCTION EQUIPMENT AVAILABILITY AND OTHER FACTORS.
6. PROPOSED CONTOURS DEPICTED REPRESENT SITE BASE GRADES. (TOP OF 1' LOW PERM SOIL)

TYPICAL REPRESENTATION: REFINEMENTS MAY BE MADE PRIOR TO CONSTRUCTION

Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

CHECKED BY:	DMR	DATE:	NOV. '99
APPROVED BY:	NXP	DATE:	NOV. '99
APPROVED BY:	GWS	DATE:	NOV. '99

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FIGURE 5.9-1

CONSTRUCTION TRAFFIC FLOW FOLLOWING STAGE I CONSTRUCTION

Scale: 0 200' 400' | Date: NOVEMBER, 1999

Prepared By: Foth & Van Dyke | By: JRB | 99C018

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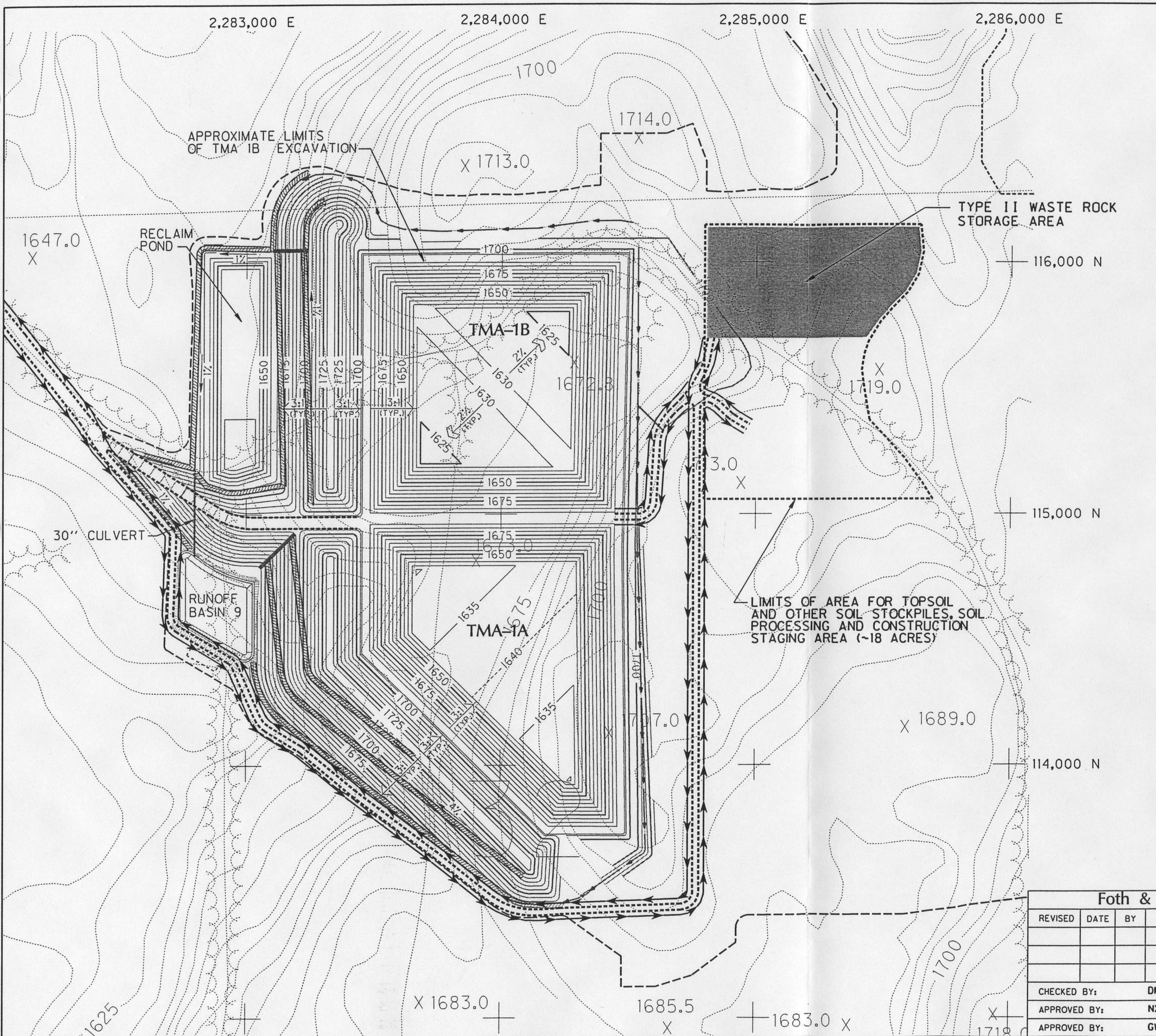

LEGEND

- EXISTING ROAD
- 1675 — EXISTING CONTOUR
- X 1726.5 — SPOT ELEVATION
- SECTION LINE
- 1700 — PROPOSED CONTOUR
- PROPOSED TEMPORARY DRAINAGE FLOW
- 2% — PROPOSED DRAINAGE DIVERSION BERM
- 2% — PROPOSED SLOPE DIRECTION
- 3:1 — PROPOSED SLOPE RATIO
- PROPOSED CULVERT
- TYPE II WASTE ROCK STORAGE AREA
- TRAFFIC FLOW DIRECTION
- HAUL ROAD

N

NOTES:

1. TOPOGRAPHIC BASE MAP DIGITIZED FROM 1''=1000' SCALE, 5' CONTOUR INTERVAL MAP PREPARED BY AERO-METRIC ENGINEERING, INC., SHEBOYGAN, WISCONSIN. DATE OF PHOTOGRAPHY APRIL 28, 1976.
2. HORIZONTAL DATUM BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM - NORTH ZONE.
3. VERTICAL DATUM BASED ON MEAN SEA LEVEL DATUM. CONTOUR INTERVAL IS FIVE FEET.
4. COUNTY AND TOWNSHIP LINES DIGITIZED FROM 7.5' SERIES USGS MAPS.
5. STOCKPILE AREAS SIZE AND LOCATION ARE APPROXIMATE. THE CONTRACTOR MAY VARY LOCATION AND SIZE BASED ON LOGISTICS, CONSTRUCTION EQUIPMENT AVAILABILITY AND OTHER FACTORS.
6. PROPOSED CONTOURS DEPICTED REPRESENT SITE BASE GRADES. (TOP OF 1' LOW PERM SOIL)

TYPICAL REPRESENTATION: REFINEMENTS MAY BE MADE PRIOR TO CONSTRUCTION

Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

CHECKED BY:	DMR	DATE:	NOV. '99
APPROVED BY:	NXP	DATE:	NOV. '99
APPROVED BY:	GWS	DATE:	NOV. '99

Nicolet Minerals COMPANY

Mining for the Future Commitment

FIGURE 5.9-2

CONSTRUCTION TRAFFIC FLOW FOLLOWING STAGE II CONSTRUCTION

Scale: 0 200' 400' | Date: NOVEMBER, 1999

Prepared By: Foth & Van Dyke | By: JRB | 99C018

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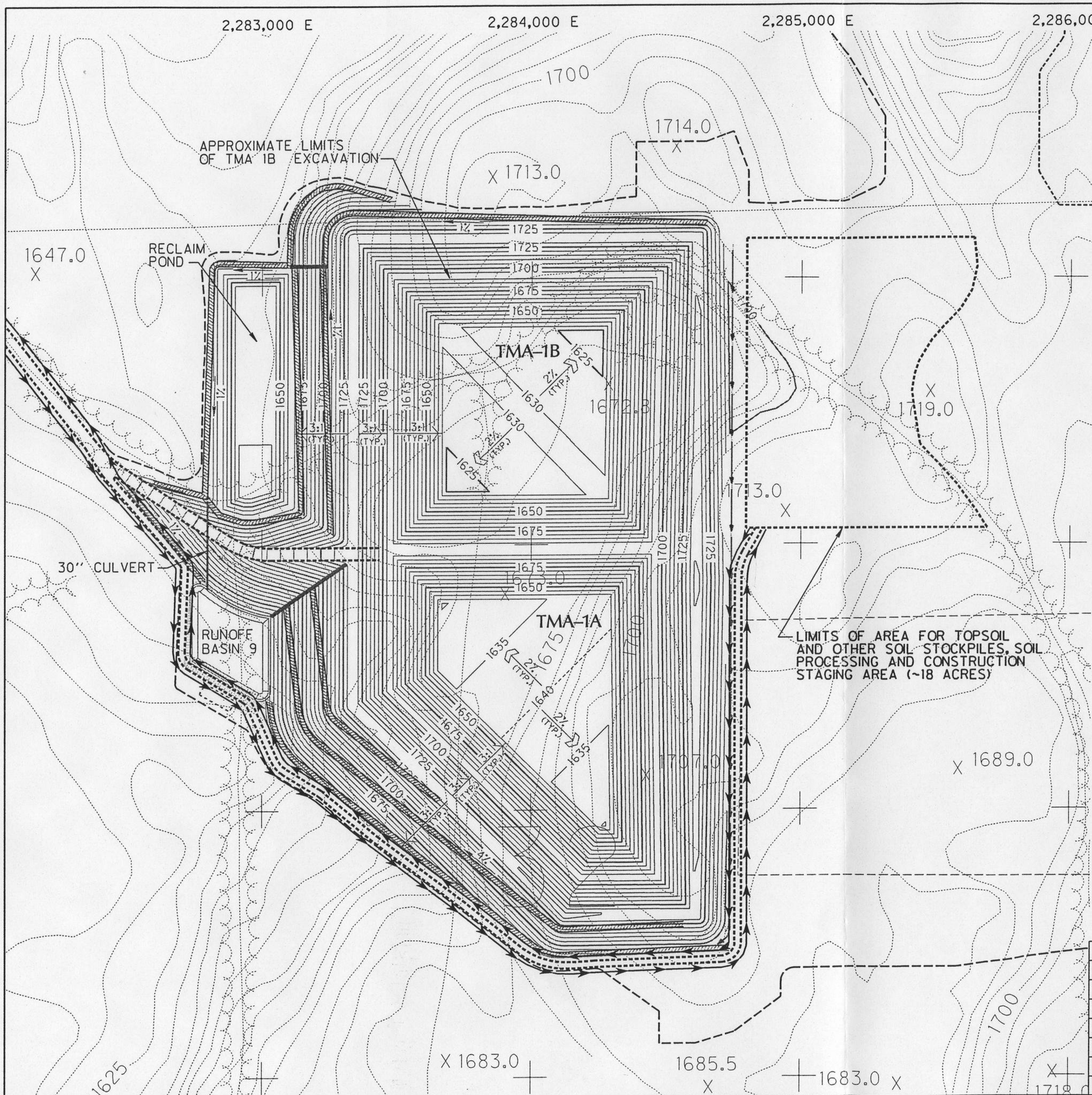

LEGEND

- EXISTING ROAD
- 1675 — EXISTING CONTOUR
- x 1726.5 — SPOT ELEVATION
- SECTION LINE
- 1700 — PROPOSED CONTOUR
- PROPOSED TEMPORARY DRAINAGE FLOW
- 2% — PROPOSED DRAINAGE DIVERSION BERM
- 2% — PROPOSED SLOPE DIRECTION
- 3:1 — PROPOSED SLOPE RATIO
- PROPOSED CULVERT
- TRAFFIC FLOW DIRECTION
- HAUL ROAD

N

NOTES:

1. TOPOGRAPHIC BASE MAP DIGITIZED FROM 1"=1000' SCALE, 5' CONTOUR INTERVAL MAP PREPARED BY AERO-METRIC ENGINEERING, INC., SHEBOYGAN, WISCONSIN. DATE OF PHOTOGRAPHY APRIL 28, 1976.
2. HORIZONTAL DATUM BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM - NORTH ZONE.
3. VERTICAL DATUM BASED ON MEAN SEA LEVEL DATUM. CONTOUR INTERVAL IS FIVE FEET.
4. COUNTY AND TOWNSHIP LINES DIGITIZED FROM 7.5' SERIES USGS MAPS.
5. STOCKPILE AREAS SIZE AND LOCATION ARE APPROXIMATE. THE CONTRACTOR MAY VARY LOCATION AND SIZE BASED ON LOGISTICS, CONSTRUCTION EQUIPMENT AVAILABILITY AND OTHER FACTORS.
6. PROPOSED CONTOURS DEPICTED REPRESENT SITE BASE GRADES. (TOP OF 1' LOW PERM SOIL)

TYPICAL REPRESENTATION: REFINEMENTS MAY BE MADE PRIOR TO CONSTRUCTION

Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

CHECKED BY:	DMR	DATE:	NOV. '99
APPROVED BY:	NXP	DATE:	NOV. '99
APPROVED BY:	GWS	DATE:	NOV. '99

Nicolet Minerals COMPANY

Mining for the Future — Commitment

FIGURE 6.2-1

CONSTRUCTION TRAFFIC FLOW FOLLOWING STAGE III CONSTRUCTION

Scale: 0 200' 400' | Date: NOVEMBER, 1999

Prepared By: Foth & Van Dyke | By: JRB | 99C018

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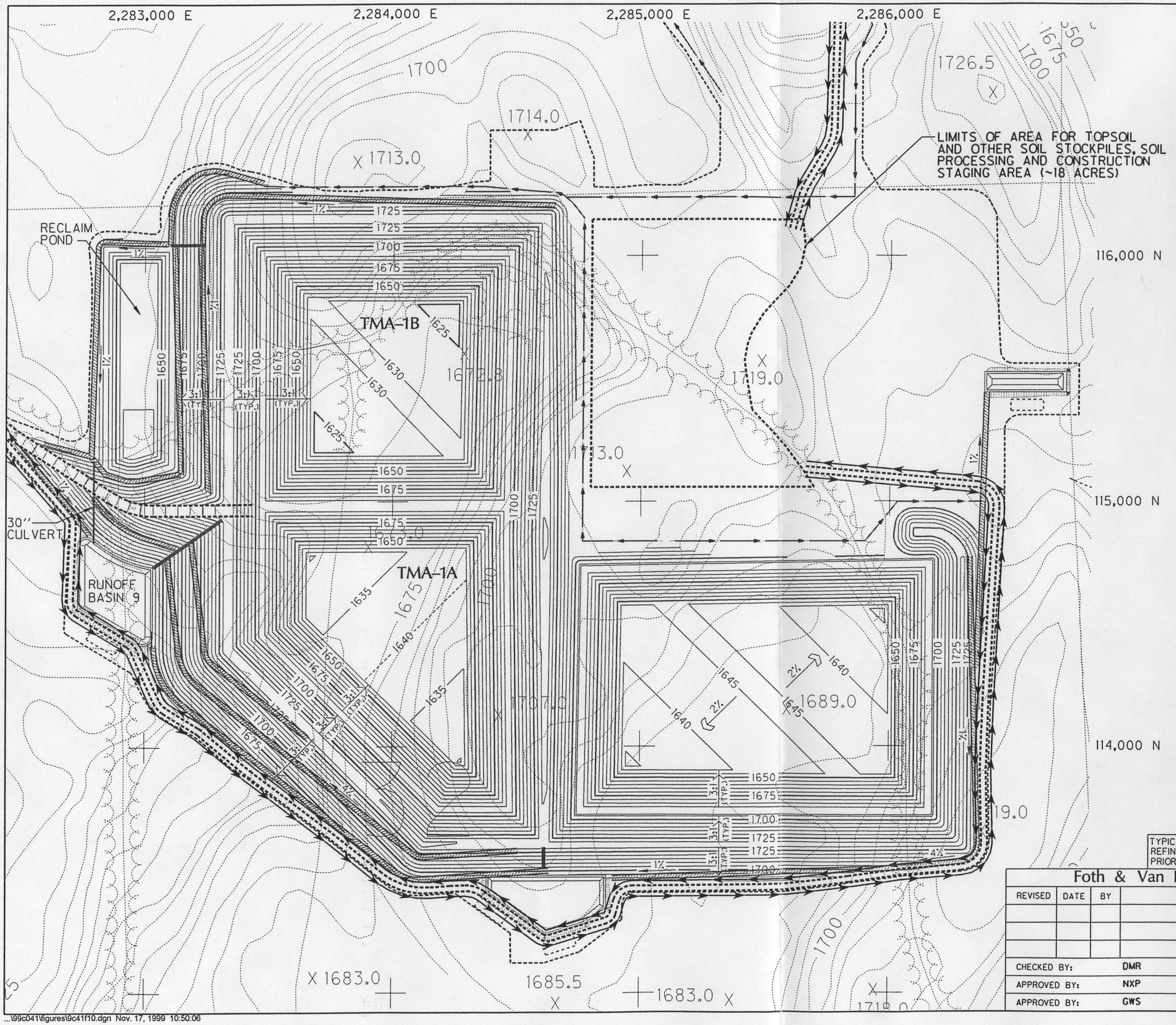


LEGEND

- EXISTING ROAD
- 1675 — EXISTING CONTOUR
- X 1726.5 — SPOT ELEVATION
- SECTION LINE
- 1700 — PROPOSED CONTOUR
- PROPOSED TEMPORARY DRAINAGE FLOW
- 2% — PROPOSED DRAINAGE DIVERSION BERM
- 2% — PROPOSED SLOPE DIRECTION
- 3:1 — PROPOSED SLOPE RATIO
- PROPOSED CULVERT
- TRAFFIC FLOW DIRECTION
- HAUL ROAD

NOTES:

1. TOPOGRAPHIC BASE MAP DIGITIZED FROM 1''=1000' SCALE, 5' CONTOUR INTERVAL MAP PREPARED BY AERO-METRIC ENGINEERING, INC., SHEBOYGAN, WISCONSIN. DATE OF PHOTOGRAPHY APRIL 28, 1976.
2. HORIZONTAL DATUM BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM - NORTH ZONE.
3. VERTICAL DATUM BASED ON MEAN SEA LEVEL DATUM. CONTOUR INTERVAL IS FIVE FEET.
4. COUNTY AND TOWNSHIP LINES DIGITIZED FROM 7.5' SERIES USGS MAPS.
5. STOCKPILE AREAS SIZE AND LOCATION ARE APPROXIMATE. THE CONTRACTOR MAY VARY LOCATION AND SIZE BASED ON LOGISTICS, CONSTRUCTION EQUIPMENT AVAILABILITY AND OTHER FACTORS.
6. PROPOSED CONTOURS DEPICTED REPRESENT SITE BASE GRADES. (TOP OF 1' LOW PERM SOIL)

TYPICAL REPRESENTATION: REFINEMENTS MAY BE MADE PRIOR TO CONSTRUCTION

Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

CHECKED BY:	DMR	DATE:	NOV. '99
APPROVED BY:	NXP	DATE:	NOV. '99
APPROVED BY:	GWS	DATE:	NOV. '99

Nicolet Minerals COMPANY

Mining for the Future — Commitment

FIGURE 6.2-2

CONSTRUCTION TRAFFIC FLOW FOLLOWING STAGE IV CONSTRUCTION

Scale: 0 200' 400' | Date: NOVEMBER, 1999

Prepared By: Foth & Van Dyke | By: JRB | 99C018

...\99c041\figures\9c41f10.dgn Nov. 17, 1999 10:50:06

DRAWINGS FOR ADDENDUM NO. 6 TO THE MAY 1995 TAILINGS MANAGEMENT AREA FEASIBILITY REPORT/PLAN OF OPERATION

Mining for the Future
Commitment

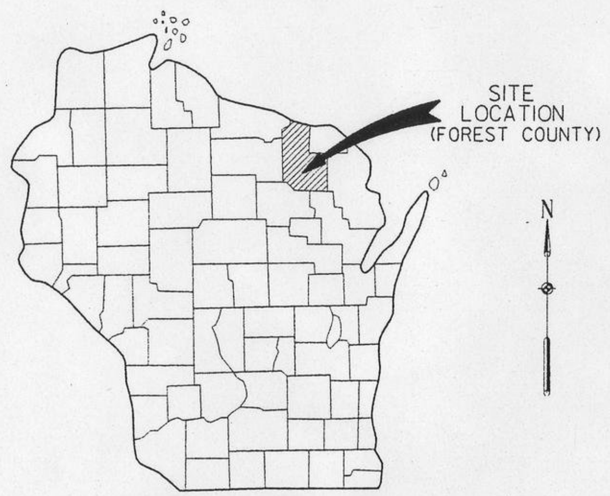
Nicolet Minerals COMPANY

CRANDON PROJECT
ADDENDUM NO. 6 TO THE FEASIBILITY REPORT/PLAN OF OPERATION TAILINGS MANAGEMENT AREA

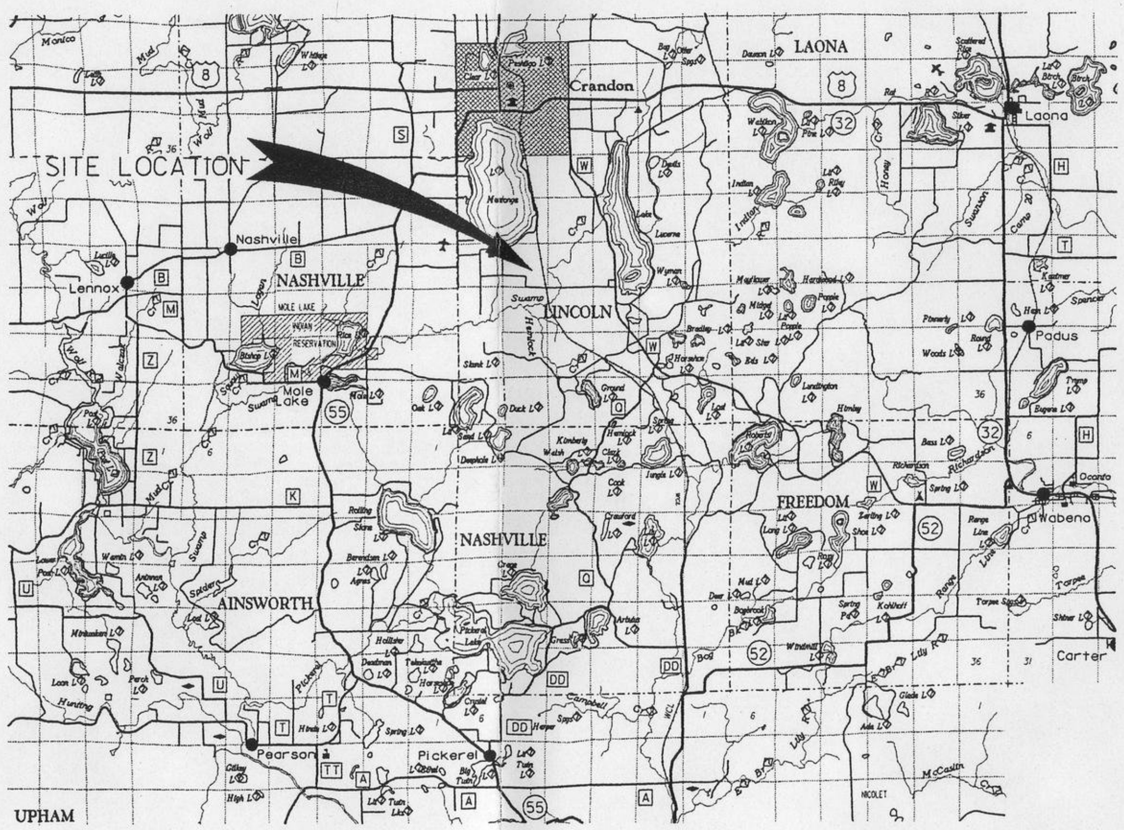
FOREST COUNTY, WISCONSIN

NOVEMBER, 1999

Foth & Van Dyke



COUNTY LOCATION MAP



SITE LOCATION MAP

APPROX. SCALE: 1"=10,000'

* DENOTES REVISED DRAWINGS AND FIGURES FOR ADDENDUM NO. 6 INCLUDED AS PART OF THIS DRAWING SET. DRAWINGS WITHOUT * ARE AS IN THE ORIGINAL FEASIBILITY REPORT/PLAN OF OPERATION OR AS MODIFIED BY SUBSEQUENT ADDENDA TO THAT REPORT.

WISCONSIN PROFESSIONAL ENGINEER
DENIS M. ROZNOWSKI
E-25946
DE PERE, WI
11/23/99

WISCONSIN PROFESSIONAL ENGINEER
Nandakumaran Parvvakat
E-25945
Green Bay,
11-23-99

TYPICAL REPRESENTATION: REFINEMENTS MAY BE MADE PRIOR TO CONSTRUCTION

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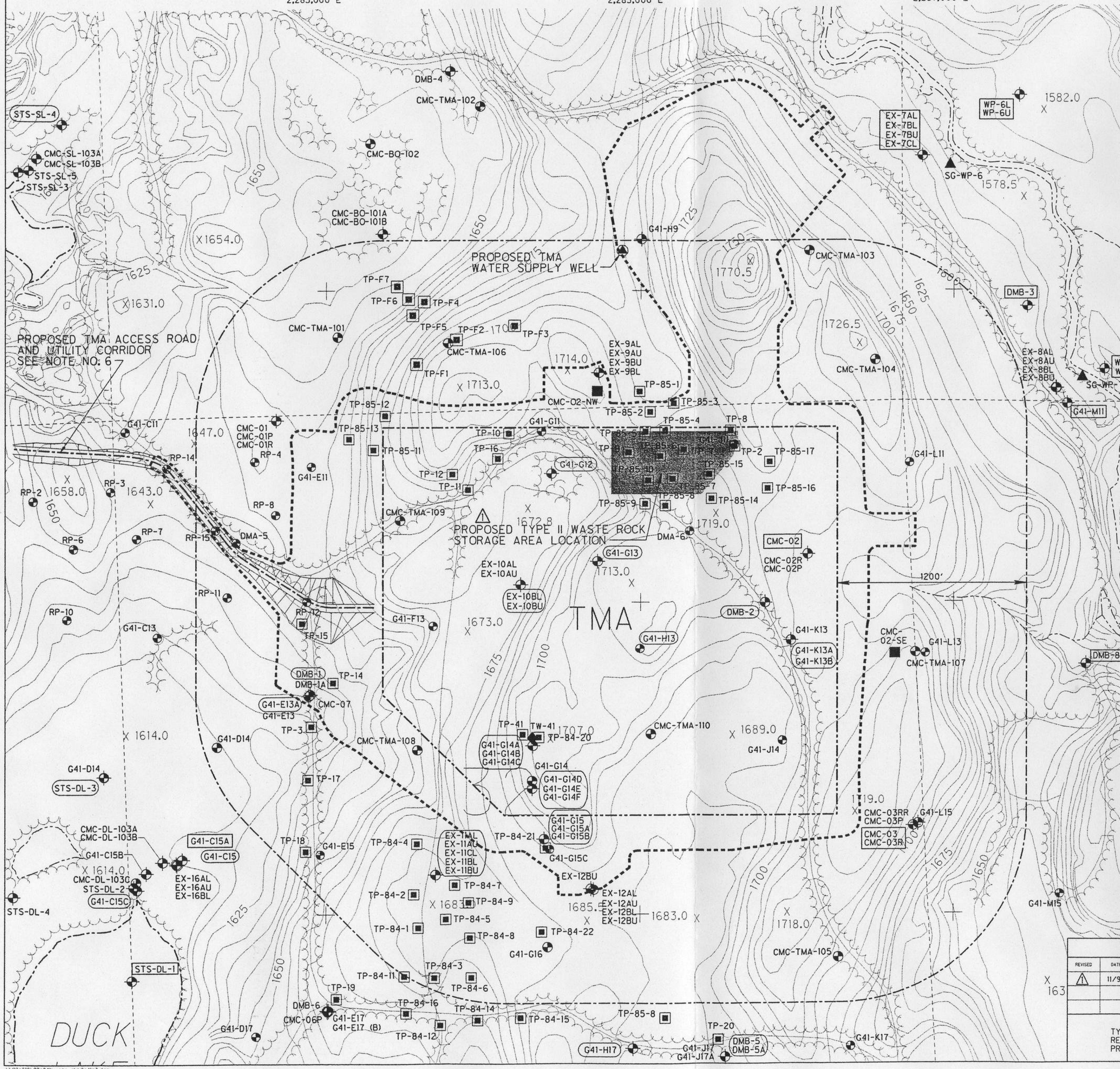

N

LEGEND

- LAKES
- STREAMS
- EXISTING ROAD
- —1675— EXISTING CONTOUR
- 1692.0 X SPOT ELEVATION
- SECTION LINE
- PERIMETER OF MINE WASTE SITE (AS PER NR182)
- DESIGN MANAGEMENT ZONE
- SOIL BORING LOCATION (SEE NOTE 5)
- MONITORING WELL LOCATION (SEE NOTE 5)
- WP-7L ABANDONED WELLS NUMBER AND LOCATION
- DMB-2 TEMPORARILY ABANDONED WELLS NUMBER AND LOCATION
- TEST PIT LOCATION (SEE NOTE 5)
- PROPOSED TMA WATER SUPPLY WELL LOCATION (SEE NOTE 5)
- OXYGEN PROBE LOCATION (SEE NOTE 5)
- STAFF GAUGE LOCATION (SEE NOTE 5)
- TEST WELL (SEE NOTE 5)
- TMA DISTURBANCE BOUNDARY
- TYPE II WASTE ROCK STORAGE AREA LOCATION

NOTES:

1. TOPOGRAPHIC BASE MAP DIGITIZED FROM 1"=1000' SCALE, 5' CONTOUR INTERVAL MAP PREPARED BY AERO-METRIC ENGINEERING, INC., SHEBOYGAN, WISCONSIN. DATE OF PHOTOGRAPHY APRIL 28, 1976.
2. HORIZONTAL DATUM BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM - NORTH ZONE.
3. VERTICAL DATUM BASED ON MEAN SEA LEVEL DATUM. CONTOUR INTERVAL IS FIVE FEET.
4. COUNTY AND TOWNSHIP LINES DIGITIZED FROM 7.5' SERIES USGS MAPS.
5. SOIL BORING, TEST PIT, WATER SUPPLY WELL, OXYGEN PROBE, STAFF GUAGE, TEST WELL AND MONITORING WELL NUMBERS ADJACENT TO SYMBOL.
6. UTILITY CORRIDOR INCLUDES TAILINGS PIPELINE, RECLAIM WATER PIPELINE, AND ELECTRICAL.

0 300' 600'
SCALE

Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION
1	11/99	MRS	ADDED TYPE II WASTE ROCK STORAGE AREA LOCATION

TYPICAL REPRESENTATION: REFINEMENTS MAY BE MADE PRIOR TO CONSTRUCTION

Nicolet Minerals COMPANY

Mining for the Future — Commitment

TITLE: EXISTING CONDITIONS - TMA

SCALE: AS SHOWN	STATE: WISCONSIN	COUNTY: FOREST			
DRAWN BY: JRB2	DATE: 12/98	CHECKED BY: DMR	DATE: 12/98		
APPROVED BY: NXP	DATE: 12/98	APPROVED BY: NXP	DATE: 12/98		
APPROVED BY: GWS	DATE: 12/98	NICOLET MINERALS COMPANY: KPB	DATE: 12/98		
DRAWING NO.: 3	SHEET 3 OF 39	REVISION NO.			

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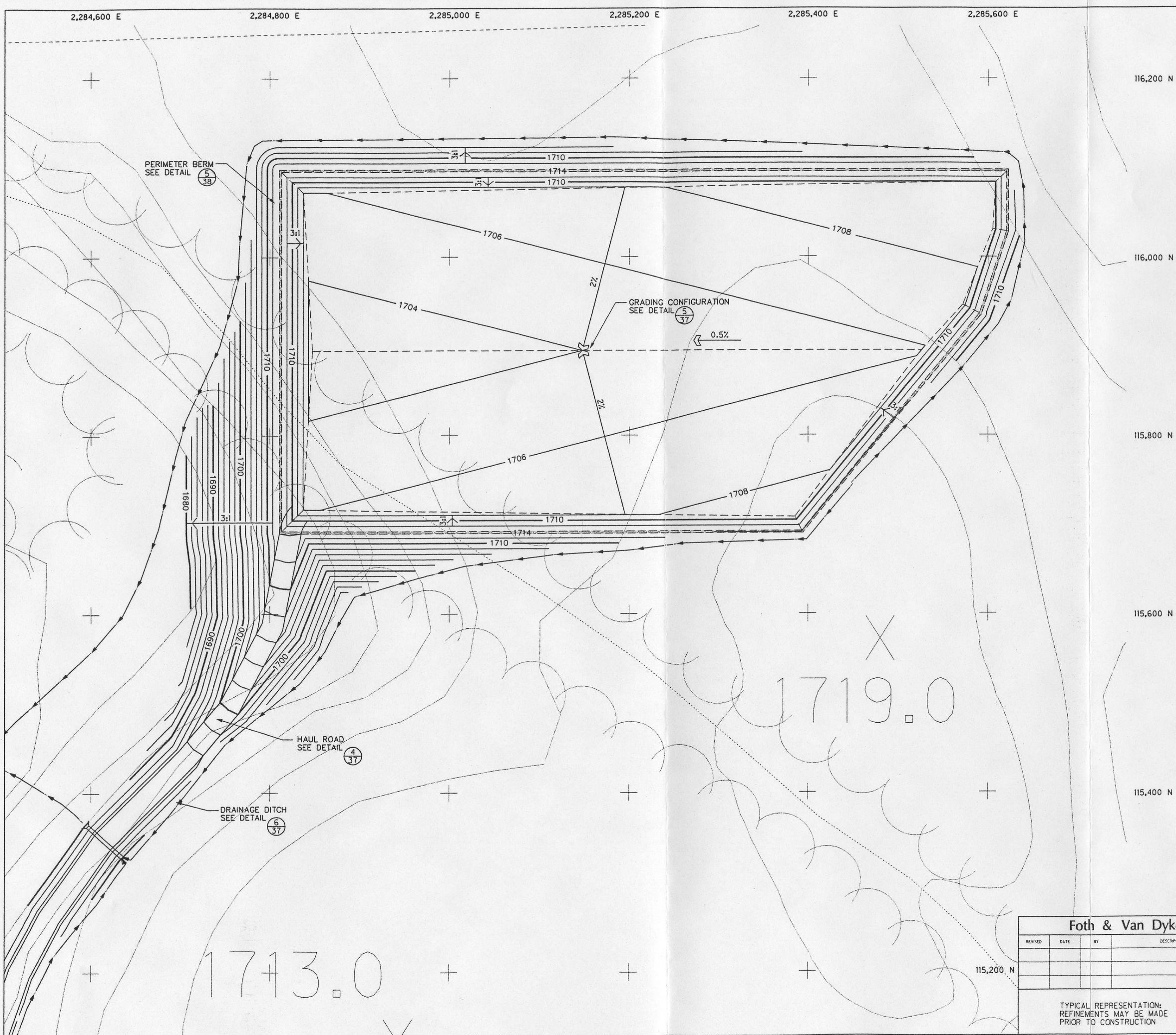

LEGEND

....	EXISTING ROAD
(tree symbol)	EXISTING TREE/BRUSH
--1675--	EXISTING CONTOUR
1692.0 X	SPOT ELEVATION
- - - - - -	SECTION LINE
— — — —	SLOPE INTERCEPT LINE
—1710—	PROPOSED CONTOUR (SUBBASE GRADE)
3:1	PROPOSED SLOPE RATIO (TYP.)
2%	PROPOSED SLOPE (TYP.)
(hatched bar)	TOP OF BERM
←————	PROPOSED DRAINAGE DITCH
(culvert symbol)	PROPOSED CULVERT

CONSTRUCTION QUANTITIES

ITEM / DESCRIPTION	EST. QUANTITY
SITE PREPARATION	
CLEARING AND GRUBBING	10.62 AC
TOPSOIL STRIPPING *	8,600 CY
SITE GRADING (CUT)	24,700 CY
SITE GRADING (FILL)	32,600 CY
ROADS	
WASTE ROCK STORAGE AREA TO TMA 1-A BOUNDARY	812 LF
LANDSCAPING	
TOPSOIL	2,120 CY
SEED, FERTILIZE, MULCH	2.63 AC

* ASSUMES 6" OF TOPSOIL WILL BE STRIPPED.

NOTES:

1. TOPOGRAPHIC BASE MAP DIGITIZED FROM 1"=1000' SCALE, 5' CONTOUR INTERVAL MAP PREPARED BY AERO-METRIC ENGINEERING, INC., SHEBOYGAN, WISCONSIN. DATE OF PHOTOGRAPHY APRIL 28, 1976.
2. HORIZONTAL DATUM BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM - NORTH ZONE.
3. VERTICAL DATUM BASED ON MEAN SEA LEVEL DATUM.
4. COUNTY AND TOWNSHIP LINES DIGITIZED FROM 7.5' SERIES USGS MAPS.
5. THIS DRAWING SHOWS PROPOSED CONTOURS DEPICTING SITE SUBBASE GRADES (BOTTOM OF 1' LOW PERMEABILITY SOIL LAYER). CONTOUR INTERVAL IS 2'.

0 50' 100'
SCALE

Nicolet Minerals COMPANY
Mining for the Future — Commitment

Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

TYPICAL REPRESENTATION: REFINEMENTS MAY BE MADE PRIOR TO CONSTRUCTION

TITLE: WASTE ROCK STORAGE AREA - SUBBASE GRADES

SCALE: AS SHOWN	STATE: WISCONSIN	COUNTY: FOREST	
DRAWN BY: JRB2	DATE: 12/98	CHECKED BY: DMR	DATE: 12/98
APPROVED BY: NXP	DATE: 12/98	APPROVED BY: NXP	DATE: 12/98
APPROVED BY: GWS	DATE: 12/98	NICOLET MINERALS COMPANY: KPB	DATE: 12/98
DRAWING NO.: 32		SHEET 32 OF 39	REVISION NO.

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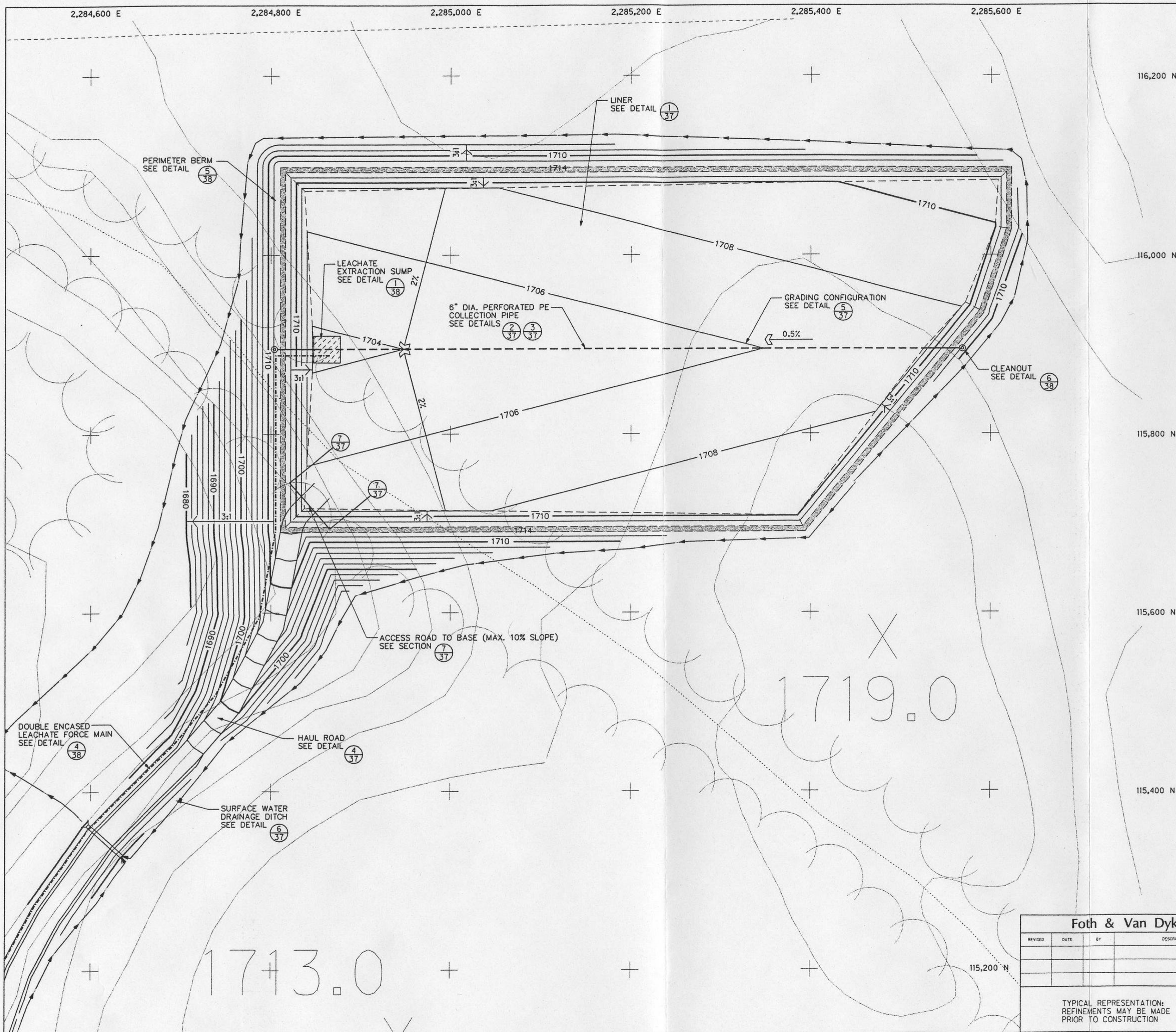

LEGEND

- EXISTING ROAD
- EXISTING TREE/BRUSH
- 1675 — EXISTING CONTOUR
- 1692.0 X — SPOT ELEVATION
- SECTION LINE
- SLOPE INTERCEPT LINE
- 1710 — PROPOSED CONTOUR (BASE GRADE)
- 3:1 — PROPOSED SLOPE RATIO (TYP.)
- 2% — PROPOSED SLOPE (TYP.)
- TOP OF BERM
- PROPOSED DRAINAGE DITCH
- PROPOSED CULVERT
- 6" DIA. PE PERFORATED LEACHATE COLLECTION PIPE
- 6" DIA. PE NON-PERFORATED LEACHATE COLLECTION PIPE
- PROPOSED CLEANOUT
- DOUBLE ENCASED LEACHATE FORCEMAIN

CONSTRUCTION QUANTITIES

ITEM / DESCRIPTION	EST. QNTY.
LINER	
LOW PERMEABLE SOIL LAYER (12")	10,800 CY
GEOSYNTHETIC CLAY LINER	300,600 SF
GEOMEMBRANE	300,600 SF
GEOCOMPOSITE (DRAINAGE LAYER)	300,600 SF
PROTECTIVE TILL LAYER	21,600 CY
LEACHATE MANAGEMENT SYSTEM	
6" LEACHATE COLLECTION PIPE	650 LF
6" CLEANOUT RISER PIPE	81 LF
18" SIDE SLOPE RISER PIPE	61 LF
2" LEACHATE FORCE MAIN (DOUBLE ENCASED)	2,231 LF

NOTES:

1. TOPOGRAPHIC BASE MAP DIGITIZED FROM 1"=1000' SCALE, 5' CONTOUR INTERVAL MAP PREPARED BY AERO-METRIC ENGINEERING, INC., SHEBOYGAN, WISCONSIN. DATE OF PHOTOGRAPHY APRIL 28, 1976.
2. HORIZONTAL DATUM BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM - NORTH ZONE.
3. VERTICAL DATUM BASED ON MEAN SEA LEVEL DATUM.
4. COUNTY AND TOWNSHIP LINES DIGITIZED FROM 7.5' SERIES USGS MAPS.
5. THIS DRAWING SHOWS PROPOSED CONTOURS DEPICTING SITE BASE GRADES (TOP OF 1' LOW PERMEABILITY SOIL LAYER). CONTOUR INTERVAL IS 2'.

0 50' 100'
SCALE

Nicolet Minerals COMPANY

Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

TYPICAL REPRESENTATION: REFINEMENTS MAY BE MADE PRIOR TO CONSTRUCTION

TITLE
WASTE ROCK STORAGE AREA - BASE GRADES AND LEACHATE COLLECTION SYSTEM

SCALE AS SHOWN	STATE: WISCONSIN	COUNTY FOREST	
DRAWN BY JRB2	DATE 12/98	CHECKED BY DMR	DATE 12/98
APPROVED BY NXP	DATE 12/98	APPROVED BY NXP	DATE 12/98
APPROVED BY GWS	DATE 12/98	NICOLET MINERALS COMPANY KPB	DATE 12/98
DRAWING NO. 33		SHEET 33 OF 39	REVISION NO.

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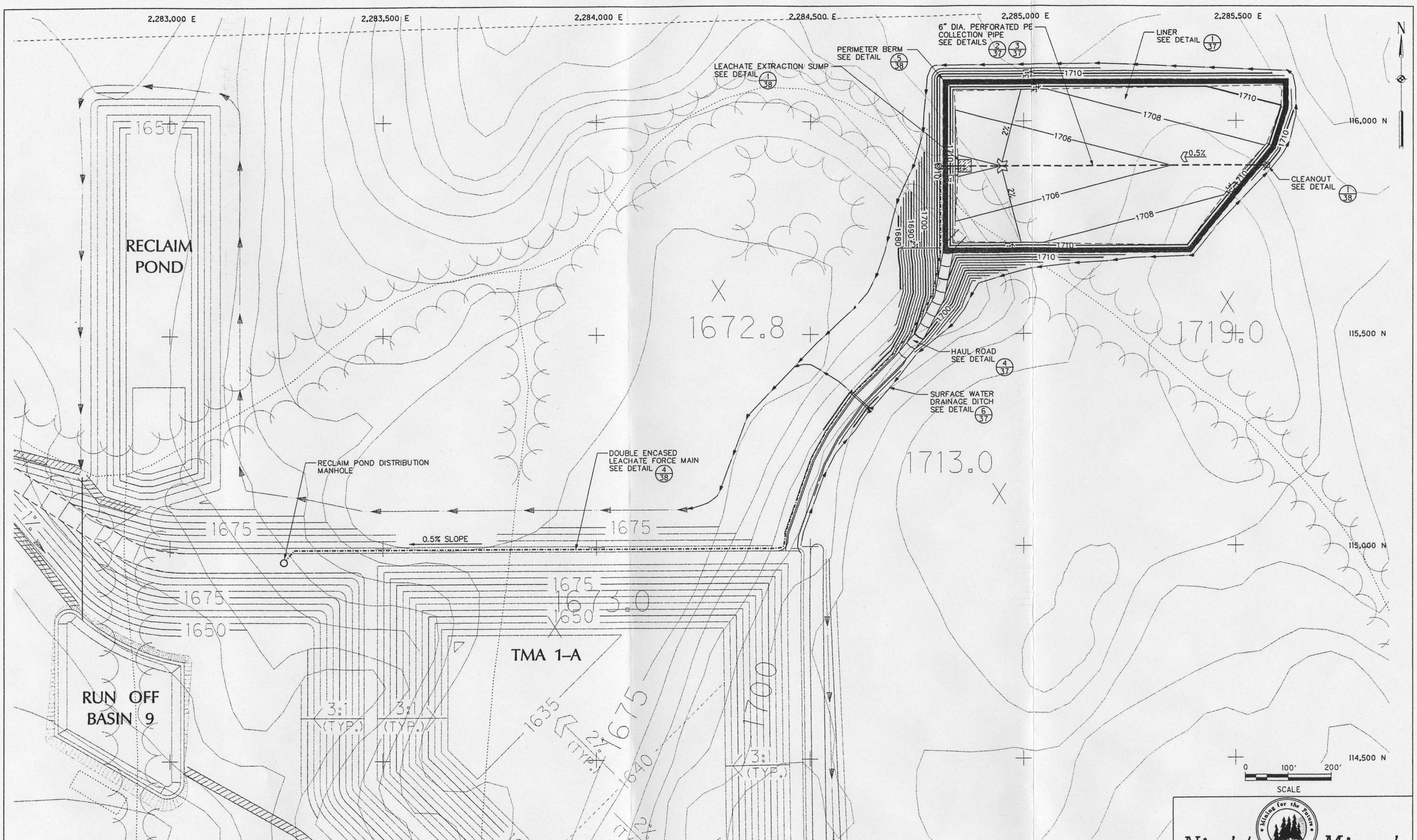

LEGEND

....	EXISTING ROAD
(tree symbol)	EXISTING TREE/BRUSH
—1675—	EXISTING CONTOUR
1692.0 X	SPOT ELEVATION
- - - - - -	SECTION LINE
— — — —	SLOPE INTERCEPT LINE
—1710—	PROPOSED CONTOUR (BASE GRADE)
3:1	PROPOSED SLOPE RATIO (TYP.)
2%	PROPOSED SLOPE (TYP.)
←——	PROPOSED DRAINAGE DITCH
(culvert symbol)	PROPOSED CULVERT
(heavy line)	TOP OF BERM
-·-·-·-	PROPOSED FORCE MAIN
◎	PROPOSED CLEANOUT
— — — —	PROPOSED 6" DIA. PERFORATED PE LEACHATE COLLECTION PIPE
————	PROPOSED 6" DIA. NONPERFORATED PE LEACHATE COLLECTION PIPE

NOTES:

1. TOPOGRAPHIC BASE MAP DIGITIZED FROM 1"=1000' SCALE, 5' CONTOUR INTERVAL MAP PREPARED BY AERO-METRIC ENGINEERING, INC., SHEBOYGAN, WISCONSIN. DATE OF PHOTOGRAPHY APRIL 28, 1976.
2. HORIZONTAL DATUM BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM - NORTH ZONE.
3. VERTICAL DATUM BASED ON MEAN SEA LEVEL DATUM.
4. COUNTY AND TOWNSHIP LINES DIGITIZED FROM 7.5' SERIES USGS MAPS.

Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

TYPICAL REPRESENTATION: REFINEMENTS MAY BE MADE PRIOR TO CONSTRUCTION

Nicolet Minerals COMPANY

TITLE
WASTE ROCK STORAGE AREA - LEACHATE AND SURFACE WATER MANAGEMENT SYSTEM

SCALE AS SHOWN	STATE WISCONSIN		COUNTY FOREST		
DRAWN BY JRB2	DATE 12/98	CHECKED BY DMR		DATE 12/98	
APPROVED BY NXP	DATE 12/98	APPROVED BY NXP		DATE 12/98	
APPROVED BY GWS	DATE 12/98	NICOLET MINERALS COMPANY KPB		DATE 12/98	
DRAWING NO. 34		SHEET 34 OF 39		REVISION NO.	

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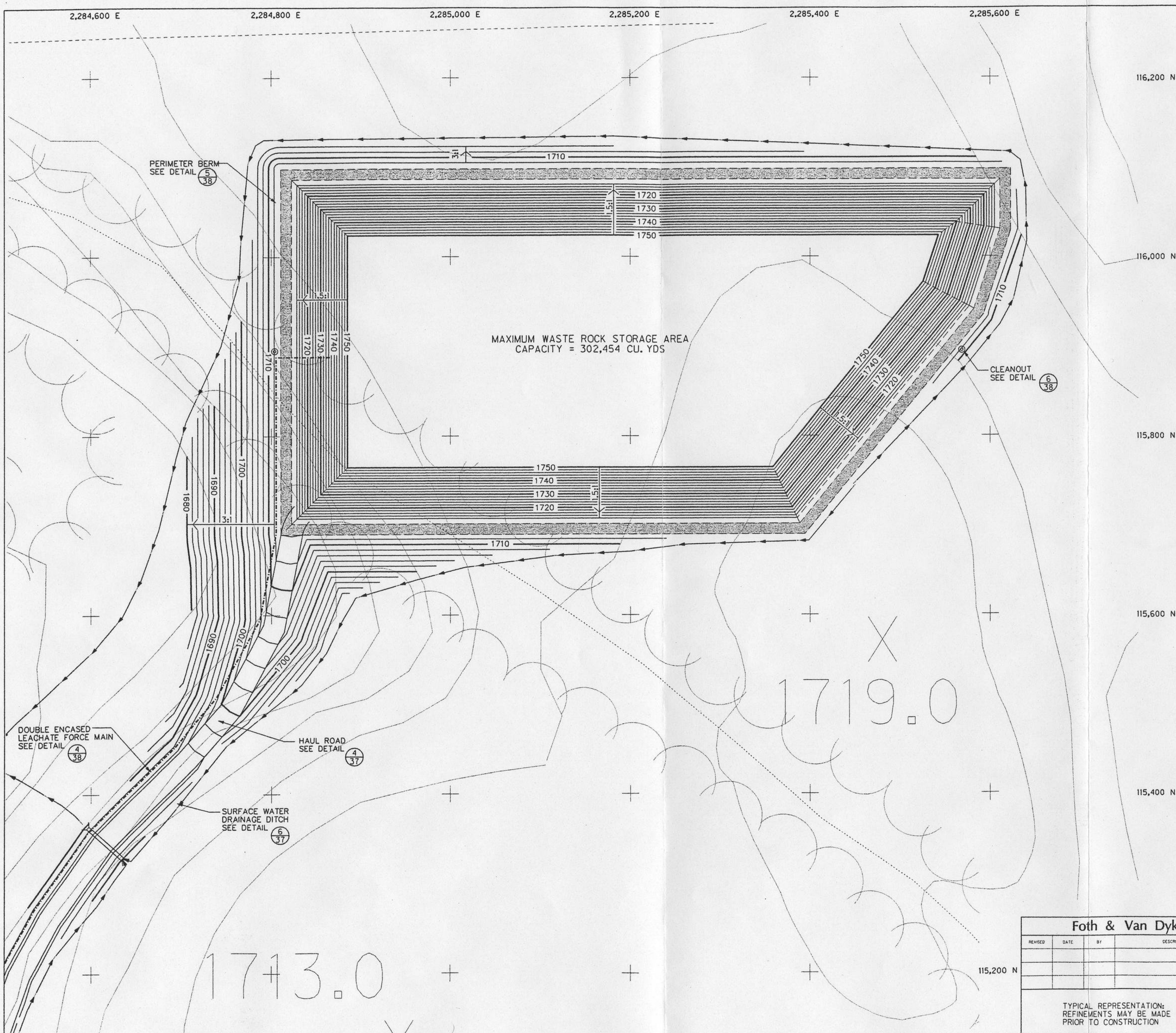

LEGEND

- EXISTING ROAD
- EXISTING TREE/BRUSH
- 1675 — EXISTING CONTOUR
- 1692.0 X — SPOT ELEVATION
- SECTION LINE
- SLOPE INTERCEPT LINE
- 1710 — PROPOSED CONTOUR (MAXIMUM GRADE)
- 3:1 — PROPOSED SLOPE RATIO (TYP.)
- 2% — PROPOSED SLOPE (TYP.)
- TOP OF BERM
- PROPOSED DRAINAGE DITCH
- PROPOSED CULVERT
- PROPOSED CLEANOUT

NOTES:

1. TOPOGRAPHIC BASE MAP DIGITIZED FROM 1"=1000' SCALE. 5' CONTOUR INTERVAL MAP PREPARED BY AERO-METRIC ENGINEERING, INC., SHEBOYGAN, WISCONSIN. DATE OF PHOTOGRAPHY APRIL 28, 1976.
2. HORIZONTAL DATUM BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM - NORTH ZONE.
3. VERTICAL DATUM BASED ON MEAN SEA LEVEL DATUM.
4. COUNTY AND TOWNSHIP LINES DIGITIZED FROM 7.5' SERIES USGS MAPS.
5. THIS DRAWING SHOWS PROPOSED CONTOURS DEPICTING THE MAXIMUM TOP OF WASTE ROCK GRADES. CONTOUR INTERVAL IS 2'.

SCALE: 0 50' 100'

Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

TYPICAL REPRESENTATION: REFINEMENTS MAY BE MADE PRIOR TO CONSTRUCTION

Nicolet Minerals COMPANY

TITLE: WASTE ROCK STORAGE AREA - MAXIMUM WASTE ROCK GRADES

SCALE AS SHOWN	STATE WISCONSIN	COUNTY FOREST	
DRAWN BY JRB2	DATE 12/98	CHECKED BY DMR	DATE 12/98
APPROVED BY NXP	DATE 12/98	APPROVED BY NXP	DATE 12/98
APPROVED BY GWS	DATE 12/98	NICOLET MINERALS COMPANY KPB	DATE 12/98
DRAWING NO. 35	SHEET 35 OF 39	REVISION NO.	

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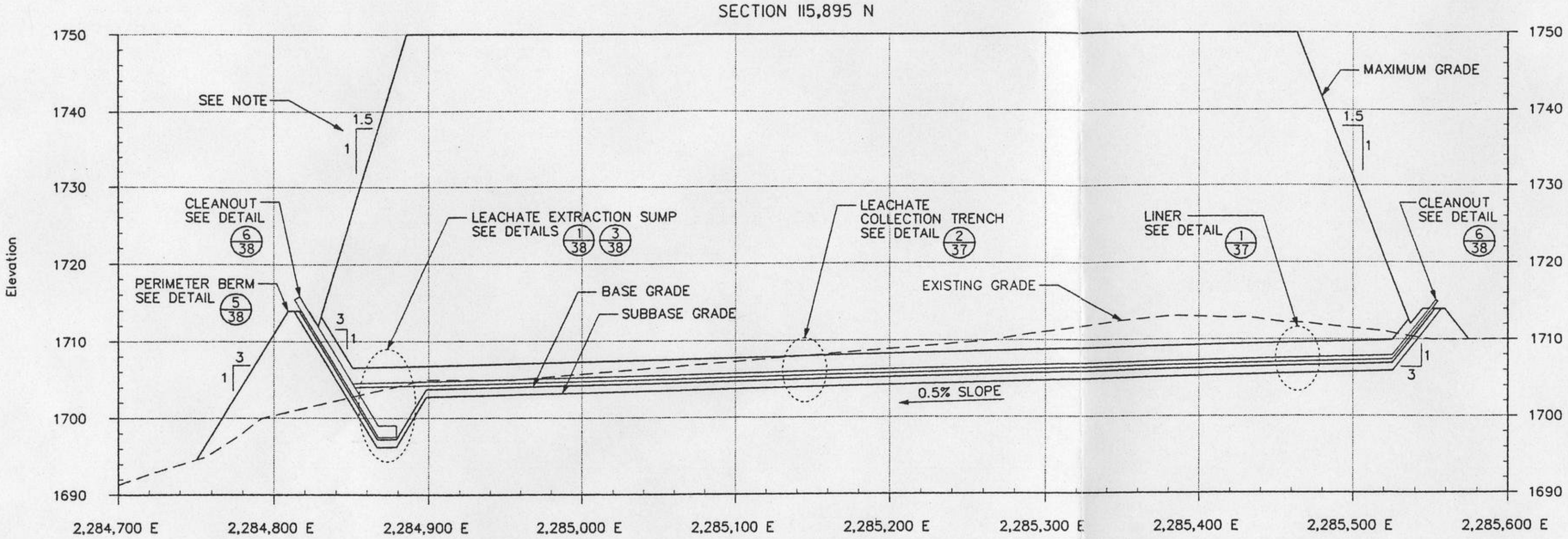
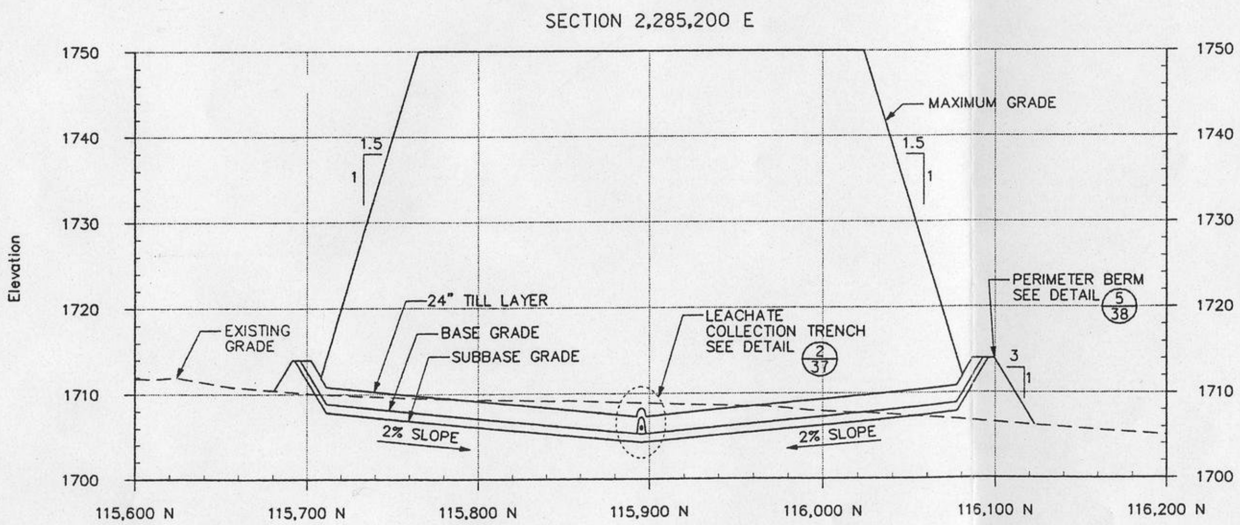
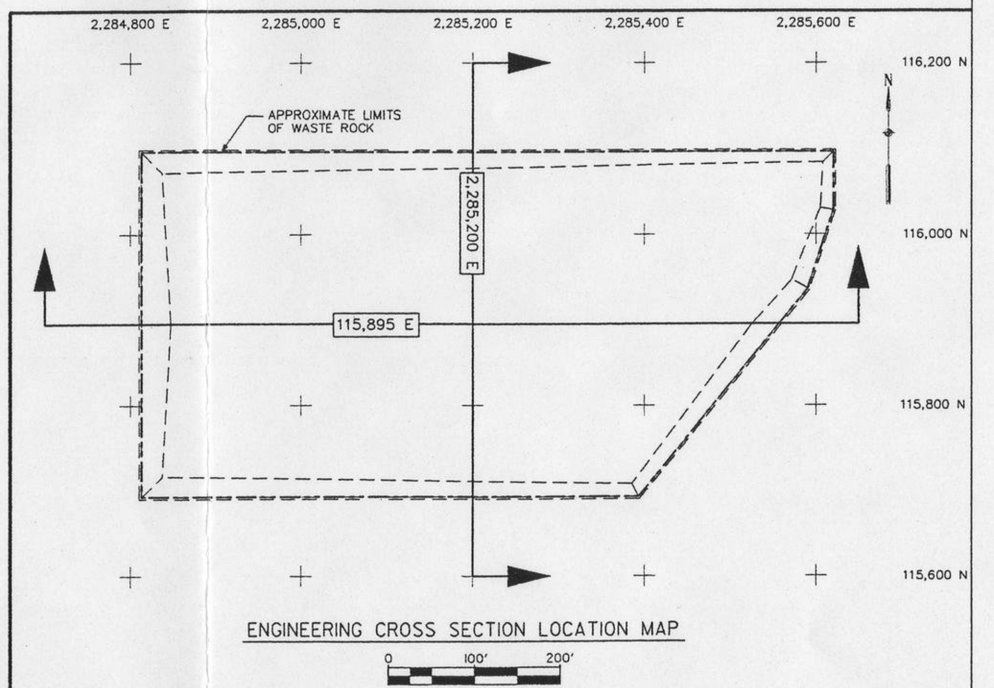
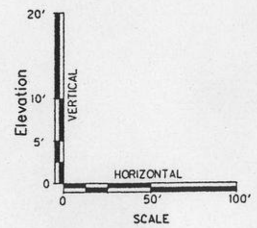


NOTE:
THE ACTUAL SLOPE WILL LIKELY CONSIST OF TWO SLOPES AT THE ANGLE OF REPOSE OF THE WASTE ROCK WITH A BENCH IN BETWEEN. THE EXTERIOR SLOPE OF THE WASTE ROCK (1.5 TO 1) IS AN AVERAGE.





ENGINEERING CROSS SECTION LOCATION MAP



Nicolet Minerals COMPANY

Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

TYPICAL REPRESENTATION:
REFINEMENTS MAY BE MADE
PRIOR TO CONSTRUCTION

TITLE
WASTE ROCK STORAGE AREA -
ENGINEERING CROSS SECTIONS

SCALE AS SHOWN	STATE: WISCONSIN		COUNTY FOREST		
DRAWN BY JRB2	DATE 12/98	CHECKED BY DMR		DATE 12/98	
APPROVED BY NXP	DATE 12/98	APPROVED BY NXP		DATE 12/98	
APPROVED BY GWS	DATE 12/98	NICOLET MINERALS COMPANY KPB		DATE 12/98	
DRAWING NO. 36			SHEET 36 OF 39	REVISION NO.	

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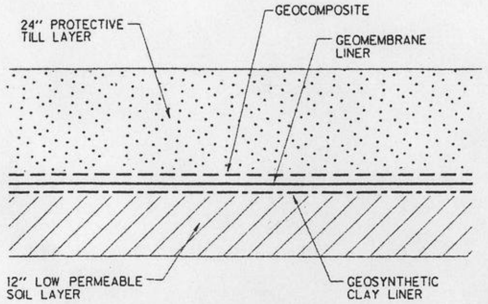
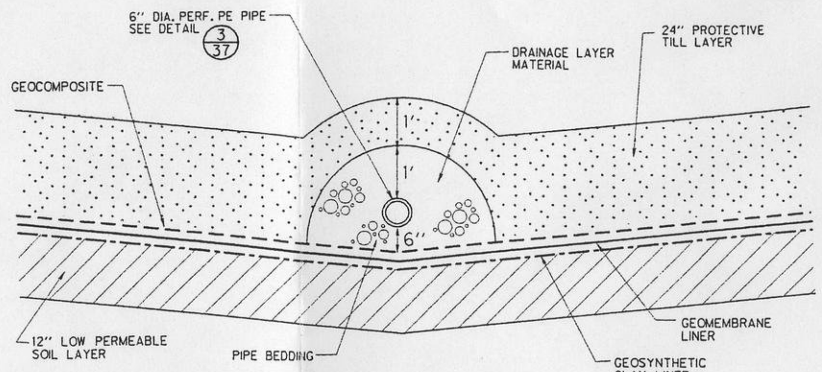


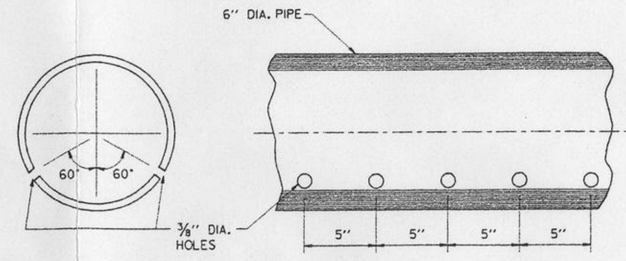
1/37 TYPICAL LINER DETAIL

NOT TO SCALE



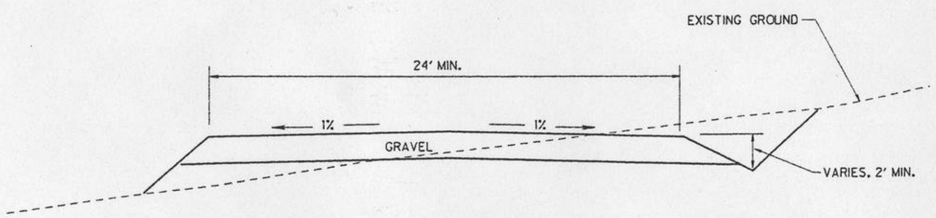
2/37 TYPICAL LEACHATE COLLECTION PIPE DETAIL

NOT TO SCALE



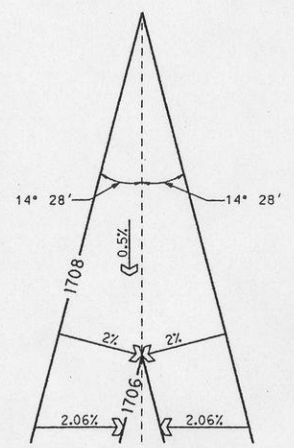
3/37 LEACHATE COLLECTION PIPE PERFORATION DETAIL

NOT TO SCALE



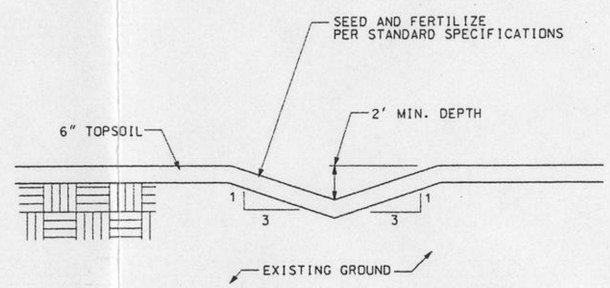
4/37 TYPICAL HAUL ROAD DETAIL

NOT TO SCALE



5/37 TYPICAL GRADING CONFIGURATION DETAIL

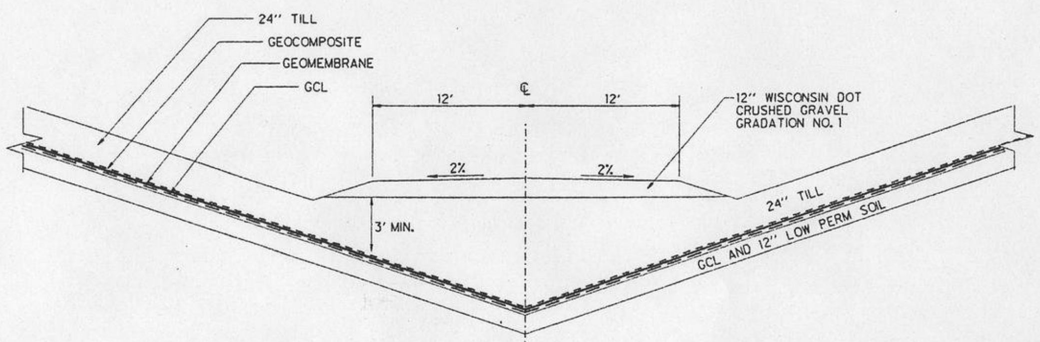
NOT TO SCALE



6/37 TYPICAL PERIMETER DRAINAGE DITCH DETAIL

NOT TO SCALE

NOTE: SEE DRAWING NO. 33 FOR SECTION LOCATION



7/37 SECTION THROUGH ACCESS ROAD TO BASE OF STORAGE AREA

NOT TO SCALE

Nicolet Minerals COMPANY

Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

TYPICAL REPRESENTATION: REFINEMENTS MAY BE MADE PRIOR TO CONSTRUCTION

TITLE: WASTE ROCK STORAGE AREA - DETAILS

SCALE: AS SHOWN	STATE: WISCONSIN		COUNTY: FOREST		
DRAWN BY: JRB2	DATE: 12/98	CHECKED BY: DMR		DATE: 12/98	
APPROVED BY: NXP	DATE: 12/98	APPROVED BY: NXP		DATE: 12/98	
APPROVED BY: GWS	DATE: 12/98	NICOLET MINERALS COMPANY: KPB		DATE: 12/98	
DRAWING NO.: 37			SHEET 37 OF 39	REVISION NO. 1	

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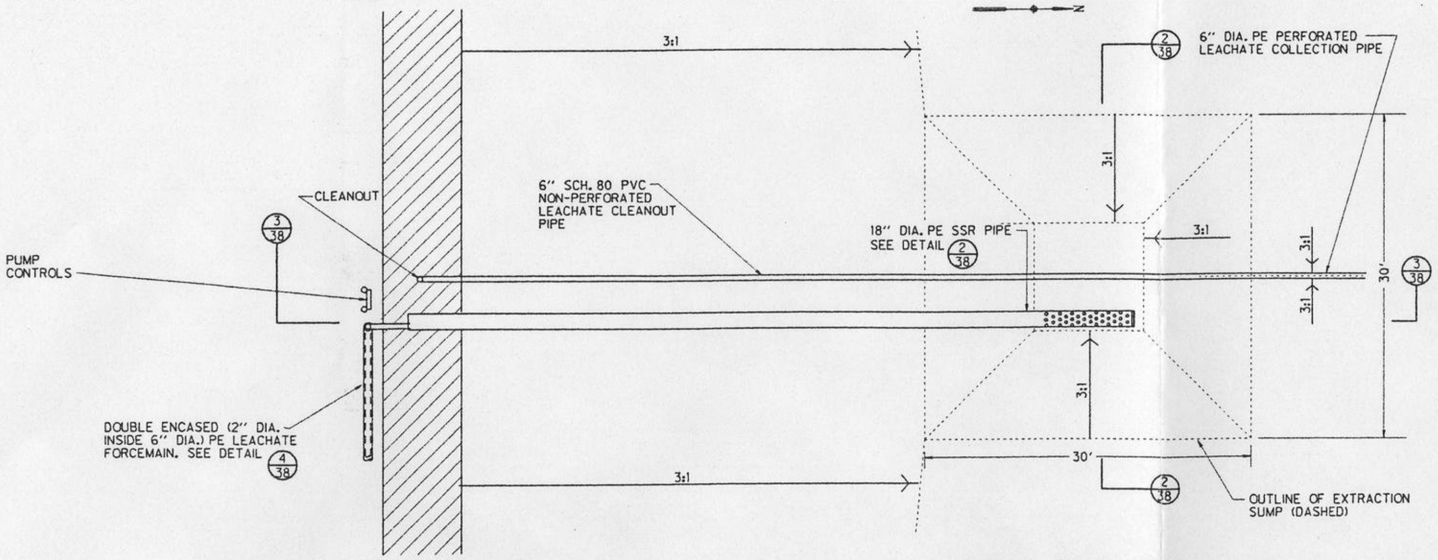
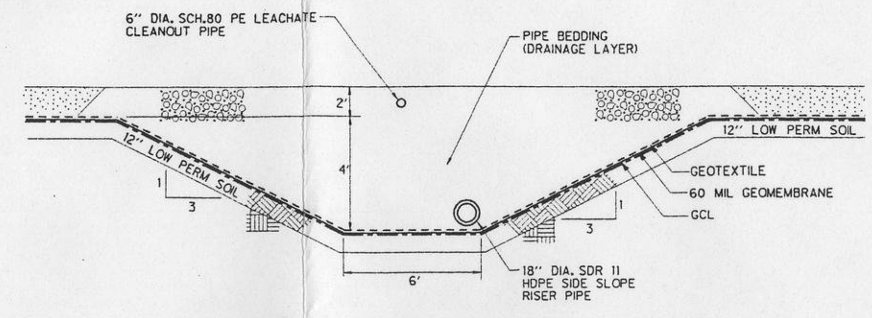
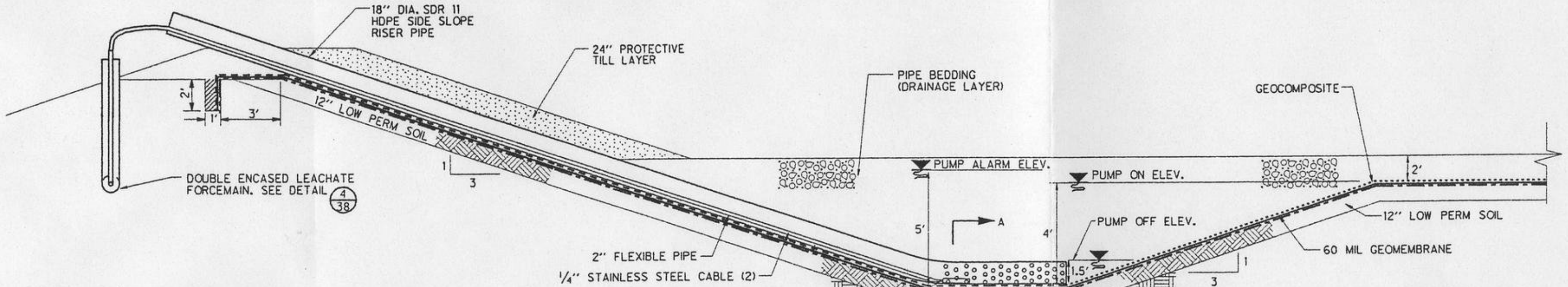


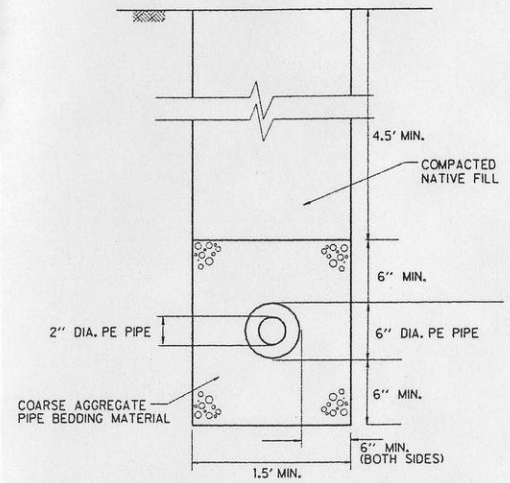
1/38 TYPICAL PLAN VIEW LEACHATE EXTRACTION SUMP
NOT TO SCALE



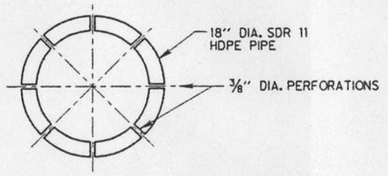
2/38 SECTION THRU LEACHATE EXTRACTION SUMP
NOT TO SCALE



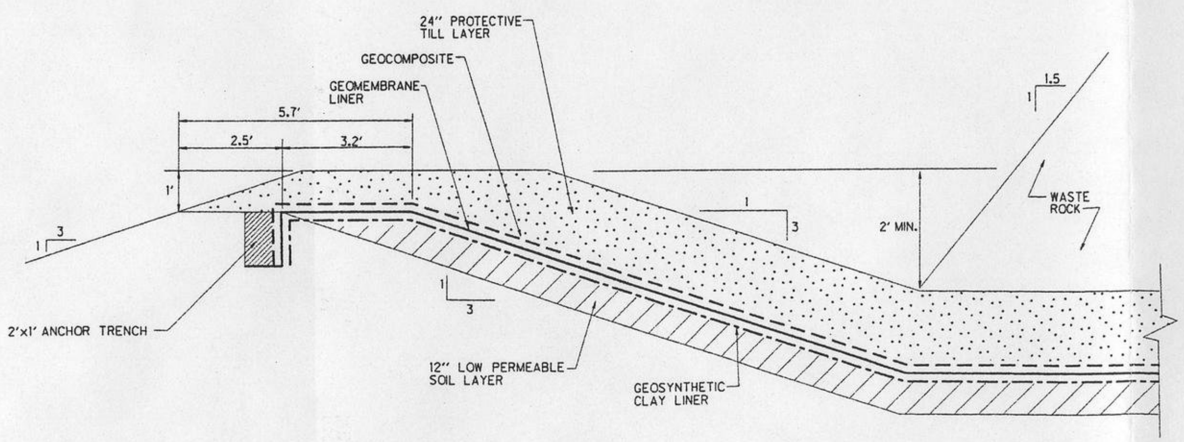
3/38 SECTION THRU LEACHATE EXTRACTION SUMP
NOT TO SCALE



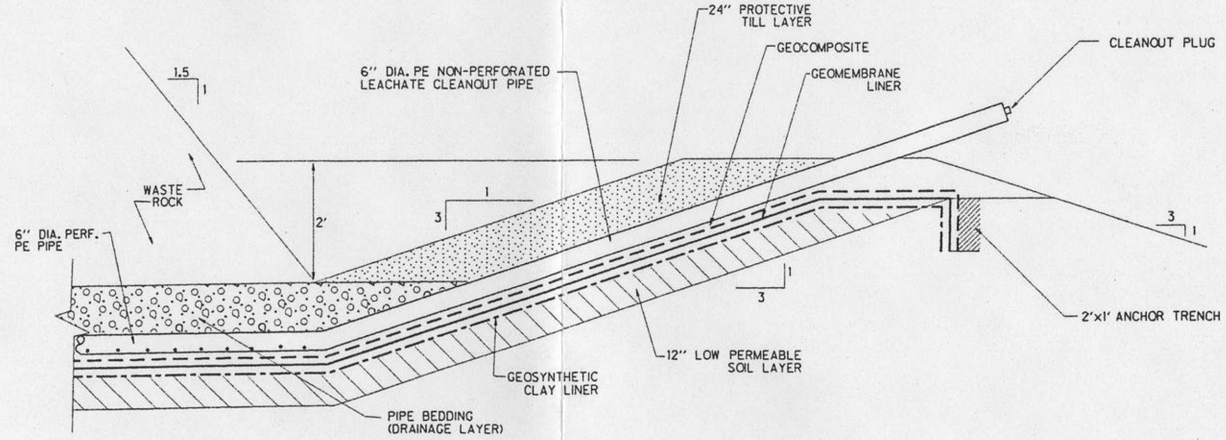
4/38 TYPICAL DOUBLE ENCASED LEACHATE FORCEMAIN PIPE BEDDING DETAIL
NOT TO SCALE



SECTION A-A' PIPE PERFORATION DETAIL
NOT TO SCALE



5/38 TYPICAL PERIMETER BERM DETAIL
NOT TO SCALE



6/38 TYPICAL CLEANOUT DETAIL
NOT TO SCALE

Nicolet Minerals COMPANY

Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

TITLE: WASTE ROCK STORAGE AREA - DETAILS

SCALE: AS SHOWN	STATE: WISCONSIN	COUNTY: FOREST	
DRAWN BY: JRB2	DATE: 12/98	CHECKED BY: DMR	DATE: 12/98
APPROVED BY: NXP	DATE: 12/98	APPROVED BY: NXP	DATE: 12/98
APPROVED BY: GWS	DATE: 12/98	NICOLET MINERALS COMPANY: KPB	DATE: 12/98
DRAWING NO.: 38		SHEET 38 OF 39	REVISION NO.: 1

TYPICAL REPRESENTATION: REFINEMENTS MAY BE MADE PRIOR TO CONSTRUCTION

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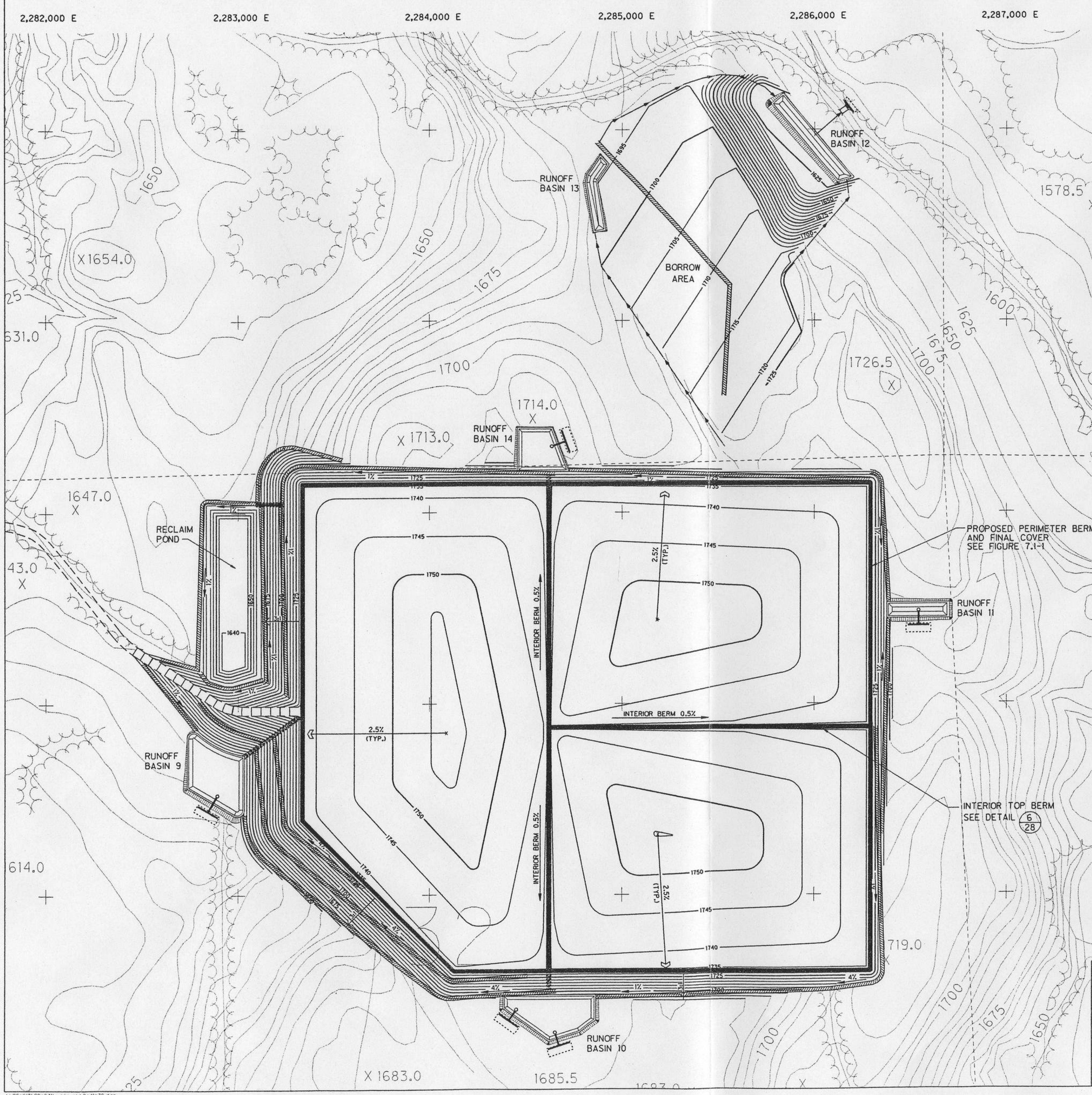

LEGEND

	EXISTING ROAD
—1675—	EXISTING CONTOUR
1692.0 X	SPOT ELEVATION
- - - - -	SECTION LINE
—1725—	PROPOSED CONTOUR (FINAL GRADE)
3:1	PROPOSED SLOPE RATIO (TYP.)
2.5%	PROPOSED SLOPE (TYP.)
	PROPOSED SPILLWAY
	PROPOSED SURFACE WATER DIVERSION BERM

NOTES:

1. TOPOGRAPHIC BASE MAP DIGITIZED FROM 1"=1000' SCALE, 5' CONTOUR INTERVAL MAP PREPARED BY AERO-METRIC ENGINEERING, INC., SHEBOYGAN, WISCONSIN. DATE OF PHOTOGRAPHY APRIL 28, 1976.
2. HORIZONTAL DATUM BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM - NORTH ZONE.
3. VERTICAL DATUM BASED ON MEAN SEA LEVEL DATUM. CONTOUR INTERVAL IS FIVE FEET.
4. COUNTY AND TOWNSHIP LINES DIGITIZED FROM 7.5' SERIES USGS MAPS.
5. THIS DRAWING SHOWS CONTOURS DEPICTING SITE FINAL GRADES. (TOP OF FINAL COVER).

SCALE
0 250' 500'

Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

TYPICAL REPRESENTATION: REFINEMENTS MAY BE MADE PRIOR TO CONSTRUCTION

Nicolet Minerals COMPANY

TITLE
TMA FINAL COVER GRADES FOR CONSTRUCTION

SCALE AS SHOWN	STATE WISCONSIN		COUNTY FOREST		
DRAWN BY JRB2	DATE 12/98	CHECKED BY DMR		DATE 12/98	
APPROVED BY NXP	DATE 12/98	APPROVED BY NXP		DATE 12/98	
APPROVED BY GWS	DATE 12/98	NICOLET MINERALS COMPANY KPB		DATE 12/98	
DRAWING NO. 39		SHEET 39 OF 39		REVISION NO.	

Appendix A

Calculation of Tailings to Waste Rock Ratio

SRK Consulting
Engineers and Scientists

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Vancouver, BC.
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MEMORANDUM

DATE: November 10, 1999
TO: File 1US004.08 – Waste Rock Management
FROM: Daryl Hockley and Kelly Sexsmith

RE: Revised Acidity Alkalinity Balance when Type II waste is concentrated in TMA Cell 1

The attached tables show acidity-alkalinity balance calculations based on those presented in Appendix A-2 of the 1999 GWQPE. The balance calculations have been revised to show the effect of the proposed deposition of Type II waste rock in TMA Cell 1.

Table 1 shows that, if the Lower Mole Lake Master Composite, the Lower Mole Lake High Sulfur composite and the Skunk Lake Master Composite are assumed to be representative of Type II waste rock, in the tonnages estimated by Joe Erickson, the Type II waste rock will have:

- an AP of 11 kg $CaCO_3$ equivalent per tonne and
- a CO_3-NP of 35 kg $CaCO_3$ equivalent per tonne.

Under these conditions, the NP:AP ratio of the overall mixture will be approximately 1.87 (Table 2), which is more than sufficient to maintain neutral conditions in the TMA.

It is recognized that a concentration of the Type II waste rock in one small area could lead to locally lower NP:AP ratios. To address this issue, NMC has committed to a deposition method that will spread Type II waste rock over a wide volume of tailings, keeping the typical ratio of Type II waste rock to tailings to less than 1 part waste rock to 2 parts tailings. However, in some instances, Type II waste rock will be used in construction, which could lead to locally higher ratios of waste rock to tailings. A sensitivity analysis was done to determine the NP:AP ratios for various operating assumptions. A summary of the calculations is also provided in Table 2.

The results in Table 2 indicate that under normal operating conditions, areas where waste rock will be mixed with tailings at a ratio of less than 1 part waste rock to 2 parts tailings, the NP:AP ratio will be 1.74, which is more than sufficient to maintain neutral conditions. Even if the contribution of NP from the waste rock is completely discounted in the calculations, the NP:AP ratio would be 1.65, also sufficient to maintain neutral conditions.

The maximum amount of waste rock that could be mixed with tailings is approximately 2.5 parts waste rock to one part tailings. At this ratio, the NP:AP ratios of the mixture would be close to the maximum allowable value. However, NP and AP contents of the Type II rock will vary over the short term, and at times will be different from the estimates used in these calculations. If the local proportion of waste rock to tailings is close to this limit of 2.5:1, variability in the sulphide content could push the local NP:AP ratio below neutral. In areas where a higher rock to tailings ratio is needed, such as the waste rock ramps internal to the TMA, it may be desirable to use Type I waste rock.

Table 1 - Type II Waste Rock

Type II Waste Rock Production:*

Formation	Composite	Total Est. Production tons	Indiv tons	Distribution within formation (%)
Lower Mole Lake	Master	829,100	822,900	99.25
	High Sulfur		6,200	0.75
Skunk Lake	Master	64,100	64,100	100
	High Sulfur		0	0
Total		893,200	893,200	

Type II Waste Rock Properties:**

Formation	Composite	Weight (tons)	Sulfide (%)	AP	CO3 NP	NNP	NP:AP
Lower Mole Lake	Master	822,900	0.34	11	37	26	3.5
	High Sulfur	6,200	4.15	130	32	-98	0.2
Skunk Lake	Master	64,100	0.14	4.4	6.7	2.3	1.5
	High Sulfur	0	3.95	123	20	-103	0.2
Total		893,200					
Weighted Average			0.35	11	34.8	23.8	3.2

Notes: * Source is GWQPE, Appendix A-2, Table 2
** Source is GWQPE, Appendix A-2, Table 3

Table 2

Summary of NP:AP ratios resulting from different mixtures of waste rock and tailings.

Ratio of waste rock to tailings	NP:AP ratio	Notes
1:6.9	1.87	Overall mixture in TMA
1:2	1.74	maximum projected ratio of waste rock to tailings under normal operating conditions
1:2	1.65	maximum projected ratio of waste rock to tailings under normal operating conditions, NP in waste rock not included in calculations
2.5:1	1.03	maximum allowable amount of Type II waste rock to maintain NP:AP ratio of greater than 1, assumes sulphide content does not exceed average values.

Appendix B

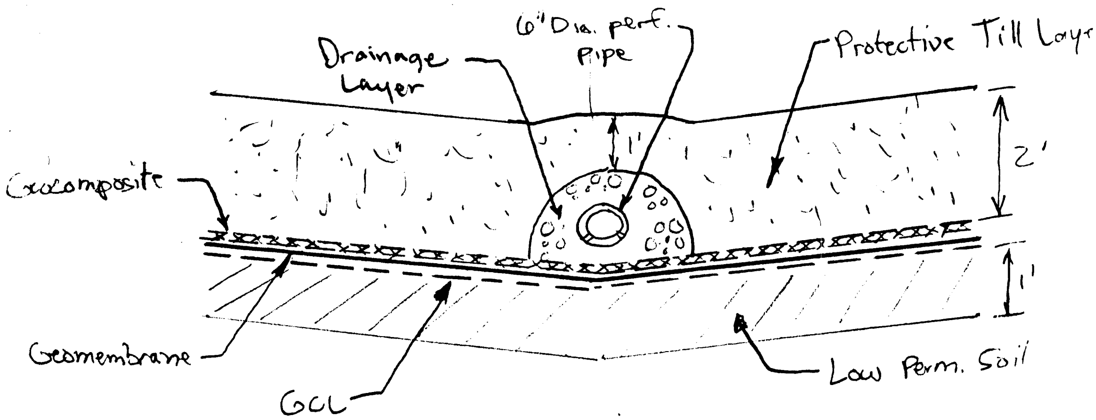
Drainage Material Compatibility Analysis

Foth & Van Dyke	Client: NMC	Scope I.D.: 99C018
	Project: Type II Storage Area	Page: 1 of 3
	Prepared By: MRS	Date: 11/8/99
	Checked By: NxP	Date: 11-9-99

Drainage Material Compatibility Analysis

Background: The design of the Type II storage area includes different layers of soil and synthetic materials used for collection and transport of leachate. The adjacent layers must be compatible with each other to prevent clogging and reduction in flow.

The following is a typical section through the drainage components of the storage area.



Purpose: The purpose of this analysis is the following:

I. Evaluate the compatibility of the protective till layer and the drainage layer material.

II. Specify an apparent opening size for the geotextile component of the geocomposite drainage material to be compatible with the protective till layer and drainage layer material.

III. Evaluate the size of pipe perforations for compatibility with the drainage layer material.

References:

1. NAVFAC DM-7.1
2. Koerner, Robert M., Designing with Geosynthetics, Prentice Hall Inc., 1990
3. Nicolet Minerals Company (formerly Crandon Mining Company), 1997. Letter dated December 12, 1997, from Don Moe to W. Tans, C. Carlson, and R. Grefe, Wisconsin Department of Natural Resources, Re: Crandon Project - Response to WDNR September 26, 1997, Completeness Determination on the Feasibility Report for the Proposed Crandon Mine Tailings Management Area.

Design Criteria:

The following is the design criteria used to determine compatibility of materials (per Ref. 1)

To avoid head loss in filter: $D_{15F}/D_{15B} > 4$

To avoid movement of particles from base: $D_{15F}/D_{85B} < 5$, $D_{50F}/D_{50B} < 25$, $D_{15F}/D_{15B} < 20$ (40 for broadly graded base material)

To avoid movement of pipe bedding in perforations: D_{85F} /Diameter of hole > 1.0-1.2

Solutions:

I. <u>Protective Till Layer/Drainage Layer Compatibility</u>

The till layer is the base and the drainage layer is the filter.

See Attachment 6, revised Liner Filter Drain Calculation (Ref.3 - NMC, 1997)

The drainage material will act as a good filter for the protective till layer.

II. <u>Specify an apparent opening size for the geotextile component of the geocomposite drainage material to be compatible with the protective till layer</u>.

From Ref.2 for soil with a $C_u>3$, Koerner recommends using relationships formulated by Giroud as the most conservative method for filtration design.

AOS (apparent opening size) $< (13.5*d_{50})/C_u$
AOS $< (13.5*0.3)/25$
AOS < 0.162 mm

Therefore, a geocomposite with a geotextile with an AOS less than 0.162 mm will be selected. The drainage layer is coarser than the till layer, therefore the AOS of 0.162 mm will function as an adequate filter for it as well.

III. Drainage layer\perforated pipe compatibility

a) Leachate collection piping

See Attachment 6, revised Liner Filter Drain Calculation (Ref. 3 - NMC, 1997)

A maximum 3/8" diameter pipe perforation will be used.

Summary:

I. The till layer/drainage layer interface meets the compatibility criteria, therefore the drainage layer will be a good filter material

II. The geotextile component of the geocomposite must have an apparent opening size <0.162 mm.

III. The proposed size of perforations in the piping (maximum 3/8" diameter) is compatible with the drainage layer material.

Appendix C

Sump Design Calculations

Foth & Van Dyke consultants · engineers · scientists	
Client: NMC	Scope I.D.: 99C018
Project: TMA - Add. 6	Page: 1 of 5
Prepared By: MRS	Date: 10-27-99
Checked By: NxP	Date: 11-5-99

Type II Waste Rock Storage Area

Storage Pad & Sump Size Determination

Purpose: 1) Evalutate the ability of storage pad to handle a 100 year storm without overtopping perimeter berm.

2) Determine the required size of sump to store peak monthly average leachate generation with 6 pumping cycles per day.

Data:

	Source
• Area of Type II Storage Pad = 285,500 ft²	— CADD
• 100 year storm = 5 inches	— Figure 1
• Peak monthly Average Leachate generation — 1.4208"	— HELP Results (Attachment C1)
• porosity of waste rock = 0.4	

Calculations:

1) The storage volume available (see Fig. A) = 48,200 cy (CADD)

$= 48{,}200\,cy \times 27\,\frac{ft^3}{cy} \times 7.48\,\frac{gal}{ft^3} \times 0.4$

$= \underline{3{,}894{,}000\ gal}$

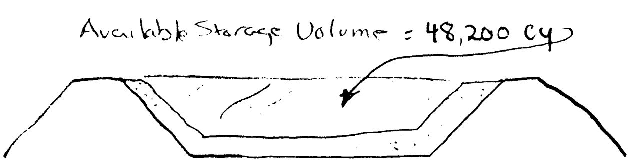


Figure A

required storage volume = $285{,}500\,ft^2 \times \frac{5\,in}{12\,in/ft} \times 7.48\,\frac{gal}{ft^3}$ -

$= \underline{889{,}800\ gal}$

∴ 3,894,000 gal > 889,800 gal, storage capacity is adequate

Foth & Van Dyke
consultants · engineers · scientists

Client: NMC — Scope I.D.: 99C018
Project: TMA - Add. 6 — Page: 2 of 5
Prepared By: MRS — Date: 10/27/99
Checked By: NxP — Date: 11/2/99

2) Sump Sizing

$$\text{Volume/sump/day} = 285{,}500\ ft^2 \left(\frac{1.4208\ in/mon}{12\ in/ft}\right)\left(12\ mon/yr\right)\left(\frac{1\ yr}{365\ day}\right)$$

$$= \underline{1111.3}\ \frac{ft^3}{day}$$

with 6 pumping cycles per day, size of sump required

$$= \frac{1111.3\ ft^3/yr}{6n} \quad \text{where } n = \text{porosity of stone in sump} = 0.3$$

$$= \frac{1111.3}{6 \times 0.3} = 617.4\ ft^3$$

Assume the shape of the sump to be a truncated square pyramid.

using 2.5' lowering of leachate per cycle, ie difference in elevation between on and off elevations, required area at on elevation is

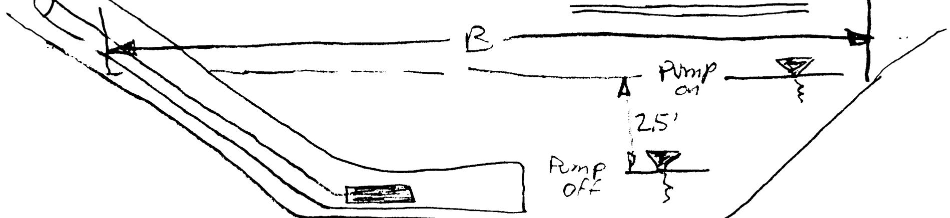
$$\left[B^2 + (B-15)^2\right]\frac{2.5}{2} = 617.4\ ft^3$$

$$\left[2B^2 - 30b + 225\right] = 493.9$$

$$B^2 - 15b + 112.5 = 246.96$$

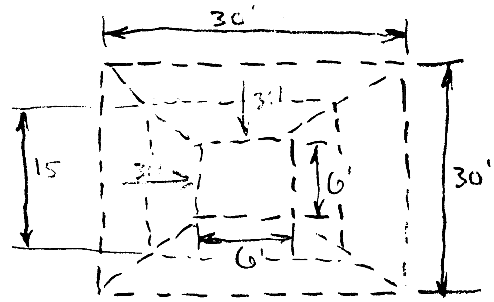
$$B^2 - 15b - 134.5 = 0 \Rightarrow B = \frac{+15 \pm \sqrt{225 + 537.8}}{2}$$

$$\underline{B = 21.3'}$$



Foth & Van Dyke consultants · engineers · scientists	
	Client: NMC Scope I.D.: 99C018
	Project: TMA - Add. 6 Page: 3 of 5
	Prepared By: MRS Date: 10/27/99
	Checked By: NxP Date: 11/2/99

Therefore, the minimum size sump required is 21.3' x 21.3'. This would be too small at the bottom if it is 4' deep with 3:1 sideslopes. Therefore, increase to 30' x 30'. The capacity is as follows:



$V = \frac{1}{3} h \left(B_1 + B_2 + \sqrt{B_1 B_2}\right)$ where B_1 = Area of off elev.
B_2 = Area of on elev.

$V = \frac{1}{3}(2.5')\left(15'^2 + 30'^2 + \sqrt{(15^2)(30^2)}\right) = 1312.5 \text{ ft}^3$

$V = 1312.5 \text{ ft}^3 \times$ porosity of stone $= 1312.5 \text{ ft}^3 \times 0.3 = 393.8 \text{ ft}^3$

capacity $= 393.8 \text{ ft}^3 \times 7.48 \text{ gal/ft}^3$

V = **2,945 gallons**

Size pump to evacuate sump in 2 hours

pumping rate $= \frac{2945 \text{ gal}}{2 \text{ hr}} \cdot \frac{1 \text{ hr}}{60 \text{ min}} = 24.5 \text{ gal/min}$

Select a **25 gpm (min) pump**

The pump system curve is presented on the following page.

A typical pump curve is provided on page 5.

Foth & Van Dyke	Client: NMC	Scope I.D.: 99C018
	Project: Addendum 6	Page: 4 of 5
	Prepared By: MRS	Date: 11/8/99
	Checked By: HJA	Date: 11/24/99

LEACHATE PUMP SYSTEM CURVE

Instructions: input number of each fitting into Table A

Table A - Fittings

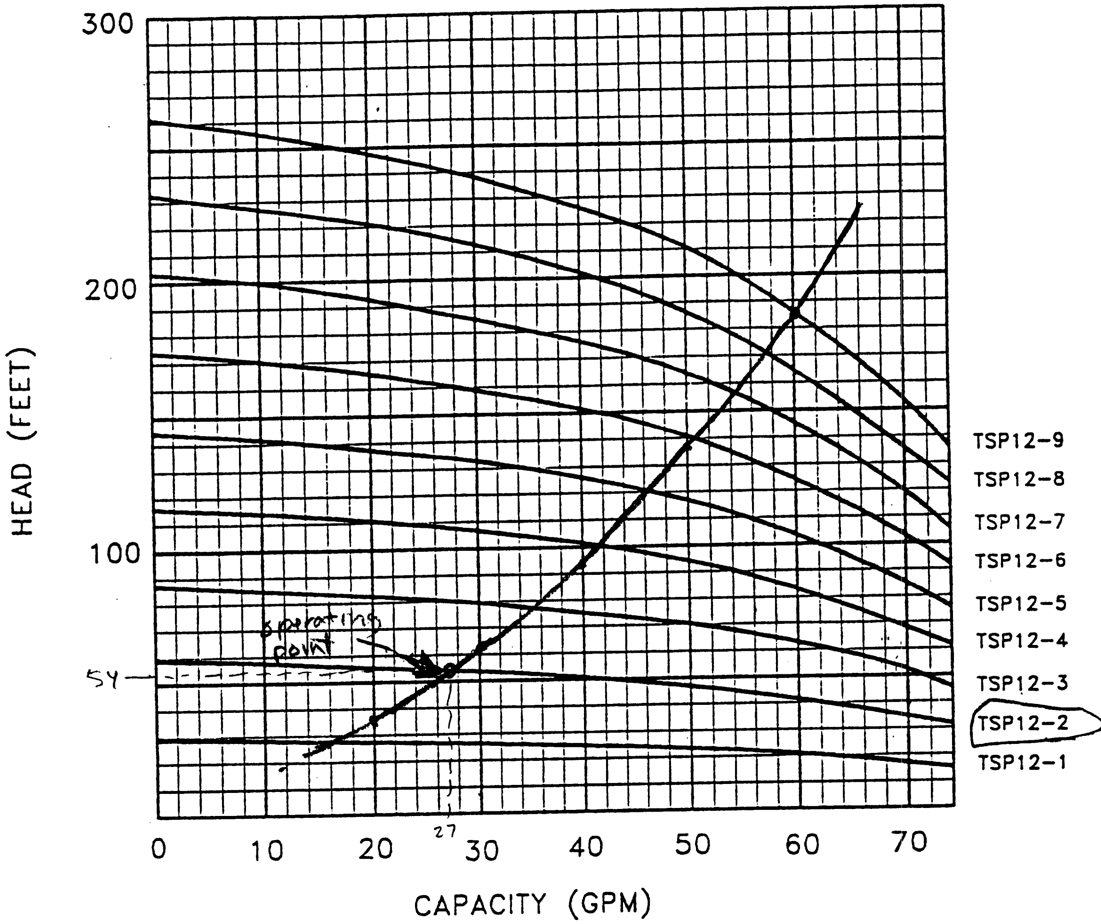
Fitting	Ke	No.	subtotal	Fitting	Ke	No.	subtotal
Entrance	0.5	1	0.5	Gate Valve	0.19		0.0
Exit	1.0	1	1.0	Standard elbow	0.90	3	2.7
Globe Valve (open)	10.0	0	0.0	Elbow (45)	0.45		0.0
Ball Valve	0.3	0	0.0	Tee (through)	0.60	0	0.0
Check Valve	2.3	0	0.0	Tee (out)	1.8	0	0.0
					Total Ke =		4.2

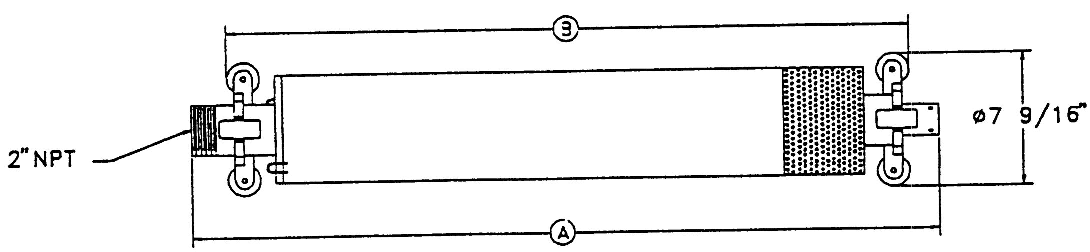
Input C value = 150

Flow (gpm)	Dia. (in)	Velocity (ft/sec)	Ke (table A)	Hm (ft)	L (ft)	S, slope of energy grade line (ft/ft)	Hf (ft)	Static Head (ft)	TDH (ft)
15	1.943	1.62	4.2	0.17	2231	0.0059	13.1	14.0	27.3
20	1.943	2.16	4.2	0.31	2231	0.0100	22.3	14.0	36.6
25	1.943	2.71	4.2	0.48	2231	0.0151	33.7	14.0	48.2
30	1.943	3.25	4.2	0.69	2231	0.0212	47.3	14.0	62.0
35	1.943	3.79	4.2	0.94	2231	0.0282	62.9	14.0	77.8
40	1.943	4.33	4.2	1.22	2231	0.0361	80.5	14.0	95.7
45	1.943	4.87	4.2	1.55	2231	0.0449	100.1	14.0	115.7
50	1.943	5.41	4.2	1.91	2231	0.0545	121.7	14.0	137.6
55	1.943	5.95	4.2	2.31	2231	0.0650	145.1	14.0	161.4
60	1.943	6.49	4.2	2.75	2231	0.0764	170.5	14.0	187.2

EPG COMPANIES

TSP12 SurePump™ SIDE SLOPE RISER





PUMP MODEL	SINGLE PHASE			THREE PHASE			SHIPPING WEIGHT (LBS)	
	MOTOR HP	A (in)	B (in)	MOTOR HP	A (in)	B (in)	1Ø	3Ø
TSP12-1	1.0	35.75	33.75	1.0	35.75	33.75	56.7	56.7
TSP12-2	1.0	37.75	35.75	1.0	37.75	35.75	59.2	59.2
TSP12-3	1.5	42.00	40.00	1.5	41.00	39.00	69.0	64.4
TSP12-4	2.0	46.25	44.25	2.0	44.50	42.50	75.7	70.9
TSP12-5	3.0	57.00	55.00	3.0	54.25	52.25	103.5	93.0
TSP12-6	3.0	59.50	57.50	3.0	56.75	54.75	106.3	95.8
TSP12-7	5.0	68.25	66.25	5.0	62.25	60.25	129.4	110.2
TSP12-8	5.0	70.75	68.75	5.0	64.75	62.75	132.7	113.5
TSP12-9	5.0	73.25	71.25	5.0	67.25	65.25	136.1	116.9

SEE 0576-2 FOR HIGH HEAD MODELS.

figure 1

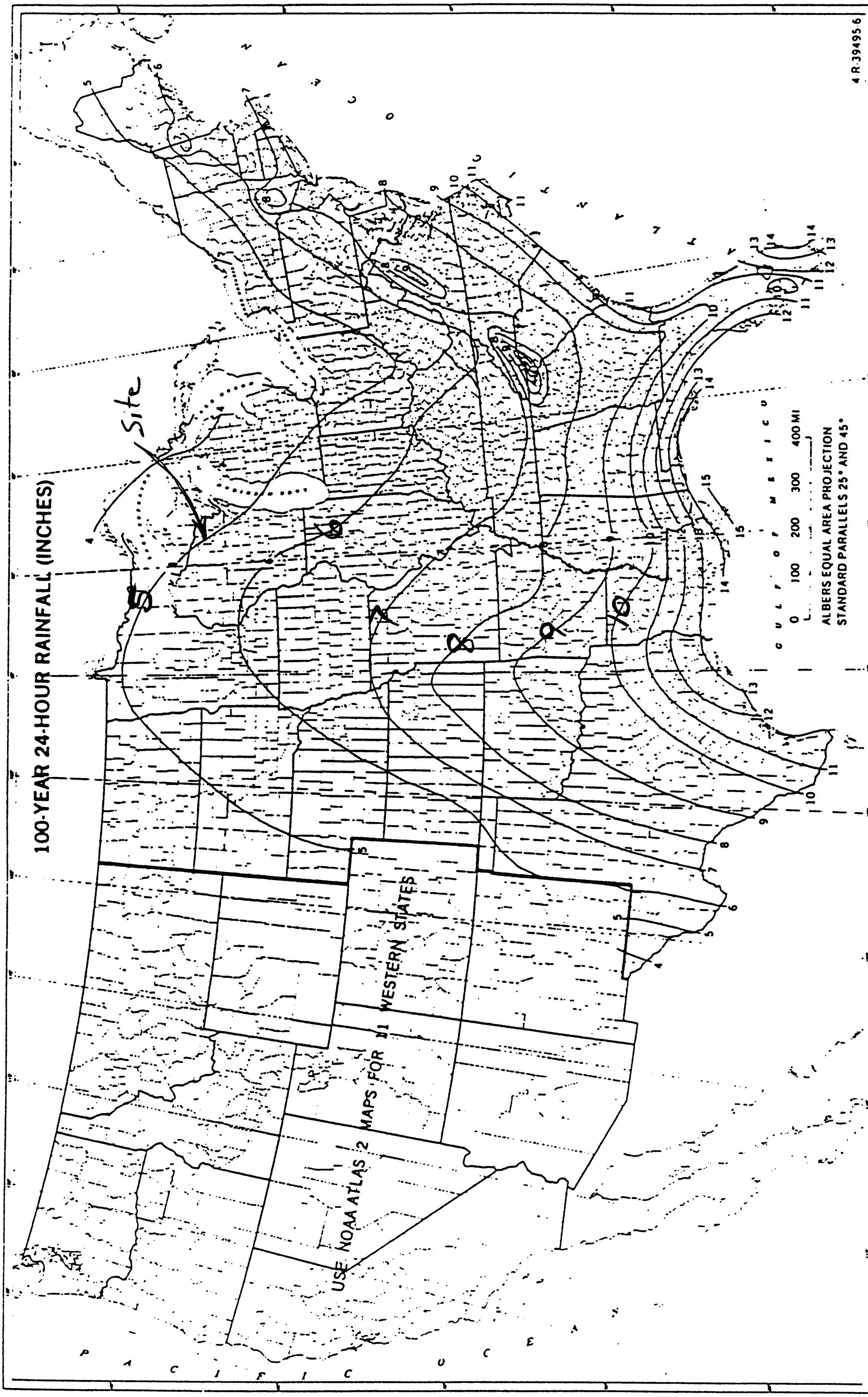


Figure B-8.—On[illegible]red-year, 24-hour rainfall.

ATTACHMENT C1

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                 HELP MODEL VERSION 3.04a  (10 JULY 1995)                 **
**                 DEVELOPED BY ENVIRONMENTAL LABORATORY                    **
**                   USAE WATERWAYS EXPERIMENT STATION                      **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:     j:\scopes\93c049\mrs_help\1_PREC.D4
TEMPERATURE DATA FILE:       j:\scopes\93c049\mrs_help\1_PREC.D7
SOLAR RADIATION DATA FILE:   j:\scopes\93c049\mrs_help\1_PREC.D13
EVAPOTRANSPIRATION DATA:     j:\scopes\93c049\mrs_help\1_PREC.D11
SOIL AND DESIGN DATA FILE:   j:\scopes\93c049\mrs_help\9_21_99\RUN_2B.D10
OUTPUT DATA FILE:            j:\scopes\93c049\mrs_help\9_21_99\RUN_2b.OUT


TIME:  11: 8     DATE:  10/19/1999


******************************************************************************

     TITLE:  Run #2-Type II storage area

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                  LAYER  1
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   0
           THICKNESS                     =    480.00    INCHES
           POROSITY                      =      0.3970 VOL/VOL
           FIELD CAPACITY                =      0.0320 VOL/VOL
           WILTING POINT                 =      0.0130 VOL/VOL
           INITIAL SOIL WATER CONTENT    =      0.0320 VOL/VOL
           EFFECTIVE SAT. HYD. COND.     =    1.00000000000     CM/SEC


                                  LAYER  2
```

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 10

THICKNESS	=	24.00 INCHES
POROSITY	=	0.3980 VOL/VOL
FIELD CAPACITY	=	0.2440 VOL/VOL
WILTING POINT	=	0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2440 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.119999997000E-03 CM/SEC

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 34

THICKNESS	=	0.24 INCHES
POROSITY	=	0.8500 VOL/VOL
FIELD CAPACITY	=	0.0100 VOL/VOL
WILTING POINT	=	0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	33.0000000000 CM/SEC
SLOPE	=	2.00 PERCENT
DRAINAGE LENGTH	=	180.0 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	=	2 - EXCELLENT

LAYER 5

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 0

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.	=	0.879999970000E-05 CM/SEC

LAYER 6

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	12.00	INCHES
POROSITY	=	0.5010	VOL/VOL
FIELD CAPACITY	=	0.2840	VOL/VOL
WILTING POINT	=	0.1350	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.5010	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999995000E-04	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	0.00	
FRACTION OF AREA ALLOWING RUNOFF	=	0.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	20.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	0.640	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	7.940	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.260	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	27.405	INCHES
TOTAL INITIAL WATER	=	27.405	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
GREEN BAY WISCONSIN

STATION LATITUDE	=	45.29	DEGREES
MAXIMUM LEAF AREA INDEX	=	3.00	
START OF GROWING SEASON (JULIAN DATE)	=	130	
END OF GROWING SEASON (JULIAN DATE)	=	275	
EVAPORATIVE ZONE DEPTH	=	20.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	10.10	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 GREEN BAY WISCONSIN

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.08	0.82	1.62	2.35	3.18	3.58
3.73	4.14	3.99	2.46	1.96	1.45

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR GREEN BAY WISCONSIN

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
10.20	14.20	26.00	40.40	53.20	61.50
66.10	63.30	54.90	44.70	30.50	15.50

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR GREEN BAY WISCONSIN
AND STATION LATITUDE = 45.29 DEGREES

****

ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	26.82	97356.602	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	17.524	63613.055	65.34
DRAINAGE COLLECTED FROM LAYER 3	0.0364	132.276	0.14
PERC./LEAKAGE THROUGH LAYER 5	0.000001	0.004	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0000		
PERC./LEAKAGE THROUGH LAYER 6	2.723969	9888.006	10.16
CHANGE IN WATER STORAGE	6.535	23723.273	24.37
SOIL WATER AT START OF YEAR	27.405	99480.672	
SOIL WATER AT END OF YEAR	33.511	121645.562	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.429	1558.387	1.60

ANNUAL WATER BUDGET BALANCE	0.0000	-0.012	0.00

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	33.59	121931.703	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	19.559	70999.539	58.23
DRAINAGE COLLECTED FROM LAYER 3	9.7909	35541.148	29.15
PERC./LEAKAGE THROUGH LAYER 5	0.000005	0.020	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0013		
PERC./LEAKAGE THROUGH LAYER 6	0.190793	692.579	0.57
CHANGE IN WATER STORAGE	4.049	14698.474	12.05
SOIL WATER AT START OF YEAR	33.511	121645.562	
SOIL WATER AT END OF YEAR	36.677	133136.984	
SNOW WATER AT START OF YEAR	0.429	1558.387	1.28
SNOW WATER AT END OF YEAR	1.313	4765.428	3.91
ANNUAL WATER BUDGET BALANCE	0.0000	-0.037	0.00

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	35.29	128102.703	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	19.717	71573.367	55.87
DRAINAGE COLLECTED FROM LAYER 3	14.9546	54285.258	42.38
PERC./LEAKAGE THROUGH LAYER 5	0.000007	0.027	0.00

AVG. HEAD ON TOP OF LAYER 4	0.0020		
PERC./LEAKAGE THROUGH LAYER 6	0.109855	398.773	0.31
CHANGE IN WATER STORAGE	0.476	1727.052	1.35
SOIL WATER AT START OF YEAR	36.677	133136.984	
SOIL WATER AT END OF YEAR	38.024	138027.625	
SNOW WATER AT START OF YEAR	1.313	4765.428	3.72
SNOW WATER AT END OF YEAR	0.441	1601.845	1.25
ANNUAL WATER BUDGET BALANCE	0.0326	118.256	0.09

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	28.80	104544.016	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	17.987	65292.012	62.45
DRAINAGE COLLECTED FROM LAYER 3	11.8570	43040.973	41.17
PERC./LEAKAGE THROUGH LAYER 5	0.000006	0.023	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0016		
PERC./LEAKAGE THROUGH LAYER 6	0.073610	267.204	0.26
CHANGE IN WATER STORAGE	-1.122	-4071.576	-3.89
SOIL WATER AT START OF YEAR	38.024	138027.625	
SOIL WATER AT END OF YEAR	37.289	135357.422	
SNOW WATER AT START OF YEAR	0.441	1601.845	1.53
SNOW WATER AT END OF YEAR	0.055	200.467	0.19
ANNUAL WATER BUDGET BALANCE	0.0042	15.405	0.01

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	33.38	121169.414	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	15.441	56050.566	46.26
DRAINAGE COLLECTED FROM LAYER 3	15.2233	55260.469	45.61
PERC./LEAKAGE THROUGH LAYER 5	0.000007	0.027	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0020		
PERC./LEAKAGE THROUGH LAYER 6	0.055080	199.939	0.17
CHANGE IN WATER STORAGE	2.661	9658.410	7.97
SOIL WATER AT START OF YEAR	37.289	135357.422	
SOIL WATER AT END OF YEAR	39.268	142542.109	
SNOW WATER AT START OF YEAR	0.055	200.467	0.17
SNOW WATER AT END OF YEAR	0.737	2674.194	2.21
ANNUAL WATER BUDGET BALANCE	0.0000	0.033	0.00

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ANNUAL TOTALS FOR YEAR 6

	INCHES	CU. FEET	PERCENT
PRECIPITATION	32.16	116740.797	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	19.451	70607.148	60.48
DRAINAGE COLLECTED FROM LAYER 3	14.2282	51648.395	44.24
PERC./LEAKAGE THROUGH LAYER 5	0.000007	0.025	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0019		
PERC./LEAKAGE THROUGH LAYER 6	0.043918	159.421	0.14
CHANGE IN WATER STORAGE	-1.571	-5702.326	-4.88
SOIL WATER AT START OF YEAR	39.268	142542.109	
SOIL WATER AT END OF YEAR	38.291	138995.828	

SNOW WATER AT START OF YEAR	0.737	2674.194	2.29
SNOW WATER AT END OF YEAR	0.143	518.147	0.44
ANNUAL WATER BUDGET BALANCE	0.0078	28.159	0.02

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ANNUAL TOTALS FOR YEAR 7

	INCHES	CU. FEET	PERCENT
PRECIPITATION	29.68	107738.391	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	13.515	49059.750	45.54
DRAINAGE COLLECTED FROM LAYER 3	12.0676	43805.305	40.66
PERC./LEAKAGE THROUGH LAYER 5	0.000006	0.023	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0016		
PERC./LEAKAGE THROUGH LAYER 6	0.035958	130.528	0.12
CHANGE IN WATER STORAGE	4.053	14712.730	13.66
SOIL WATER AT START OF YEAR	38.291	138995.828	
SOIL WATER AT END OF YEAR	40.276	146202.266	
SNOW WATER AT START OF YEAR	0.143	518.147	0.48
SNOW WATER AT END OF YEAR	2.211	8024.439	7.45
ANNUAL WATER BUDGET BALANCE	0.0083	30.073	0.03

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ANNUAL TOTALS FOR YEAR 8

	INCHES	CU. FEET	PERCENT
PRECIPITATION	32.30	117249.023	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	15.494	56243.602	47.97

DRAINAGE COLLECTED FROM LAYER 3	19.6785	71432.781	60.92
PERC./LEAKAGE THROUGH LAYER 5	0.000009	0.032	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0026		
PERC./LEAKAGE THROUGH LAYER 6	0.030950	112.348	0.10
CHANGE IN WATER STORAGE	-2.903	-10539.688	-8.99
SOIL WATER AT START OF YEAR	40.276	146202.266	
SOIL WATER AT END OF YEAR	37.557	136330.453	
SNOW WATER AT START OF YEAR	2.211	8024.439	6.84
SNOW WATER AT END OF YEAR	2.027	7356.569	6.27
ANNUAL WATER BUDGET BALANCE	0.0000	-0.016	0.00

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ANNUAL TOTALS FOR YEAR 9

	INCHES	CU. FEET	PERCENT
PRECIPITATION	34.30	124509.023	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	20.117	73026.484	58.65
DRAINAGE COLLECTED FROM LAYER 3	15.9824	58016.027	46.60
PERC./LEAKAGE THROUGH LAYER 5	0.000007	0.024	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0021		
PERC./LEAKAGE THROUGH LAYER 6	0.026666	96.799	0.08
CHANGE IN WATER STORAGE	-1.827	-6632.565	-5.33
SOIL WATER AT START OF YEAR	37.557	136330.453	
SOIL WATER AT END OF YEAR	37.164	134906.828	
SNOW WATER AT START OF YEAR	2.027	7356.569	5.91
SNOW WATER AT END OF YEAR	0.592	2147.636	1.72
ANNUAL WATER BUDGET BALANCE	0.0006	2.277	0.00

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ANNUAL TOTALS FOR YEAR 10

	INCHES	CU. FEET	PERCENT
PRECIPITATION	28.35	102910.516	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	18.584	67458.766	65.55
DRAINAGE COLLECTED FROM LAYER 3	9.8996	35935.391	34.92
PERC./LEAKAGE THROUGH LAYER 5	0.000006	0.020	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0013		
PERC./LEAKAGE THROUGH LAYER 6	0.023801	86.397	0.08
CHANGE IN WATER STORAGE	-0.162	-587.250	-0.57
SOIL WATER AT START OF YEAR	37.164	134906.828	
SOIL WATER AT END OF YEAR	36.744	133381.141	
SNOW WATER AT START OF YEAR	0.592	2147.636	2.09
SNOW WATER AT END OF YEAR	0.850	3086.060	3.00
ANNUAL WATER BUDGET BALANCE	0.0047	17.207	0.02

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 10

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.87	0.81	1.63	2.46	3.45	4.10
	4.92	4.17	3.66	2.22	1.83	1.35
STD. DEVIATIONS	0.60	0.50	0.87	0.91	1.87	1.75
	2.05	1.59	1.40	1.15	0.65	0.78
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000

	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

EVAPOTRANSPIRATION

TOTALS	0.446	0.402	0.411	0.695	2.293	3.187
	3.326	2.550	2.274	1.203	0.601	0.351
STD. DEVIATIONS	0.071	0.104	0.093	0.453	1.119	1.377
	0.861	0.721	0.571	0.420	0.191	0.046

LATERAL DRAINAGE COLLECTED FROM LAYER 3

TOTALS	0.8745	0.6220	0.5629	0.4569	1.3879	1.3136
	1.2254	1.4208	1.1443	1.2145	1.1002	1.0487
STD. DEVIATIONS	0.4719	0.3186	0.2802	0.2099	1.2759	0.7458
	0.5727	0.8222	0.7218	0.6447	0.4879	0.4715

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 6

TOTALS	0.2023	0.0277	0.0197	0.0145	0.0122	0.0102
	0.0097	0.0069	0.0080	0.0077	0.0068	0.0059
STD. DEVIATIONS	0.6217	0.0681	0.0420	0.0273	0.0211	0.0161
	0.0138	0.0065	0.0101	0.0094	0.0073	0.0049

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0013	0.0011	0.0009	0.0007	0.0022	0.0021
	0.0019	0.0022	0.0018	0.0019	0.0018	0.0016
STD. DEVIATIONS	0.0007	0.0005	0.0004	0.0003	0.0020	0.0012
	0.0009	0.0013	0.0012	0.0010	0.0008	0.0007

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 10

	INCHES	CU. FEET	PERCENT

PRECIPITATION	31.47	(	2.860)	114225.2	100.00
RUNOFF	0.000	(	0.0000)	0.00	0.000
EVAPOTRANSPIRATION	17.739	(	2.2310)	64392.43	56.373
LATERAL DRAINAGE COLLECTED FROM LAYER 3	12.37185	(	5.27007)	44909.805	39.31689
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00001	(	0.00000)	0.022	0.00002
AVERAGE HEAD ON TOP OF LAYER 4	0.002	(	0.001)		
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.33146	(	0.84220)	1203.199	1.05336
CHANGE IN WATER STORAGE	1.019	(	3.1266)	3698.65	3.238

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 10

	(INCHES)	(CU. FT.)
PRECIPITATION	4.05	14701.501
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 3	0.23058	836.99933
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000000	0.00030
AVERAGE HEAD ON TOP OF LAYER 4	0.011	
MAXIMUM HEAD ON TOP OF LAYER 4	0.022	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	2.5 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.682713	2478.24951
SNOW WATER	4.24	15373.6377

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3970
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0130

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 10

LAYER	(INCHES)	(VOL/VOL)
1	27.1891	0.0566
2	6.6770	0.2782
3	0.0033	0.0139
4	0.0000	0.0000
5	0.1772	0.7500
6	2.6975	0.2248
SNOW WATER	0.850	

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Appendix D

Estimates of Tailings Settlement

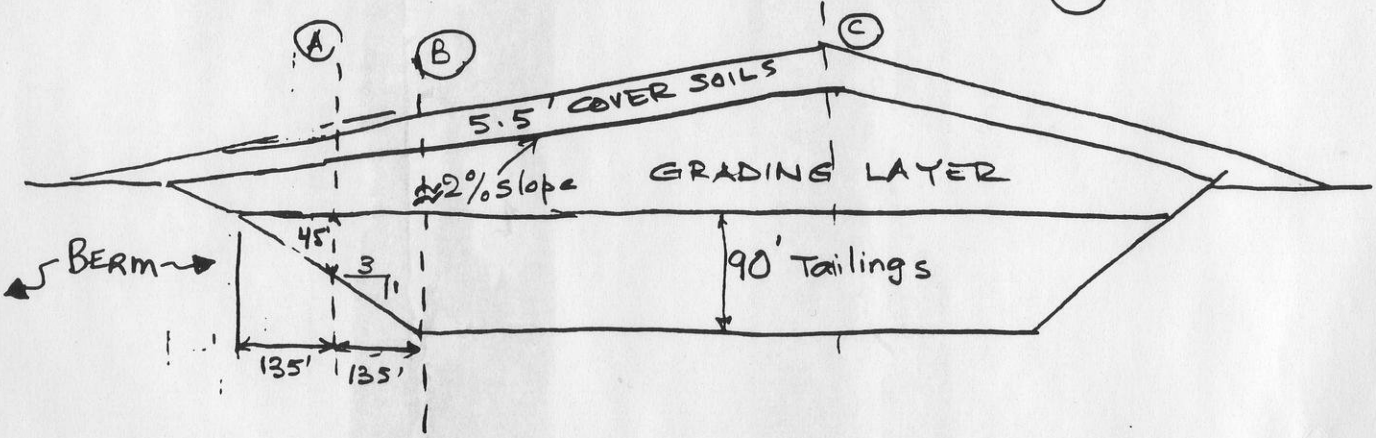
Foth & Van Dyke
consultants · engineers · scientists

Client:	NMC	Scope I.D.:	99C018
Project:	TMA	Page:	1 of 1
Prepared By:	NXP	Date:	9-23-99
Checked By:	DMR	Date:	9-26-99

ESTIMATES OF TAILINGS SETTLEMENTS

Purpose: To evaluate the maximum reduction in the finished slope of the TMA grading layer due to the settlement caused by the final cover construction.

Scope: Use data from earlier tailings settlements calculations (orig: 12-31-96; revised: 4-8-98) and determine the settlement of tailings at section (A) - see the Figure reproduced from 12-31-96. Earlier work had shown that the maximum reduction in slope occurs between the berm and section (A)



CROSS SECTION OF TMA AND SECTIONS FOR SETTLEMENT ANALYSIS (FROM 12-31-96)

Calculations: Assuming maximum considered cover soil unit weights (150 pcf), settlement is given by:

$$\text{settlement } s = C_c H \log\left(\frac{(22.5\times 90\times 1.4)+(5.5\times 150)}{(22.5\times 90\times 1.4)}\right)$$

$$= 0.1\times 45 \log \frac{2835+825}{2835} = 4.5\times .11 = 0.5' \checkmark$$

$$\text{change in slope} = \frac{0.5}{135} = 0.0037 = 0.37\% \checkmark$$

$$\therefore \%\text{Resultant slope} = \%\text{Initial slope} - 0.37\% \checkmark$$