

E 6881 - E 7108
TRANSMITTAL MANIFEST

Plant Copy

Date July 27, 1973

To:

- D.E. Gilberts (2)
- J.R. Zylkowski
- J.V. Sullivan
- P.A. Johnson
- FILE (JEK, RLH, CJT and AVD)

PH 12M000

ND PROJECT

GE AREA
PLANT -

NY

Description:

Dames & Moore Report on Review of
Design Criteria and Project Specification
for Sherco Ash Pond Dikes

Remarks:

For your information.

P.A. Johnson/gg

FROM

NORTHERN STATES POWER COMPANY
PLANT ENGINEERING & CONSTRUCTION DEPARTMENT

FORM 0330-25

*X ash storage
area*

- X Dames + Moore rpt*
- X dikes ash pond rpt*
- X Rpt Dames + Moore*

DAMES & MOORE

S-030

REPORT
REVIEW OF DESIGN CRITERIA AND PROJECT
SPECIFICATIONS

PROPOSED COAL AND ASH STORAGE AREA
SHERBURNE COUNTY GENERATING PLANT -
UNIT 1
SHERBURNE COUNTY, MINNESOTA
FOR
NORTHERN STATES POWER COMPANY



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CABLE: DAMEMORE TELEEX: 28-2491

July 17, 1973

Northern States Power Company
414 Nicollet Mall
Minneapolis, Minnesota 55401

Attention: Mr. Pete A. Johnson
Senior Civil Engineer

Gentlemen:

Eight copies of our "Report of Review of Design Criteria and Project Specifications, Proposed Coal and Ash Storage Area, Sherburne County Generating Plant - Unit 1, Sherburne County, Minnesota for Northern States Power Company" are herewith submitted.

The scope of our services were planned in collaboration with Messrs. Jerry Zylkowski, Roger Hertzberg, Pete Johnson, and Richard McGinnis of Northern States Power Company and were outlined in our proposal dated February 22, 1973. This work was authorized by your purchase order No. C-86459.

Preliminary copies of the project specifications, construction drawings, supporting analyses, boring logs, and laboratory test data were submitted for review by Black & Veatch, Consulting Engineers. Following our review of the preliminary project plans and documents, a joint meeting attended by representatives of Northern States Power Company, Black & Veatch, and Dames & Moore was held in Minneapolis on May 1, 1973. During the meeting, agreement was reached regarding certain modifications of the project documents and the need for additional laboratory tests to substantiate assumptions used in the supporting analyses.

Northern States Power Company
July 17, 1973
Page - 2

Subsequent to the May 1 meeting, additional laboratory tests were performed and Black & Veatch prepared final versions of the project documents. We have completed our review of these documents and are in agreement with the final version. However, we have noted that the revised gradation requirements and lift thickness for filter blankets and proof-rolling of the clay blankets prior to filling had not been incorporated in the project specifications at the time of our review. All modifications noted in Memorandum 519 by Black & Veatch, dated June 18, 1973 should be incorporated in the specifications before issuing the project documents in final form.

Please do not hesitate to contact us if you have any questions pertaining to the contents of this report. It has been a pleasure to be of service to you on this project.

Yours very truly,

DAMES & MOORE



William G. Paratore
Partner

WGP:RWC:sb

REPORT
REVIEW OF DESIGN CRITERIA AND PROJECT SPECIFICATIONS
PROPOSED COAL AND ASH STORAGE AREA
SHERBURNE COUNTY GENERATING PLANT - UNIT 1
SHERBURNE COUNTY, MINNESOTA
FOR
NORTHERN STATES POWER COMPANY

INTRODUCTION

This report presents the results of our review of design criteria and project specifications performed for the proposed coal and ash storage area for the Sherburne County Generating Plant - Unit 1 in Sherburne County, Minnesota.

The purposes of our engineering studies were as follows:

1. To review the design and supporting analysis, including stability, settlement, and seepage, for the Proposed Coal and Ash Storage Area submitted by Black & Veatch, Consulting Engineers.
2. To review the project specifications and construction drawings for the proposed construction.
3. To provide an evaluation of the design, supporting analysis, project specifications, and construction drawings for the proposed construction.

DESIGN CRITERIA

SOIL PARAMETERS

The relevant soil parameters for design of the earth retaining structures for the coal and ash storage facilities include:

- 1 - In-Situ Natural Soils and On-Site Cohesionless Embankment Fill Material
 - Density
 - Angle of Internal Friction
 - Permeability
- 2 - Impervious Core and Impervious Blanket
 - Density
 - Shear Strength
 - Permeability
- 3 - Filter Blankets
 - Density
 - Gradation
 - Angle of Internal Friction
 - Permeability

Soil parameters used in the analyses are based on the results of field and laboratory tests performed on the in-situ natural soils and borrow materials by Dames & Moore and by Soil Exploration Company, Inc. as documented in the report of "Supporting Analysis II-M" by Black & Veatch dated

June 27, 1973. The borrow materials selected for construction of the dikes, impervious core and blankets, filter blankets, and slope protection are suitable for the proposed construction. The soil parameters used for the analyses are, in each case, reasonable and consistent with conservative practice.

SETTLEMENT

The natural granular soils underlying the embankments are relatively incompressible and free-draining. Settlements may be expected to be relatively minor and will occur simultaneously with the application of the loads. A maximum settlement of approximately two inches under the dikes was computed. The compression parameters used in the calculations and the magnitude of settlement have been verified by independent calculations performed by Dames & Moore.

SEEPAGE

The coefficients of permeability of the embankment and foundation soils used in the seepage analyses appear to be conservative but reasonable in view of possible unforeseen variations in the natural soils and compacted fill. The seepage calculations have been verified by Dames & Moore. The computed seepage losses are well within tolerable limits. Filter blankets have been provided to control seepage paths and to carry seepage water to collection ditches. The gradation characteristics, permeability, and thickness requirements of the filter blankets have been checked and found to be adequate.

SLOPE STABILITY

Stability analyses of the slopes have been performed for all conditions which could be reasonably anticipated during the service life of the structures. The soil parameters and loading conditions used in these analyses have been conservatively chosen. Selected critical cases, including full reservoir with earthquake loading, have been verified by Dames & Moore. Those cases which were not specifically verified are less critical and the computed factors of safety appear to be reasonable and consistent.

The factors of safety for the slopes used in the design are adequate to ensure the safety of the structures. Moreover, the computed factors of safety probably represent lower bound values in view of the conservative assumptions of soil parameters and loading conditions used in the analyses.

CONSTRUCTION

COMPACTION CRITERIA

Granular Soils. It is specified that granular soils will be compacted to at least 95 percent of the maximum dry density as determined by the ASTM 1557 Method of Compaction. This compaction requirement is considered satisfactory for the proposed construction and is consistent with the density, permeability, and shear strength parameters used in the supporting analyses.

Impervious Soils. The clay core and impervious earth blankets will be compacted to at least 93 percent of the maximum dry density as determined by the ASTM 1557 Method of Compaction at a moisture content between optimum and three percent wet of optimum. This degree of compaction should be obtainable under field conditions and is consistent with the permeability and shear strength parameters used in the analyses of seepage losses and slope stability.

PROOF-ROLLING

Proof-rolling of the exposed natural soils to a dry density of at least 95 percent of the maximum prior to construction of the dikes and impervious earth blankets is required. This compaction criterion is sufficient to restore the exposed natural soils to a condition equal or superior to the in-situ condition and should be readily obtainable in the field.

Proof-rolling of the clay blankets within the ash ponds immediately prior to filling is also required to knead the surface and close any shrinkage cracks that may develop. This requirement is essential for the prevention of excessive seepage losses and piping.

PLACEMENT OF FILTER BLANKETS

The required thickness of filter blankets is 18 inches. This thickness is adequate to carry the anticipated seepage quantities, if it is properly constructed. Placement of the

filter blankets should be closely supervised to ensure that particle size segregation and contamination of the filter material by the adjacent embankment fill material is prevented and that proper compaction is achieved. The filter material should be placed in lifts no greater than 12 inches in thickness.

--oOo--

If you have any questions concerning the information contained in this report, please do not hesitate to contact us.

Respectfully Submitted,

DAMES & MOORE



William G. Paratore
Partner



Richard W. Christiansen
Project Engineer

WGP:RWC:sb

Eight Copies Submitted

TWIN CITY TESTING AND ENGINEERING LABORATORY, Inc.

CHEMICAL & PHYSICAL TESTS • INSPECTIONS • RESEARCH

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ST. PAUL, MINN. 55114
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Vice-President Chemistry
CLINTON R. EUE
Secretary-Treasurer

June 27, 1974

Northern States Power Company
414 Nicollet Mall
Minneapolis, MN 55401

Attn: Mr J V Sullivan

Gentlemen

Subj: Additional strength tests for dike core
and impervious earth blanket clay -
Sherburne County Generating Plant -
Unit No. 1 - Becker, Minnesota
Laboratory No. 9-5483

This report concerns the recent laboratory testing we conducted to check the strength properties of the borrow clays for use in the dike cores and impervious blanket at this project. The purpose of this report is to present the test results. This work was conducted in accordance with your verbal authorization on May 29, 1974, and your Purchase Order Number C88754. We are sending you three copies of our report. Additional copies are being sent as noted below.

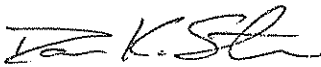
If you have any questions or desire further information, please contact us.

Very truly yours

Michael O'Donnell
Civil Engineer

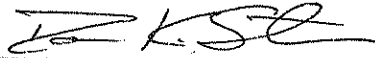
Northern States Power Company
June 26, 1974
Page two

Very truly yours



Donovan K Stormoe, P E

I hereby certify that this plan,
specification, or report was prepared
by me or under my direct supervision
and that I am a duly Registered Pro-
fessional Engineer under the laws of
the State of Minnesota.



DONOVAN K. STORMOE

Date 6-27-74 Reg. No. 10493

MO/DKS/fl

Copies to:

- 1) Northern States Power Co
Quality Assurance
Attn: Mr John Meier
- 2) Northern States Power (Becker)
Attn: Mr Curt Sillman
- 1) Northern States Power Co
Attn: Mr Pete Johnson
- 1) Black & Veatch
Attn: Mr John Vines

REPORT ON ADDITIONAL STRENGTH TESTS OF IMPERVIOUS CLAY SOIL
COAL AND ASH STORAGE AREAS
NORTHERN STATES POWER COMPANY
SHERBURNE COUNTY GENERATING PLANT
UNIT NO. 1
NEAR BECKER, MINNESOTA

#9-5483

INTRODUCTION

This report presents the results of the laboratory triaxial testing and classification tests we have performed for the referenced project. The purpose of this additional testing was to check the strength properties of the impervious clay fill when compacted to relative densities less than 93 percent of maximum and at moisture contents greater than 3 percent above optimum moisture content.

We are performing full-time, on-site inspection and testing during the earth work operations at the project. The results of that work have been/and are being forwarded to you in periodic reports.

Prior to construction, several site investigations and laboratory testing were conducted by Soil Exploration Company. The results of that work were included in reports to Black & Veatch between a period from January 1971 to June 1973.

FIELD EXPLORATION AND SAMPLING

A sample of the impervious borrow clay material was obtained from the coal and ash storage fill areas on May 29, 1974. Several bag samples of the material were taken from the core area of the south dam near Station 9+00 and were brought to the laboratory for testing. The sample was identified as Sample No. 3 and visually

appeared to be a brown clayey sand - sandy clay type soil with a trace of gravel.

LABORATORY TESTING PROCEDURES AND RESULTS

Laboratory tests performed on the soil samples included hydrometer analysis, atterberg limits and triaxial tests. Maximum density and optimum moisture content tests (in accordance with ASTM:D1557-70) have been previously performed on this material. The results of those tests were included in our reports 9-4822 and 9-5314 to you earlier. Copies of those moisture-density curves for both the original test and a later check-point test are included in this report.

The hydrometer and atterberg limit tests were conducted to aid in classifying the soil. The hydrometer test for particle-size distribution was performed in accordance with the procedure described by ASTM:D422-63 (reapproved 1972). The atterberg limits (liquid limit, plastic limit and plasticity index) were determined in accordance with ASTM:D423-66 (reapproved 1972) and ASTM:D424-66 (reapproved 1971). The test results indicate the soil is a clayey sand with about 48 percent of the material finer than the #200 sieve. The liquid limit and plastic limit are 29 percent and 15 percent, respectively, resulting in a plasticity index of 14. The hydrometer test results are shown on the attached grain-size distribution curve.

The triaxial tests were performed to determine the cohesion and internal friction angle (ϕ - angle) of samples of the soil remolded at various relative densities and moisture contents. The tests were conducted on 2 in. diameter by 4 in. long specimens under unconsolidated-undrained (quick) conditions. By this procedure, the molded specimens were placed in the triaxial chamber and then saturated for two days under

a 3 psi head of water. After this saturation period, the lines were closed, the confining pressure was applied and the sample was normally stressed at a strain rate of 0.06 in. per minute. The normal stress was applied until 20 percent strain (0.8 in.) had occurred.

A total of 8 series of triaxial tests were performed. Each series consisted of testing 3 different remolded specimens, with each specimen in a series compacted at as close to the same relative density and moisture content as possible. In a given series, the specimens were subjected to confining pressures of 1/2 tsf (tons per sq ft), 1 1/2 tsf and 3 tsf during application of the normal load. The series of tests included samples molded at 88 percent, 90 percent and 93 percent of maximum density. At each of these 3 relative densities, 2 series of tests were conducted with the molded moisture content at 13 percent (about 3 percent over optimum) for one series and 16 percent (about 6 percent over optimum) for the second series. As discussed with you, a total of 3 series were performed at a relative density of 90 percent and a moisture content of 16 percent. The additional series at these conditions were run to provide a check to assure that the test results were representative, since some variation can be expected due to several variables including the uniformity of compaction and moisture content in the laboratory specimen. The stress-strain and Mohr-circle plots for the triaxial tests are shown on the attached data sheets.

DISCUSSION OF TEST RESULTS

The test results indicate the undrained ϕ - angle of the material does not change appreciably for the various conditions. However, the apparent cohesion is influenced by both relative density and moisture content. A plot of cohesion versus density and relative compaction is attached.

The tests all indicate a relatively small ϕ - angle, ranging from about 2 degrees to 6 degrees. Within the normal limitations of the tests, it appears that the undrained ϕ - angle is not appreciably affected by the differing relative densities and molded moisture contents.

The cohesion of the clay-sand soil is definitely influenced by the relative density, and to a lesser degree, by the molded moisture content. As shown, an increase in relative density shows a marked increase in cohesion - from about 800-1100 psf at 88 percent relative density to 1900-2000 psf at 93 percent relative density. The cohesion is also slightly higher at the higher molded moisture content of 16 percent than at the lower value of 13 percent.

CONCLUSIONS

On the basis of these test results, it is our judgement that the impervious clayey material will have an undrained cohesion of at least 1000 psf if compacted to a minimum relative density of 90 percent of ASTM D:1557 and at a moisture content in the range of 0 percent to 6 percent above optimum moisture content.

TWIN CITY TESTING
 662 FROMWELL AVENUE
 ST. PAUL, MN. 55114

TRIAxIAL TEST DATA

JOB NO. 9-5483

PROJECT NSP SHERBURNE COUNTY GENERATING PLANT

BORING NO. 3-T-1 SAMPLE NO. 3-T-1 DEPTH

TYPE OF TEST U-U (Saturated)

SAMPLE SIZE: 2.0" x 4.0"

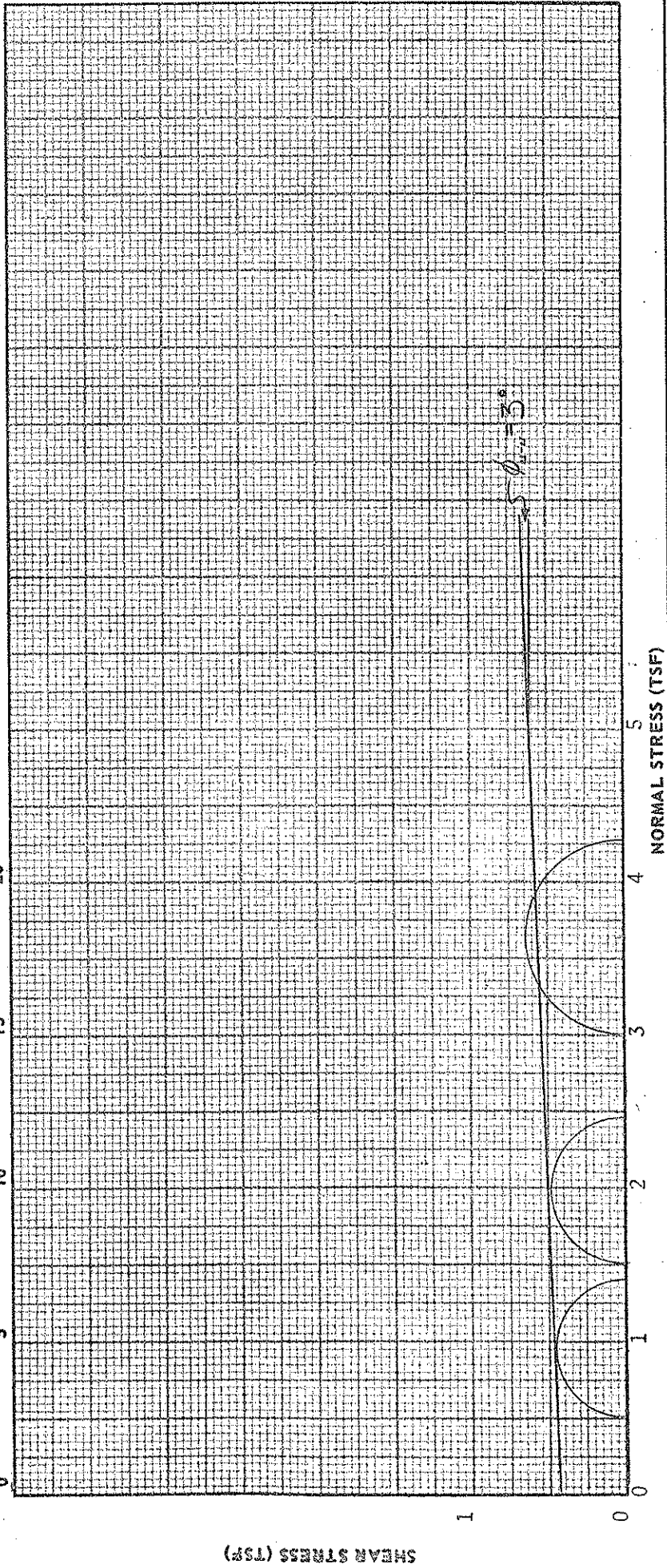
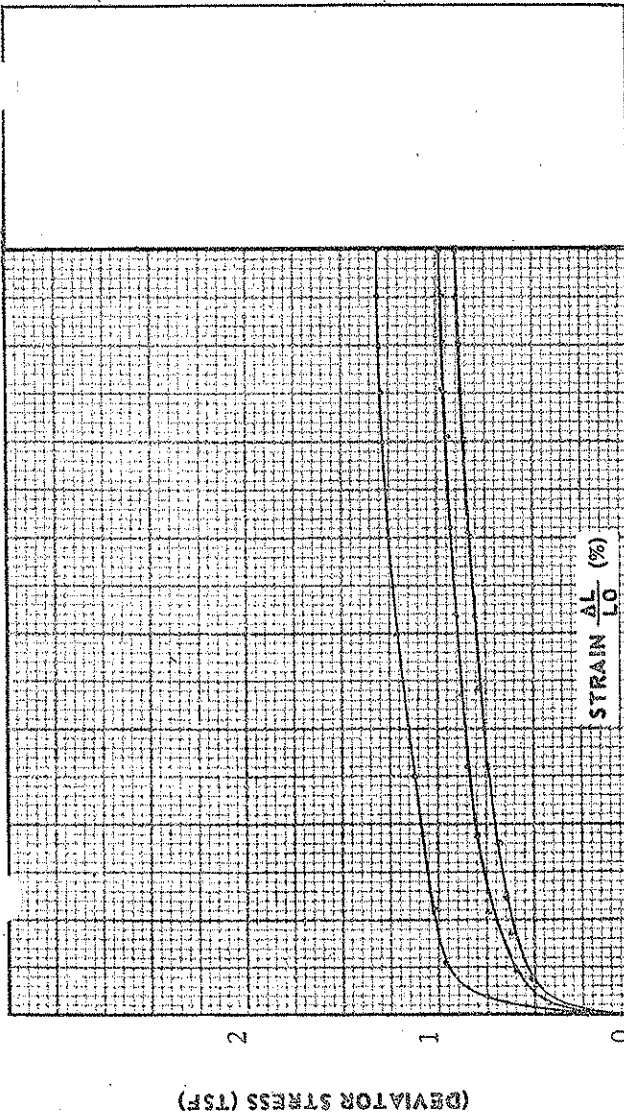
SOIL TYPE: Clayey Sand (SC)

MOISTURE-DENSITY: 13% 113.6

ATTErBERG LIMITS: LL 29 PL 15

REMARKS Samples compacted at 3% over optimum

moisture content to 88% of maximum density,
 saturated for two days, lines closed, stressed to
 20% strain at 0.06"/min..



TRIAxIAL TEST DATA

TWIN CITY TESTING
662 CROMWELL AVENUE
ST. PAUL, MN. 55114

JOB NO. 9-5483

PROJECT NSP SHERBURNE COUNTY GENERATING PLANT

BORING NO. _____ SAMPLE NO. 3-T-2 DEPTH _____

TYPE OF TEST U-U (Saturated)

SAMPLE SIZE: 2.0" x 4.0"

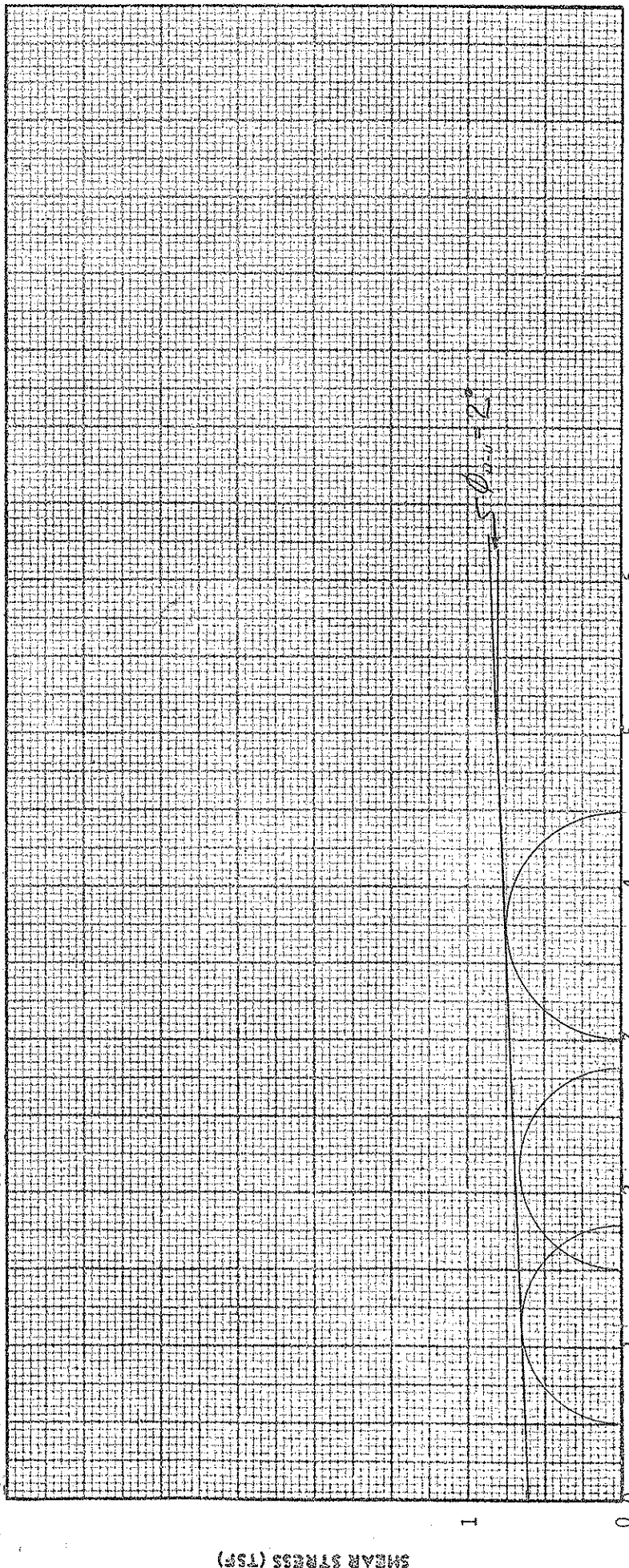
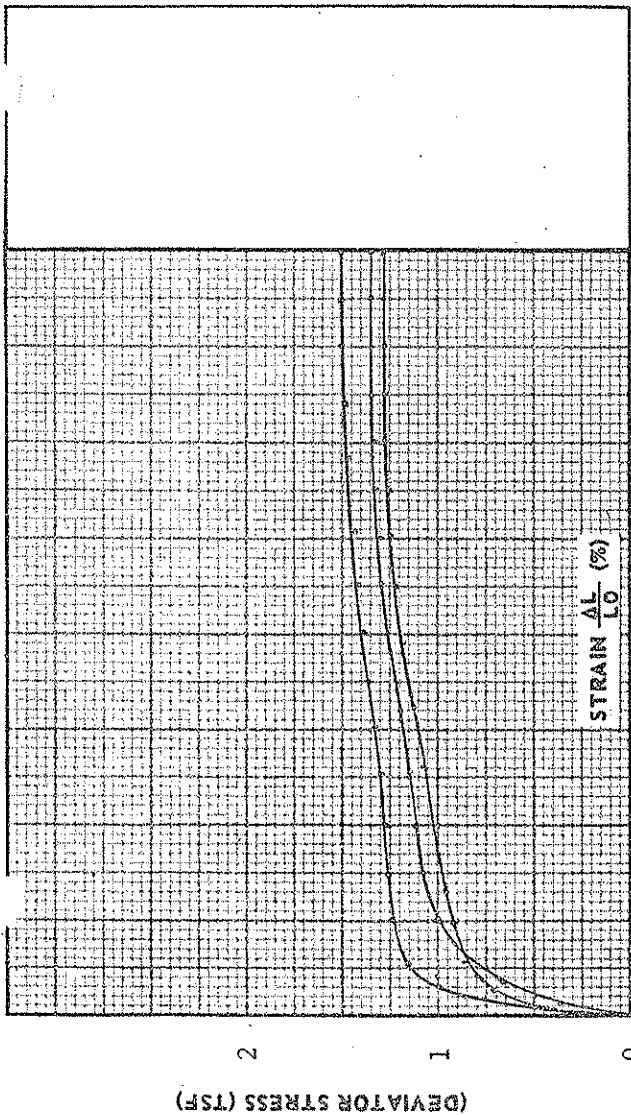
SOIL TYPE: Clayey Sand (SC)

MOISTURE-DENSITY: 13% 116.2

ATTErBERG LIMITS: LL 29 PL 15

REMARKS Samples compacted at 3% over optimum moisture content to 90% of maximum density,

saturated for two days, lines closed, stressed to 20% strain at 0.06"/min.



TWIN CITY TESTING
 662 CROMWELL AVENUE
 ST. PAUL, MN. 55114

TRIAxIAL TEST DATA

JOB NO. 9-5483

PROJECT NSP SHERBURNE COUTNY GENERATING PLANT

BORING NO. 3-T-3 DEPTH

TYPE OF TEST U-U (Saturated)

SAMPLE SIZE: 2.0" x 4.0"

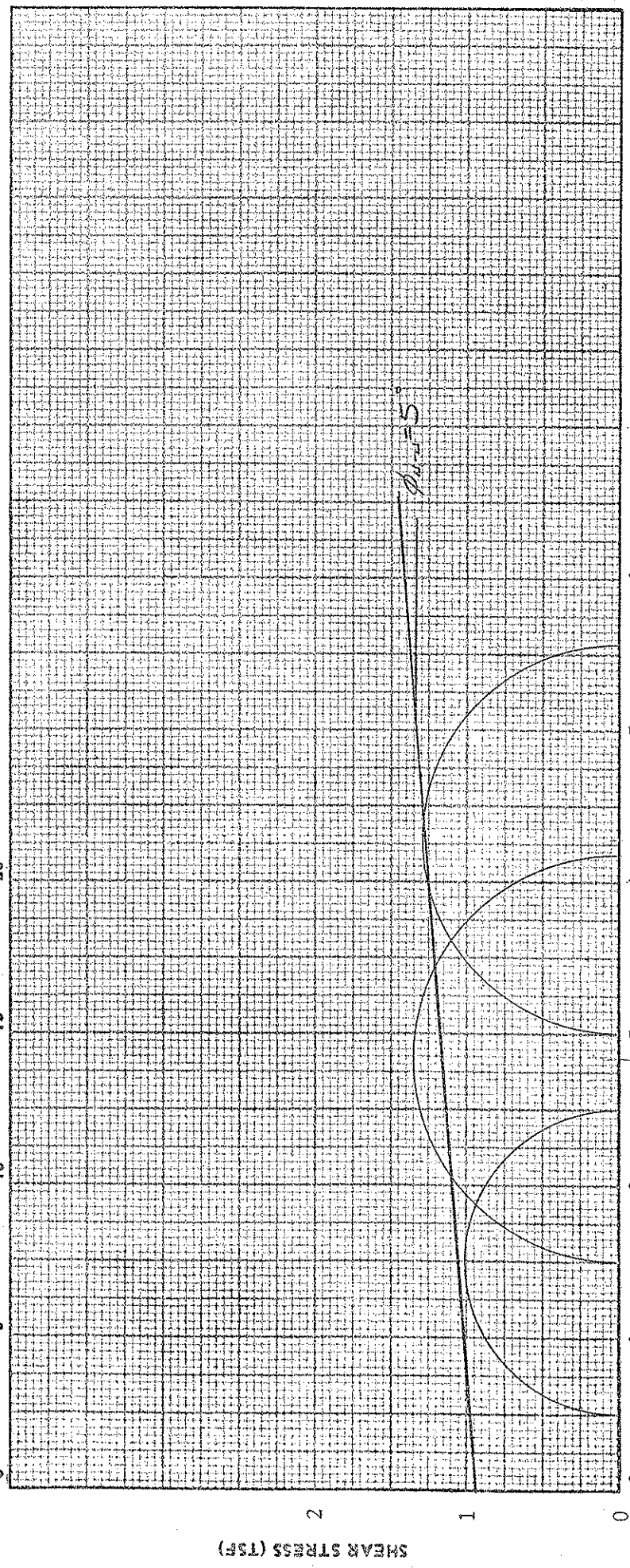
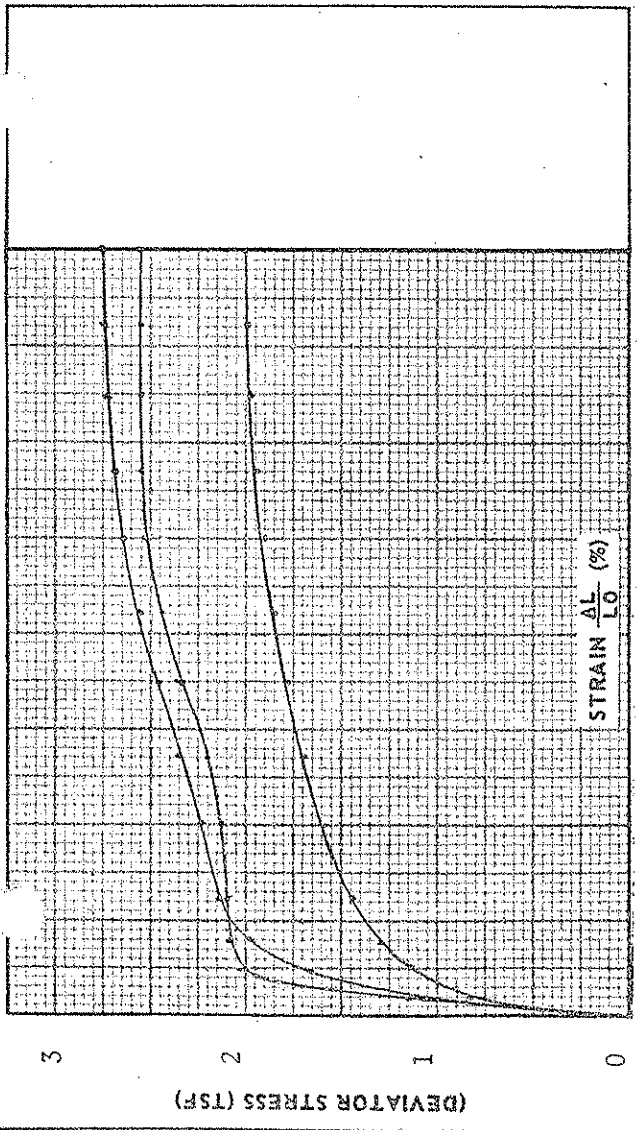
SOIL TYPE: CLAYEY SAND (SC)

MOISTURE-DENSITY: 13% 120.1

ATTERBERG LIMITS: LL 29 PL 15

REMARKS Samples compacted at 3% over optimum

moisture content to 93% of maximum density,
 saturated for two days, lines closed, stressed to
 20% strain at 0.06"/min.



TRIAxIAL TEST DATA

TWIN CITY TESTING
 662 CROMWELL AVENUE
 ST. PAUL, MN. 55114

JOB NO. 9-5483

PROJECT NSP SHERBURNE COUNTY GENERATING PLANT

BORING NO. SAMPLE NO. 3-T-4 DEPTH

TYPE OF TEST U-U (Saturated)

SAMPLE SIZE: 2.0" x 4.0"

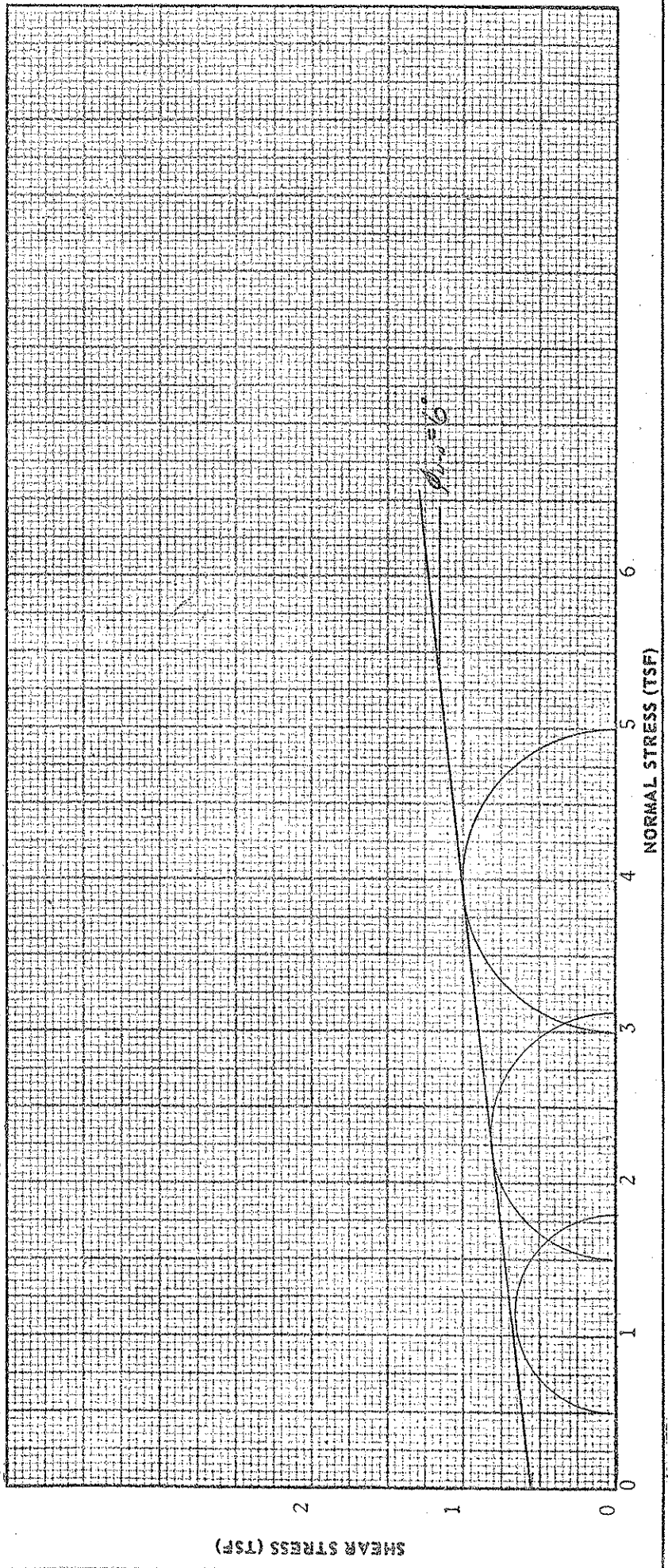
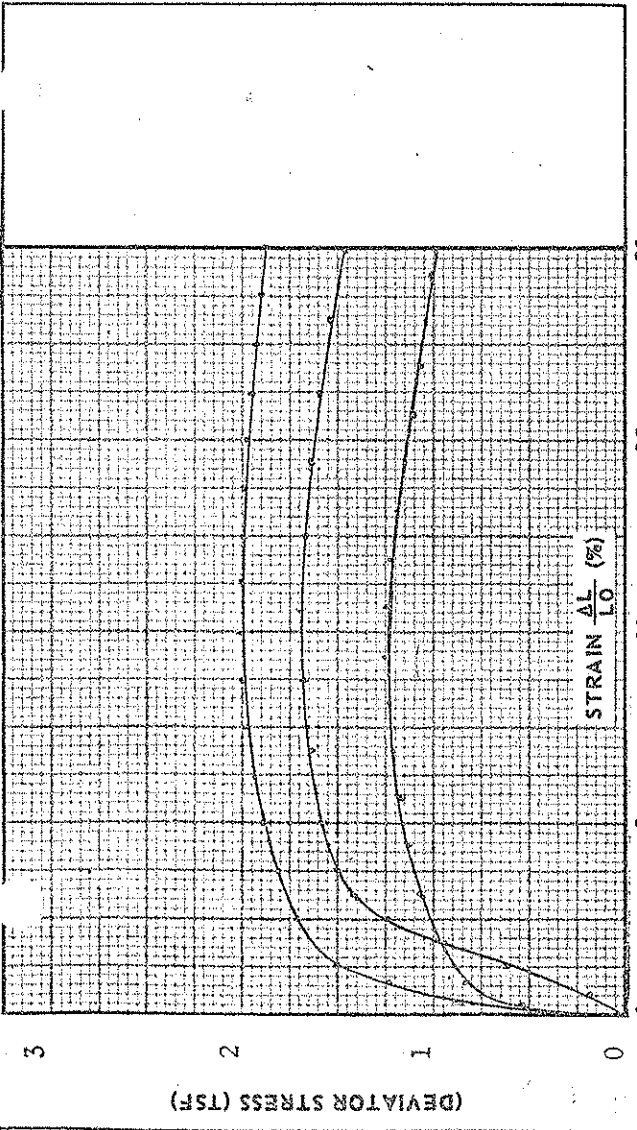
SOIL TYPE: Clayey Sand (SC)

MOISTURE-DENSITY: 16% 113.6

ATTErBERG LIMITS: LL 29 PL 15

REMARKS Samples compacted at 6% over optimum moisture content to 88% of maximum density,

saturated for two days, lines closed, stressed to 20% strain at 0.06"/min.



TRIAxIAL TEST DATA

TWIN CITY TESTING
662 CROMWELL AVENUE
ST. PAUL, MN. 55114

JOB NO. 9-5483

PROJECT NSP SHERBURNE COUNTY GENERATING PLANT

BORING NO. 3-T-5 SAMPLE NO. 3-T-5 DEPTH

TYPE OF TEST U-U (Saturated)

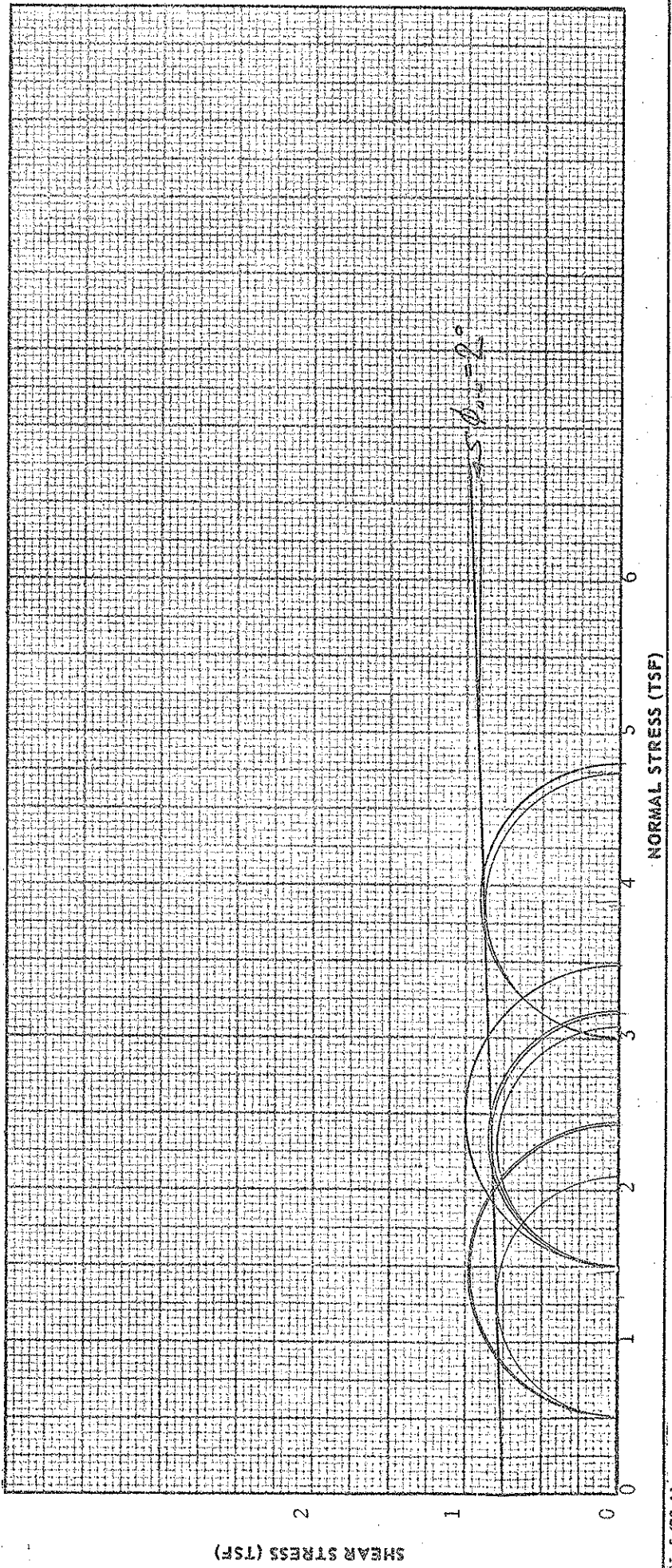
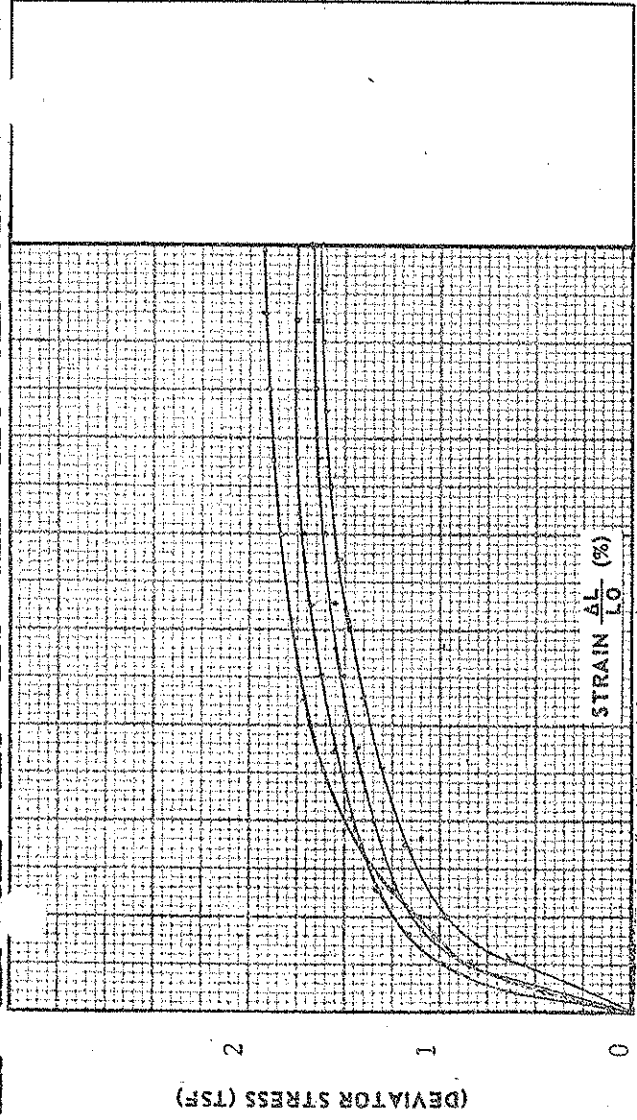
SAMPLE SIZE: 2.0" x 4.0"

SOIL TYPE: CLAYEY SAND (SC)

MOISTURE-DENSITY: 16% 116.2

ATTERBERG LIMITS: LL 29 PL 15

REMARKS Samples compacted at 6% over optimum moisture content to 90% of maximum density, saturated for two days, lines closed, stressed to 20% strain at 0.06"/min.



TWIN CITY TESTING
662 CROMWELL AVENUE
ST. PAUL, MN. 55114

TRIAxIAL TEST DATA

JOB NO. 9-5483

PROJECT NSP SHERBURNE COUNTY GENERATING PLANT

BORING NO. _____ SAMPLE NO. 3-T-6 DEPTH _____

TYPE OF TEST U-U (Saturated)

SAMPLE SIZE: 2.0" x 4.0"

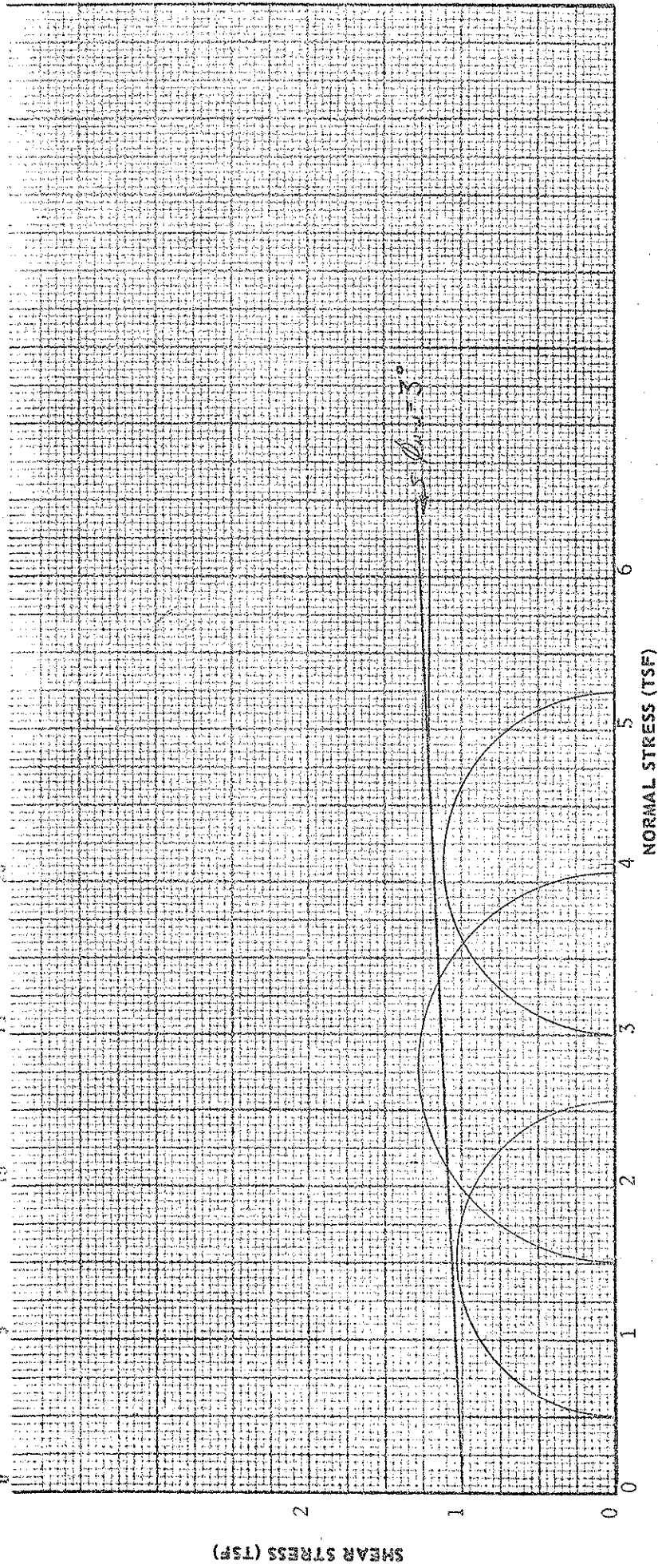
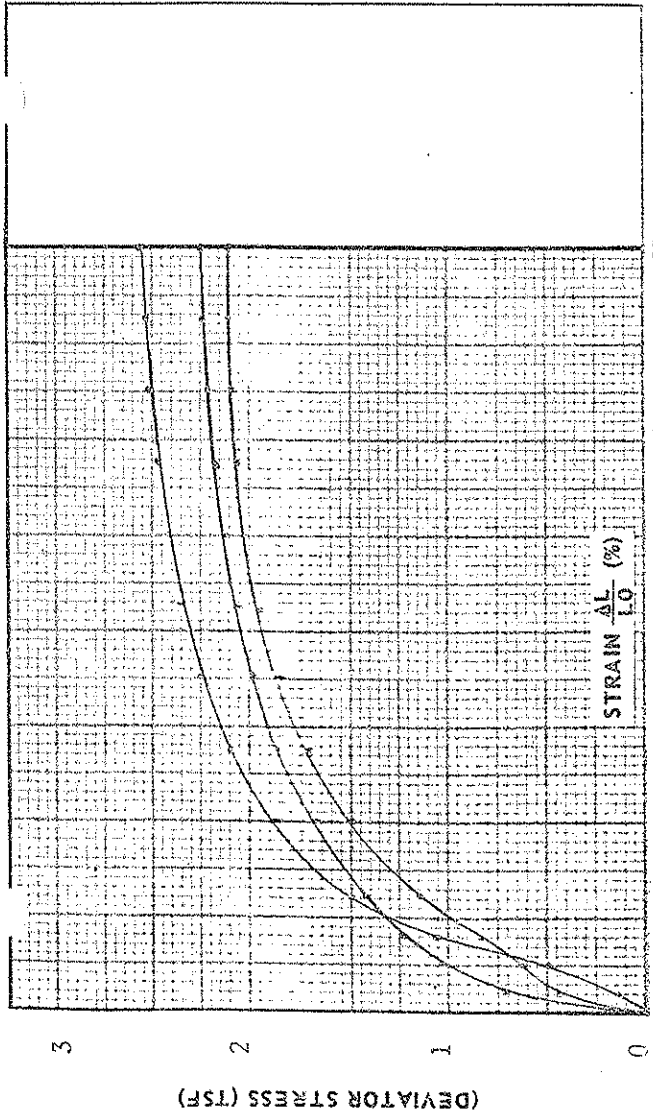
SOIL TYPE: CLAYEY SAND (SC)

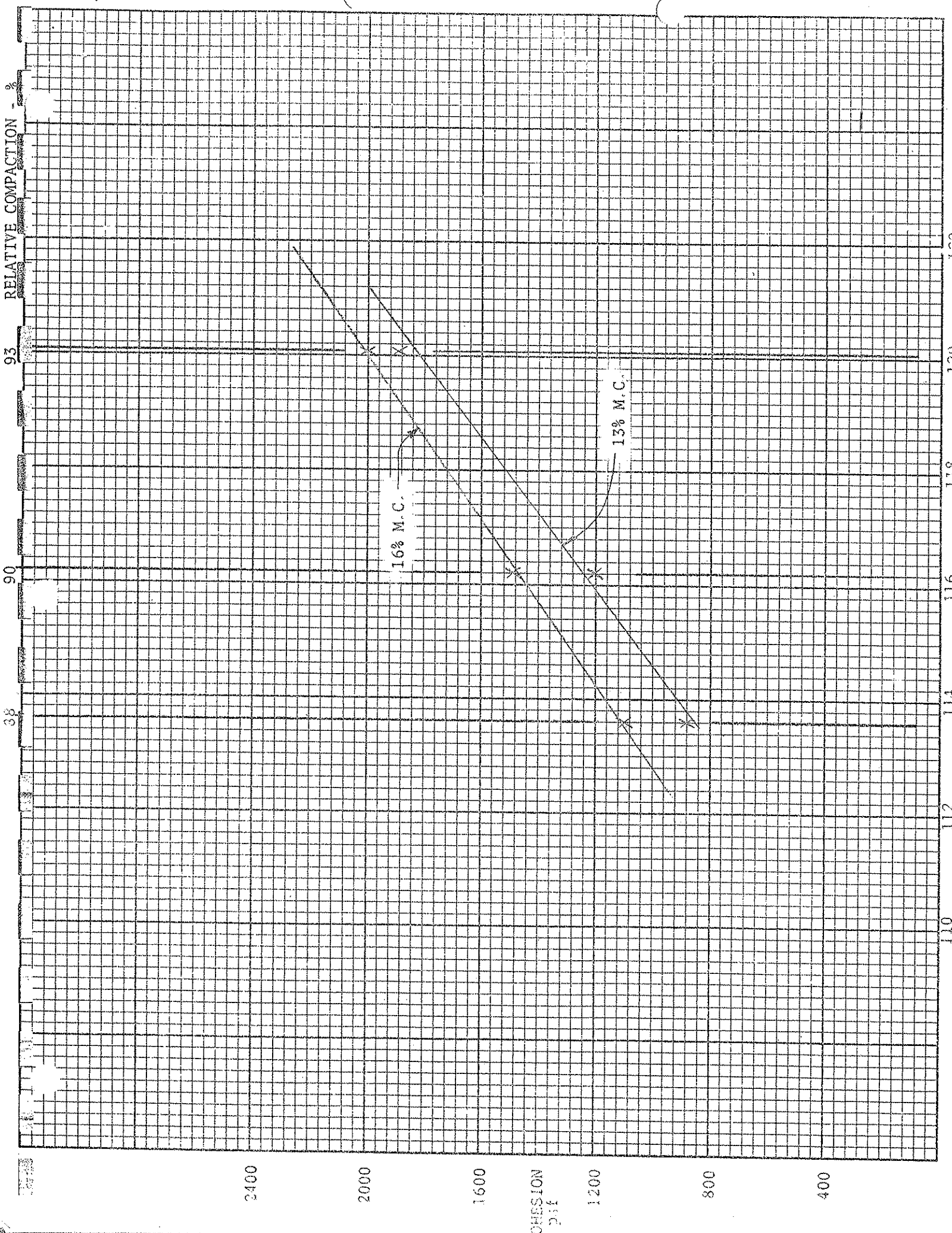
MOISTURE-DENSITY: 16% 120.1

ATTErBERG LIMITS: LL 29 PL 15

REMARKS Samples compacted at 6% over optimum moisture content to 93% of maximum density,

saturated for two days, lines closed, stressed to 20% strain at 0.06"/min.





RELATIVE COMPACTION - %

93

90

38

122

120

118

116

114

112

110

3400

2000

1600

1200

800

400

MAXIMUM DRY DENSITY
p_{max}

16% M.C.

13% M.C.

TWIN CITY TESTING AND ENGINEERING LABORATORY, INC.

ENGINEERS AND CHEMISTS

OCT 15 1974



DIN

662 Cromwell Avenue - St. Paul, Minn. 55114

REPORT OF: ADDITIONAL SOIL TESTS

SIPW 96A341

PROJECT: COAL AND ASH STORAGE AREAS
 REPORTED TO: SHERBURNE COUNTY GENERATING PLANT
 Northern States Power Company
 414 Nicollet Mall
 Minneapolis, MN 55401
 Attn: Mr. J. V. Sullivan

LABORATORY No. 9-5696

PROJECT	ENGINEER & CONST
CITY	
DATE	30S October 10, 1974
FURNISHED BY	1- Black and Veatch
COPIES TO	1-Northern States Power Company Quality Assurance
	2-Northern States Power Co. - Jobsite
Pls Handle	Return to
Comments	

INTRODUCTION

This report presents the results of additional laboratory testing we have performed on samples of the impervious fill material for the coal and ash storage areas at the referenced project. The purpose of this additional testing was to further evaluate the consolidation, shrinkage and permeability characteristics of this fill if placed at a moisture content above those currently allowed by the project specifications. The purpose of this report is to present our findings and conclusions. This work was done in accordance with your verbal authorization on August 7, 1974.

LABORATORY TEST PROCEDURES AND RESULTS

The laboratory testing consisted of consolidation, shrinkage and permeability tests. One consolidation test was performed on a sample of the clayey sand molded to a dry density of 113.5 lbs/cuft. at a moisture content of 18.2%. These values are 90% of maximum density and 7% above optimum moisture content, as determined by ASTM:D1557 (modified proctor). The test results are shown on the attached void ratio vs pressure and deformation vs time plots.

A linear shrinkage test was performed to aid in qualitatively evaluating the shrinkage properties of the soil. The test consisted of molding a rectangular sample about 4" long and 1" by 1" in cross section with the moisture content at about the liquid limit. The liquid limit was estimated at 28%, based on previous testing which indicated a range of liquid limits from 25% to 32% for this material. The sample was oven dried.

TWIN CITY TESTING AND ENGINEERING LABORATORY, INC.**ENGINEERS AND CHEMISTS**

662 Cromwell Avenue - St. Paul, Minn. 55114

REPORT OF:

ADDITIONAL SOIL TESTS

DATE: October 10, 1974

PAGE: 2



LABORATORY No. 9-5696

The test indicated a linear shrinkage of about 6.8%.

A falling head permeability test was performed on a remolded sample of the material compacted to 90% relative density and 7% over optimum moisture content. The resultant k-value was 3.93×10^{-9} cm/sec. The results are shown on the attached data sheet.

DISCUSSION OF RESULTS

The consolidation test results indicate the compacted clay will be relatively incompressible below a load intensity of 4000 psf, with the compressibility potential increasing above that load. Below 4000 psf, consolidation will be due mainly to recompression of the material. Beyond 4000 psf, consolidation will be due to virgin compression of the material. We estimate total settlement could be on the order of 10" to 12". 50% of the consolidation should occur in about 3 months and 90% in about one year after the material is placed. Since construction of the dikes has progressed over staged periods of time, and about 35' of fill has been placed to date, the post-construction settlement of the clay core would probably be less than 6", possibly on the order of 2" to 4". Almost all settlement should occur within 1½ years after all the load has been placed.

On the basis of the shrinkage test, we estimate the compacted fill would shrink very little due to a lowering of the moisture content. The linear shrinkage of the non-compacted sample was about 6.8%, which is very small.

TWIN CITY TESTING AND ENGINEERING LABORATORY, INC.

ENGINEERS AND CHEMISTS

662 Cromwell Avenue - St. Paul, Minn. 55114

ADDITIONAL SOIL TESTS

REPORT OF:



DATE: October 10, 1974

PAGE: 3

LABORATORY No. 9-5696

The permeability test results indicate the permeability of the fill material should be sufficiently low to limit seepage losses to the project requirements.

Very truly yours,

Donovan K. Stormoe, P.E.

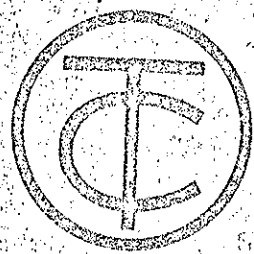
DKS:arl

Summary

Testing During Construction
OCT 26 1977
of the Ash Basin Line
- Sherco

NORTHERN STATES POWER COMPANY
SHERBURNE COUNTY GENERATING PLANT
UNIT NO. 1
NEAR BECKER, MINNESOTA

TWIN CITY TESTING AND ENGINEERING LABORATORY INC.
ST. PAUL, MINNESOTA



- TESTS
- INSPECTIONS
- RESEARCH

BISMARCK - FARGO - GRAND FORKS - MINOT, NORTH DAKOTA
SIOUX FALLS, SOUTH DAKOTA
WATERLOO, IOWA
ROCHESTER, MINNESOTA

TWIN CITY TESTING AND ENGINEERING LABORATORY, Inc.

CHEMICAL & PHYSICAL TESTS • INSPECTIONS • RESEARCH

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January 15, 1975

Northern States Power Co
414 Nicollet Mall
Minneapolis, MN 55401

Attn: Mr Pete Johnson

Dear Mr Johnson

Subj: Inspection and Testing
Coal and Ash Storage Areas
Sherburne County Generating Plant
Becker, Minnesota - Laboratory #9-5899

This is a summary of progress reports presenting our inspection findings and test results for the referenced project. We are sending you three copies. Additional copies are being sent as noted below. This work is being done in accordance with your purchase order #C88754, dated August 23, 1973.

Additional reports will be submitted as the project progresses. If you have any questions or desire further information, please contact us.

Very truly yours

Michael O'Donnell
Civil Engineer

Donovan K Stormoe, P.E.

MO/DKS/rs

Copies to

- 1) Northern States Power Co - QA
Attn: Mr David V Collins
- 2) Northern States Power Co - Becker
Attn: Mr Curt Sillman
- 1) Black & Veatch
Attn: Mr John Vines
- 2) J A Danens & Son Inc

INSPECTION AND TESTING DURING EARTHWORK OPERATIONS
COAL AND ASH STORAGE AREAS

NORTHERN STATES POWER COMPANY
SHERBURNE COUNTY GENERATING PLANT
UNIT NO. 1
NEAR BECKER, MINNESOTA

*Summary Report of Testing
From Aug 16, 1973 thru Dec 5, 1974*

Specification 5377-D-4C

DIN 96A341

Purchase Order No. C88754

Laboratory No. 9-5899

By

Twin City Testing and Engineering Laboratory Inc
662 Cromwell Avenue
St Paul, Minnesota 55114

NORTHERN STATES POWER COMPANY
SHERBURNE COUNTY GENERATING PLANT
UNIT NO. 1
NEAR BECKER, MINNESOTA

INTRODUCTION

This report concerns the full-time inspection and testing we performed during the earthwork operations at the above referenced project. The purpose of this report is to briefly summarize the contents of previous progress reports and the different tests which were performed. During the period of August 16, 1973, through December 6, 1974, twenty individual progress reports were forwarded to you describing the testing, inspection and recommendations made during each report period. In addition, two separate reports were prepared to further describe the properties of the soil used to construct the dams. Six data sheets and three graphs are attached with this report, and should supplement the progress reports and be considered as an index to all the reports.

SUMMARY

The first data sheet (Report Summary) lists the tests which were performed during each report period. The tests were categorized into five types of tests: density tests, proctors, gradations, field tests, and laboratory tests. The density tests, which were the most numerous type of test performed, are listed numerically through test #2284. The field tests are also listed numerically through test #233. The field tests include moisture content tests, -#200 gradations and Atterberg limits which were performed periodically to better define the conditions of the soil cement and impervious soils.

SUMMARY
(cont.)

The remaining tests are identified according to the type of material tested. The first numbers or letters of the identification refers to the corresponding proctor sample number. The following letters pertain to the type of test performed. The key to the letters is as follows:

- A - Asphalt Test
- C - Compression Test
- CE - Concrete Test
- CP - Check Proctor
- CS - Consolidation Test
- G - Gradation
- P - Permeability Test
- T - Triaxial Test

The last number relates the number of similar tests performed on the same type of material. In other words, this number is merely a counter if more than one test was performed.

The density test summary shows the number of initially passing and initially failing density tests in each progress report. The summary shows approximately 10% of the density tests initially taken failed to meet the project specifications. With the exception of the remaining twelve failing tests described in report #20, all failing test areas were either retested with satisfactory results or approved by you. If more information on any one density test or group of density tests is needed, refer to the individual test data sheets or summary sheets which are attached with the progres reports.

The proctor summary sheets lists the different types of materials encountered at the site. As specified, the field density tests were evaluated according to the moisture-density relationship of soil as designated by ASTM:D1557-70, Method A or C. A total of twenty-eight modified proctors (5 point curves) were performed and the corresponding maximum density and optimum moisture content are listed. The materials were visually and manually classified in accordance with the Unified

SUMMARY
(cont.)

Soil Classification System, and a gradation was performed on each soil type to verify the classification. In order to assure the continuance of a specific soil type, check proctors (3 point curves) were performed periodically, and the total number of check proctors for each soil type is shown.

The field test summary sheet contains the total number and corresponding averages of the moisture content tests taken in the soil cement, moisture content tests taken in the impervious materials, the -#200 gradation performed for the impervious materials, and the Atterberg limits performed for the questionable material.

The compression test summary sheet lists the compressive strengths in chronological order for the soil cement and Gunite concrete. By examining the results of the soil cement tests (especially proctor #8), one notices the values are very erratic. As discussed in report #12, the lower compressive strengths are due to the confinement of the water in the soil cement which causes the soil cement to cure at a much slower rate. The soil cement and Gunite had an average 7 day compressive strength of 640 psi and 4470 psi, respectively. The soil cement compressive strength increased to an average value of 1070 after 14 days, and the Gunite strength increased to an average of 7190 psi after 28 days. These tests were performed only to verify the quality and adequacy of the material used in constructing the coal retaining berm.

The permeability summary sheet includes more data pertaining to the test than the previously mentioned summary sheets. It identifies the types of tests performed and type of material tested. In addition, the consistency of the soils before the test and the general source of the material is also listed. The resultant K-values (coefficient of permeability) of the impervious material used to construct the

SUMMARY
(cont.)

dams range from 10^{-7} centimeters per second to 10^{-9} centimeters per second. These values are affected by several factors, including soil structure and texture, compaction and moisture content. At your request, K-values were plotted on a graph of permeability versus moisture content. The graph shows the permeability gradually decreasing as the moisture content is increased. The graph also approaches a K-value of 10^{-9} centimeters per second near a moisture content of 8% over optimum moisture content. At this point, we would expect the permeability to begin to increase as the moisture content increases. Other experimental data, such as the attached Portland Cement Association and the Cedargren graphs, suggests that the K-value will indeed increase as the moisture content increased beyond a certain point of wetness.

REMARKS

If you have any questions concerning this report or if we can be of further assistance to you, please contact us.

REPORT SUMMARY

<u>Report Number</u>	<u>Report Period</u>	<u>Density Tests</u>	<u>Proctors</u>	<u>Gradation</u>	<u>Field Tests</u>	<u>Laboratory Tests</u>
1	8/16-10/7	1-149	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12	4-G-1, 4-G-2, 1G, 2G, 3G, 5G, 6G, 9G, 10G, 11G	1-37	9-P, 8-C-1, 8-C-2, 8-C-3, 8-C-4, 8-C-5, 8-C-6, 8-T-1
2	10/8-10/14	150-165	14, 15, 16	12G, 13G, 15G, FR-G-2, 16G, FR-G-1	38-48	CE1, A-1, 8-C-7, C-C-8
3	10/15-10/21	166-194			49-56	
4	10/22-10/28	195-230	13, 17, 18, 3CP1, 8CP1, 8CP2, 13CP1	17G, 18G, FR-6-3, FR-G-4	57-59	13T1, 17T1, 18T1, 18T2, 15T1, 13CS1, 18CS1, 18CS2, 18CS3, 13P1, 13P2, CE2, 8C9, 14C1, 14C2, 14C3, 14C4, 14C5, 14C6, 14C7, 14C8
5	10/29-11/4	231-258	19, 20, 6CP1	19G, 4G3, 4G4, 4G5, 20G1, 20G2	60-67	
6	11/5-11/11	259-280	21	FR-G-5	68-74	14C9, 14C10, 14C11
7	11/12-11/18	281-314	13-CP-2	FR-G-6, FR-G-7, FR-G-8, FR-G-9, FR-G-10	75-79	12P1, 15P1, 15P2, 15T1
8	11/19-12/2	315-346	22, 23	20G3, 20G4, 20G5, 20G6, 23G1, 23G2, 21G1, 22G1, RA-G-1	80-82	RA-G-1
9	12/3-12/14	347-409	24	22-G-2, 24-G-1	83-85	RA-G-2, GU-G-1, GU-C-1 thru GU-C-10
10	5/1-5/12	410-457	3CP2, 19CP1, 15CP1, 21CP1	25-G-1, RA-G-3, RA-G-4	86-94	
11	5/13-5/26	459-497	25, 26, 27, 3CP3, 6CP1, 13CP3, 24CP1	26G, 27G	95-99	3-P-1, 3-P-2
12	5/27-7/31	498-1076	28, 2CP1, 5CP1, 8CP3, 8CP4, 13CP4, 6CP2, 24CP2, 28CP1, 28CP2, 28CP3, 28CP4	28G, FR-G-11 thru FR-G-14, Ballast Tests	100-145	CE3, A2, 28P1, 28P2, 28P3, 28P4, 8C10 thru 8C17, GUC11 thru GUC18

REPORT SUMMARY
(cont.)

<u>Report Number</u>	<u>Report Period</u>	<u>Density Tests</u>	<u>Proctors</u>	<u>Gradation</u>	<u>Field Tests</u>	<u>Laboratory Tests</u>
13	8/1-8/16	1077-1239	17CP1, 6CP3, 28CP5		146-173	Borings 1-4, 28P5, 28C18 thru 8C24
14	8/19-8/30	1240-1399	17CP2, 28CP6	RA-G-5, RA-G-6, RA-G-7	174-203	
15	8/31-9/13	1400-1523	19CP2		204-208	8C25, 8C26, 17P2
16	9/14-9/27	1524-1700	24CP3, 24CP4, 17CP2, 28CP7	Ballast Tests	209-215	17P3, 28P6
17	9/28-10/11	1701-1873	2CP2, 28CP8, 28CP9		216-219	
18	10/12-10/31	1874-2060	5CP2, 17CP3, 17CP4, 19CP3, 21CP2	FR II-G-1 thru FR II-G-4	220-229	
19	11/1-11/15	2061-2201	3CP4, 22CP1, 19CP4	22G3	230-233	28P7, 17P4, 17P5
20	11/18-12/6	2202-2284				
Letter	10/74					28-CS-1
Report	6/74			362		3T1 thru 3T6

DENSITY TEST SUMMARY

<u>Report Number</u>	<u>Initially Passing</u>	<u>Initially Failing</u>	<u>Retests</u>
1	107	34	26-passed; 8-failed
2	13	3	1-passed
3	25	4	5-passed; 8 approved by NSP
4	32	3	3-passed; 1-failed
5	27	1	1-passed
6	17	3	3-passed; 2-failed
7	30	3	3-passed; 1-failed
8	27	5	4-passed
9	55	6	6-passed; 2-failed
10	42	5	6-passed; 1-failed
11	30	5	5 approved by NSP; 5-failed
12	546	31	31-passed; 2-failed
13	159	3	2-passed; 1-failed
14	146	11	10-passed; 3-failed
15	113	9	10-passed; 2-failed
16	165	11	12-passed; 1-failed
17	163	9	9-passed; 1-failed
18	174	11	9-passed; 1-failed
19	128	11	11-passed; 2-failed
20	67	14	7-passed; 2-failed

PROCTOR SUMMARY

<u>Proctor Number</u>	<u>Maximum Density</u>	<u>Optimum Moisture</u>	<u>Check Proctors</u>	<u>Classification</u>
1	114.0	13.0		Sand, fine grained, brown (SP)
2	121.0	9.7	2	Sand, fine grained, brown (SP-SM)
3	129.1	9.9	4	Clayey sand, fine grained, brown (SC)
4	115	12.4		Sand, medium to fine grained, brown (SP)
5	122	11.0	2	Sand, medium to fine grained, dark brown (SP-SM)
6	117.2	11.0	4	Sand, medium to fine grained, brown (SP)
7	124	10.7		Soil Cement
8	121.2	10.3	4	Soil Cement
9	131.1	11.6		Clayey and silty sand, fine grained, brown (SC)
10	126.0	10.0		Clayey sand, fine grained, brown (SC)
11	122.7	12.4		Sandy clay, brown (CL)
12	133.2	7.1		Silty sand, fine grained, brown (SM)
13	124.5	12.0	4	Clayey sand, fine grained, brown (SC)
14	125	9.6		Soil Cement
15	131.3	8.5	1	Silty sand, fine grained, brown (SM)
16	140.7	6.7		Silty sand, fine grained, reddish-brown (SM)
17	126.2	11.2	5	Clayey sand, fine grained, brown (SC)
18	120.9	13.1		Sandy clay, brown (CL)
19	116.0	12.9	4	Sand, fine to medium grained, brown (SP-SM)
20	116.3	12.3		Sand, fine to medium grained, brown (SP)
21	109.6	12.6	2	Sand, fine grained, light brown (SP-SM)
22	141.6	5.8	1	Class #5 Road Base (40% +4)
23	125.7	9.8		Sand, fine grained, brown (SP-SM)
24	113.7	12.2	4	Sand, fine grained, brown (SP)

FIELD TEST SUMMARY

Number of moisture content tests of soil cement = 35

Average value = 10.1%

Number of moisture content tests of clay = 147

Average value = 17.1%

*4.7-4% above
30" 1/11/50*

Number of -#200 gradation of clay = 49

Average value = 40%

Number of Atterberg limits = 7

PROCTOR SUMMARY
(cont.)

<u>Proctor Number</u>	<u>Maximum Density</u>	<u>Optimum Moisture</u>	<u>Check Proctors</u>	<u>Classification</u>
25	135.5	6.7		Silty sand, fine grained, reddish-brown (SM)
26	140.2	6.6		Silty gravel, brown (57% +4) (GP-GM)
27	134.1	9.8		Gravel and sand mixture, brown (57% +4) (GP)
28	128	10.2	9	Clayey sand, fine grained, brown (SC)
FR I	-	-	-	Type I Filter Rock
FR II	-	-	-	Type II Filter Rock
RA	-	-	-	Class A Rip-Rap

COMPRESSION TESTS SUMMARY

Sample Type (Days Cured) Strength In Psi

<u>Soil Cement (Proctor No. 8)</u>	<u>Soil Cement (Proctor No. 14)</u>	<u>Gunite</u>
M(7) 450	C(14) 345	Cyl(7) 1700
M(7) 445	C(14) 225	Cyl(7) 1490
M(7) 766	CL14) 360	T.P.(28) 4960
M(7) 764	C(14) 505	T.P.(28) 5270
C(14) 970	C(7) 520	T.P.(28) 6540
C(14) 920	C(7) 520	T.P.(28) 6630
C(14) 950	C(7) 950	T.P.(28) 5700
C(14) 710	C(7) 875	T.P.(28) 5840
M(28) 1195	C(14) 830	T.P.(28) 7000
M(7) 490	C(14) 620	T.P.(28) 9200
*Cu(14) 2700	C(14) 780	Cyl(7) 4810
Cu(14) 2160		Cyl(7) 4700
Cu(14) 1210		Cyl(28) 7070
Cu(14) 1980		Cyl(28) 8880
C(14) 1870		T.P.(7) 7550
C(14) 1700		T.P.(7) 6570
Cu(14) 288		T.P.(28) 8870
C(14) 1160		T.P.(28) 10290
C(14) 1120		
Cu(14) 380		
M(14) 214		
M(14) 242		
C(14) 1430		
C(14) 1380		
Cu(64) 116		
Cu(64) 1060		

Total number of tests in Gunite = 18

Total Number of tests in soil cement = 37

Average 7 day strength of soil cement = 640 psi

Average 14 day strength of soil cement - 1070 psi

Average 7 day strength of Gunite - 4470 psi

Average 28 day strength of Gunite - 7190 psi

M - Molded

C - Cored

Cu - Cube

Cyl - Cylinder

T.P. - Test Panel

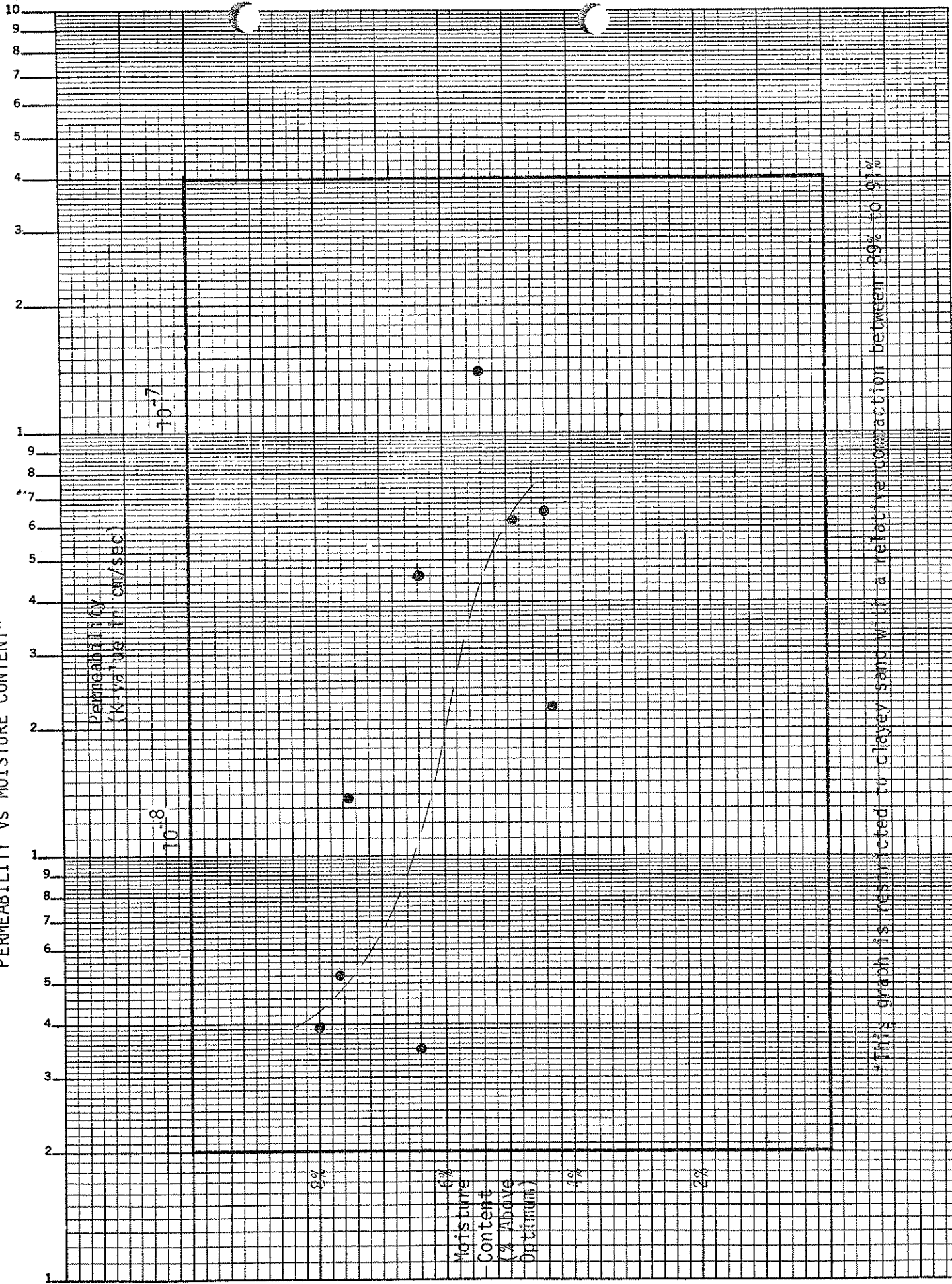
PERMEABILITY TESTS SUMMARY

<u>Material (Proctor No.)</u>	<u>Type of Test</u>	<u>Density/Moisture</u>	<u>Location</u>	<u>K-value</u>	<u>Average K-value</u>
3	Remolded	111.1/14.6	Borrow Pit	SC 6.11 x 10 ⁻⁸	3.31 x 10 ⁻⁸
3	Remolded	111.1/17.6	Borrow Pit	SC 5.09 x 10 ⁻⁹	
9	Remolded	122/11.7	Coal Yard	SC 8.4 x 10 ⁻⁸	8.4 x 10 ⁻⁸
12	Remolded	129/7.1	Borrow Pit	SM 1.46 x 10 ⁻⁵	1.46 x 10 ⁻⁵
13	In-place	111.5/15.3	North dam	SC 2.27 x 10 ⁻⁸	1.41 x 10 ⁻⁸
13	Remolded	109.6/14.6	North dam	SC 5.5 x 10 ⁻⁹	
15	Remolded	122.1/10.5	Borrow Pit	SM 1.17 x 10 ⁻⁶	6.92 x 10 ⁻⁷
15	Remolded	122.1/8.5	Borrow Pit	SM 2.13 x 10 ⁻⁷	
17	In-place	113.5/16.6	Flyash Pond	SC 1.4 x 10 ⁻⁷	6.68 x 10 ⁻⁸
17	In-place	114.0/17.6	Recycle Basin	SC 4.55 x 10 ⁻⁸	
17	In-place	115.0/15.6	West dam	SC 6.51 x 10 ⁻⁸	
17	In-place	120/13.4	Bottom Ash Pond	SC 1.64 x 10 ⁻⁸	
28	In-place	-	South Dam	SC 6.0 x 10 ⁻⁸	4.48 x 10 ⁻⁸
28	In-place	-	South Dam	SC 1.34 x 10 ⁻⁷	
28	In-place	-	South Dam	SC 4.26 x 10 ⁻⁸	
28	In-place	-	East Dam	SC 2.45 x 10 ⁻⁸	
28	Remolded	113.5/18.2	Center Dike	SC 3.93 x 10 ⁻⁹	
28	In-place	113.5/17.7	East Dam	SC 1.37 x 10 ⁻⁸	
28	Remolded	115/16.6	East Dam	SC 3.5 x 10 ⁻⁹	

PERMEABILITY TESTS SUMMARY

<u>Material (Proctor No.)</u>	<u>Type of Test</u>	<u>Density/Moisture</u>	<u>Location</u>	<u>K-value</u>	<u>Average K-value</u>
3	Remolded	111.1/14.6	Borrow Pit	6.11×10^{-8}	3.31×10^{-8}
3	Remolded	111.1/17.6	Borrow Pit	5.09×10^{-9}	
9	Remolded	122/11.7	Coal Yard	8.4×10^{-8}	8.4×10^{-8}
12	Remolded	129/7.1	Borrow Pit	1.46×10^{-5}	1.46×10^{-5}
13	In-place	111.5/15.3	North dam	2.27×10^{-8}	1.41×10^{-8}
13	Remolded	109.6/14.6	North dam	5.5×10^{-9}	
15	Remolded	122.1/10.5	Borrow Pit	1.17×10^{-6}	6.92×10^{-7}
15	Remolded	122.1/8.5	Borrow Pit	2.13×10^{-7}	
17	In-place	113.5/16.6	Flyash Pond	1.4×10^{-7}	6.68×10^{-8}
17	In-place	114.0/17.6	Recycle Basin	4.55×10^{-8}	
17	In-place	115.0/15.6	West dam	6.51×10^{-8}	
17	In-place	120/13.4	Bottom Ash Pond	1.64×10^{-8}	
28	In-place	-	South Dam	6.0×10^{-8}	4.48×10^{-8}
28	In-place	-	South Dam	1.34×10^{-7}	
28	In-place	-	South Dam	4.26×10^{-8}	
28	In-place	-	East Dam	2.45×10^{-8}	
28	Remolded	113.5/18.2	Center Dike	3.93×10^{-9}	
28	In-place	113.5/17.7	East Dam	1.37×10^{-8}	
28	Remolded	115/16.6	East Dam	3.5×10^{-9}	

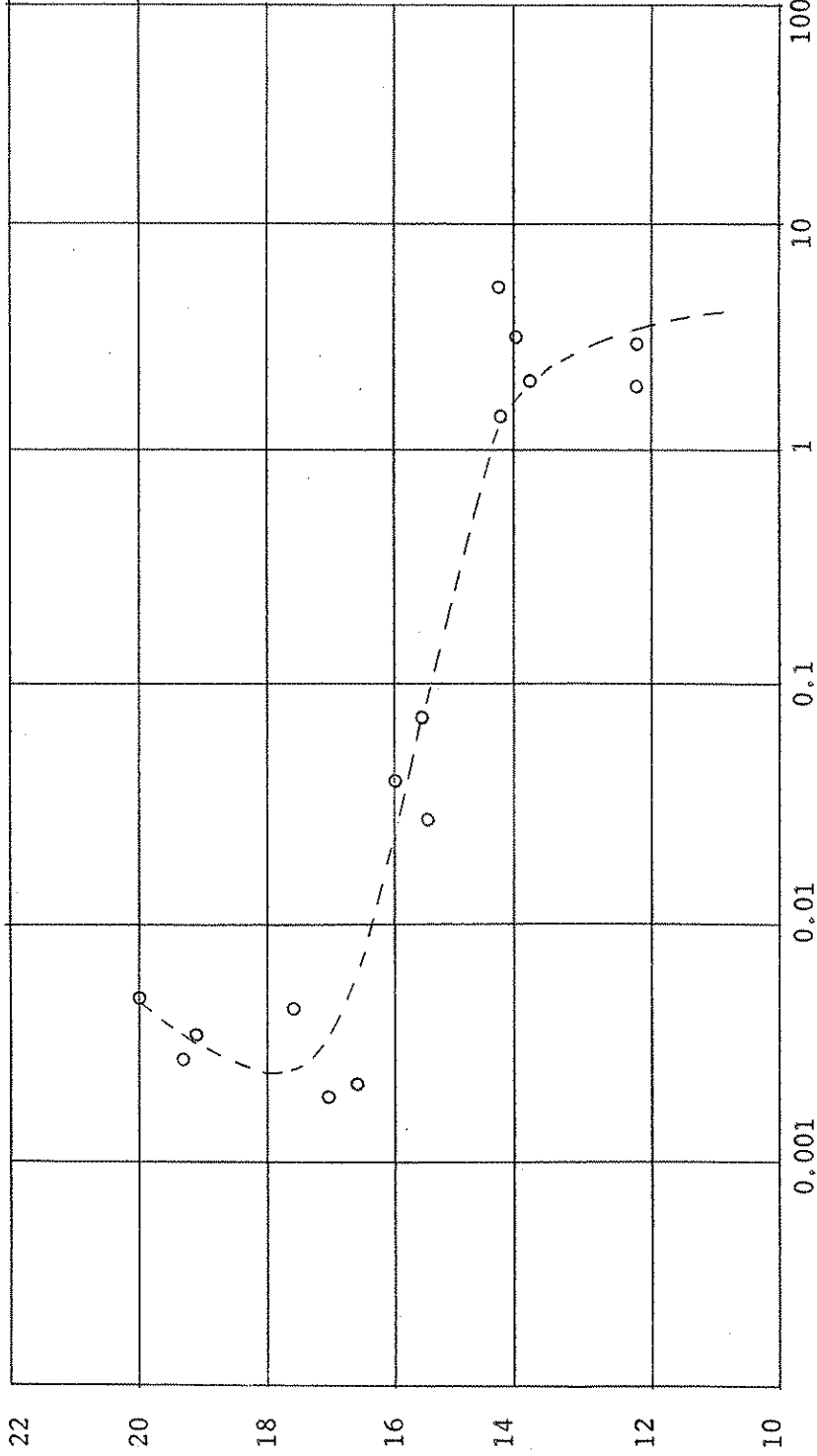
PERMEABILITY VS MOISTURE CONTENT*



PERMEABILITY VERSUS MOLDING WATER CONTENT

(After Cary, et al, 1943)

20% Glacial Till - 80% Gravel

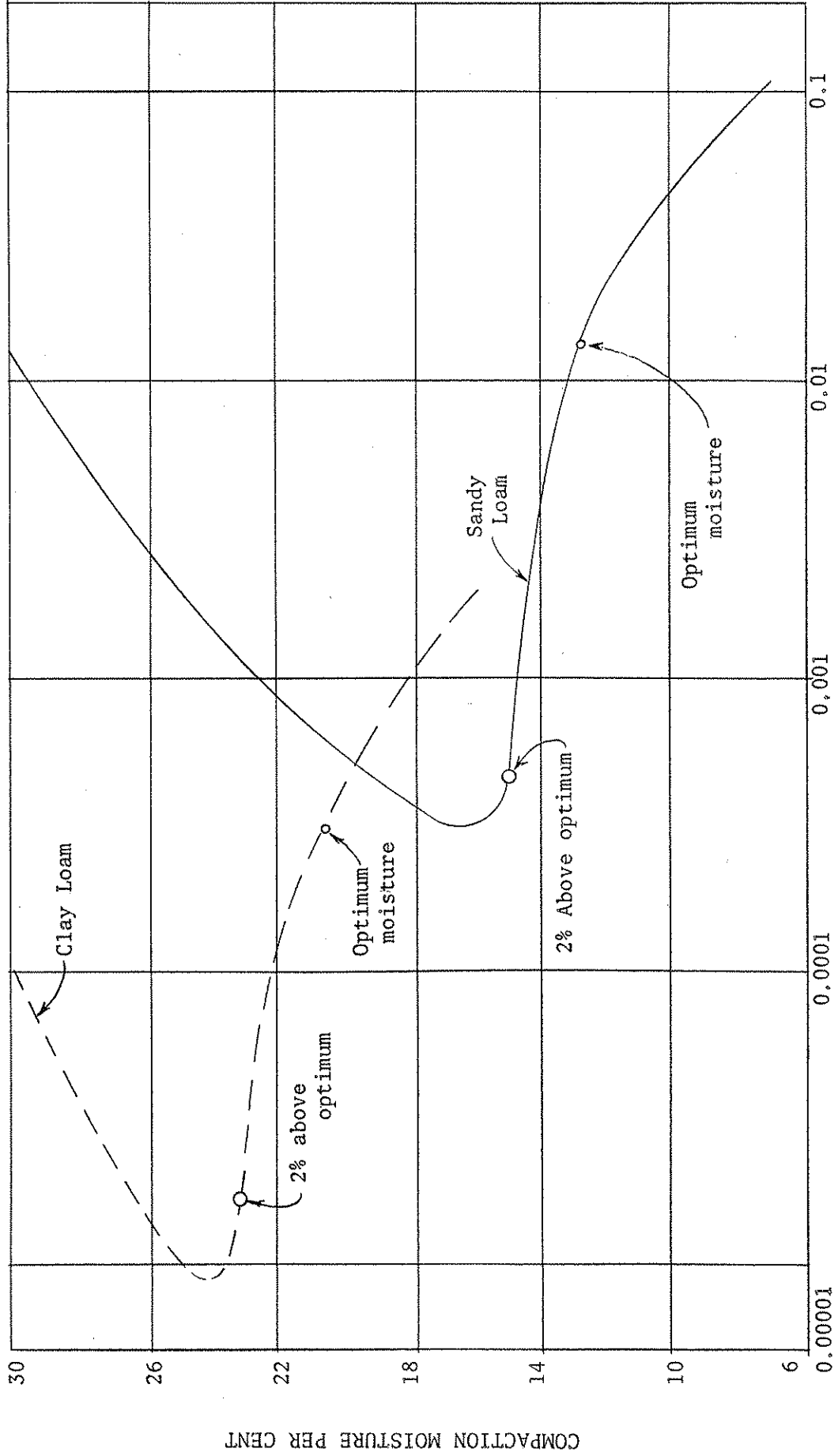


Permeability $\text{cm/sec} \times 10^{-4}$

(a)

PERMEABILITY VERSUS COMPACTION MOISTURE

(After Portland Cement Association)



PERMEABILITY, FT PER DAY

TWIN CITY TESTING AND ENGINEERING LABORATORY, INC.

ENGINEERS AND CHEMISTS

662 Cromwell Avenue - St. Paul, Minn. 55114

REPORT OF: PERMEABILITY TESTS OF SOIL

PROJECT: NORTHERN STATES POWER COMPANY DATE: August 29, 1974
 SHERBURNE COUNTY GENERATING PLANT
 REPORTED TO: UNIT NO 1 - BECKER, MINNESOTA FURNISHED BY:
 Northern States Power Co COPIES TO:
 414 Nicollet Mall
 Minneapolis, MN 55401

Attn: Mr J V Sullivan

LABORATORY No. 9-5625

SAMPLE NUMBER: 28-P-5

DATE TESTED: August 16, 1974

UNIFIED SOIL CLASSIFICATION: Clayey sand, fine grained, brown (SC)

LOCATION: 50' N of center dike, Sta 14+00

ELEVATION: 945'

MOISTURE-DENSITY RELATION OF SOIL:

Method - ASTM:D1557-70

Maximum Dry Density (pcf) - 126.2

Optimum Moisture Content - 11.2

PERMEABILITY TEST:

Type of Test - Falling head

Type of Specimen - Recompacted sample

Dry Density (pcf) - 113.5 (90% compaction)

Moisture Content - 18.2 (7.0% over optimum)

Sample Diameter (in.) - 2.85

Sample Height (in.) - 2.95

Confining Pressure (psi) - 4

Water Head (in.) - 60

Water Temperature (°C) - 23

Coefficient of Permeability (cm/sec @ 20°C) - 3.93×10^{-9}

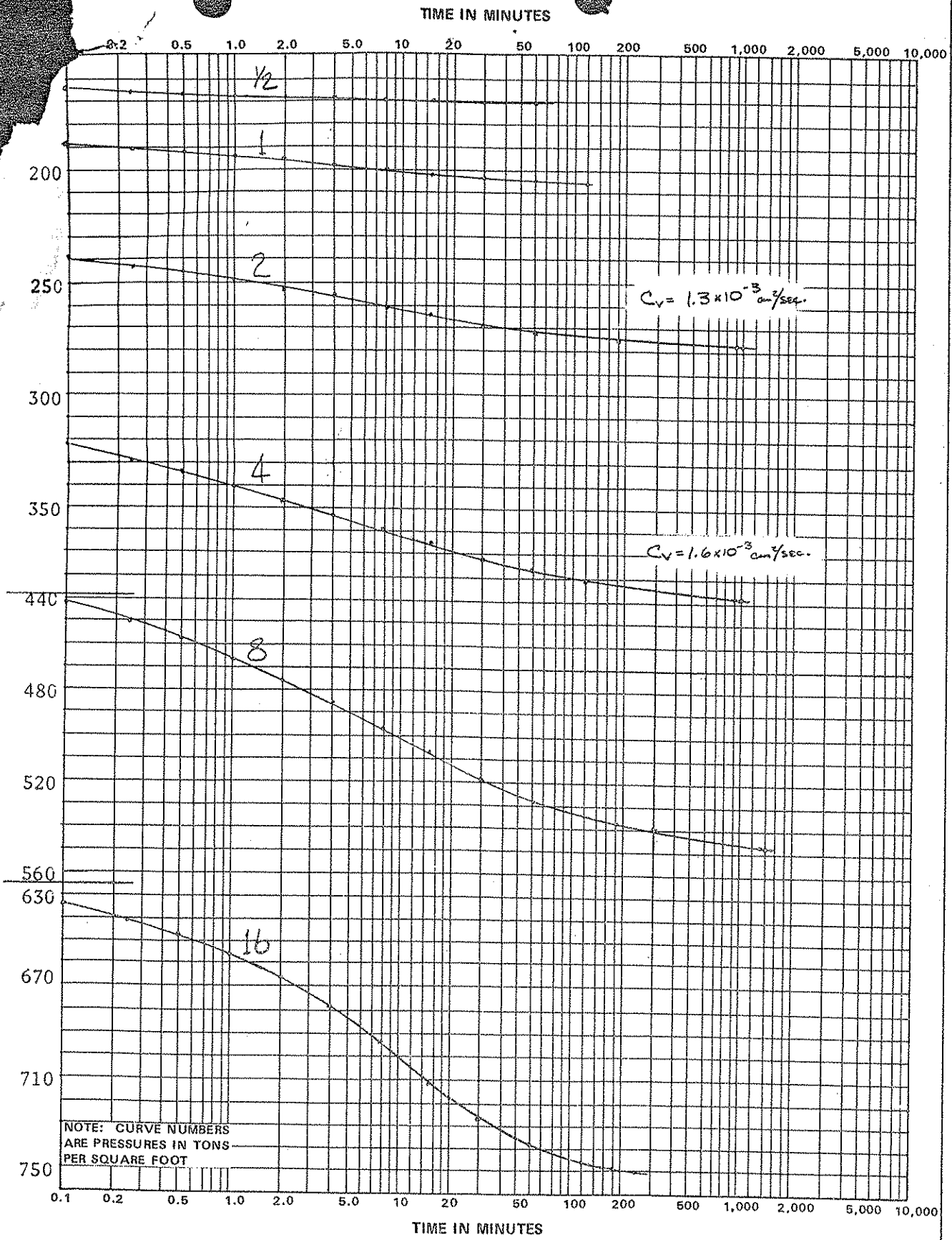
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Twin City Testing and Engineering Laboratory, Inc.

By

TWIN CITY TESTING AND
ENGINEERING LABORATORY, INC.
67 CHAMBERLAIN ST.
ST. PAUL, MN 55114
PHONE 5127645-6446

DEFORMATION IN 10⁻⁴ INCHES



PROJECT: SHERBURNE COUNTY GENERATING PLANT
 JOB NO.: 9-5625 SAMPLE NO.: 28-CS-1 Location: Center Dike Sta 14+00 Elevation: 945'

CONSOLIDATION TEST-TIME CURVES

Project: SHERBURNE COUNTY GENERATING PLANT

Job No. 9-5625

Location: Center Dike Sta 14+00

Sample No. 28-GS-1

Elevation: 945'

Initial Sample Height (IN.) 0.803

Sample Diameter (IN.) 1.875

Date: August 27, 1974

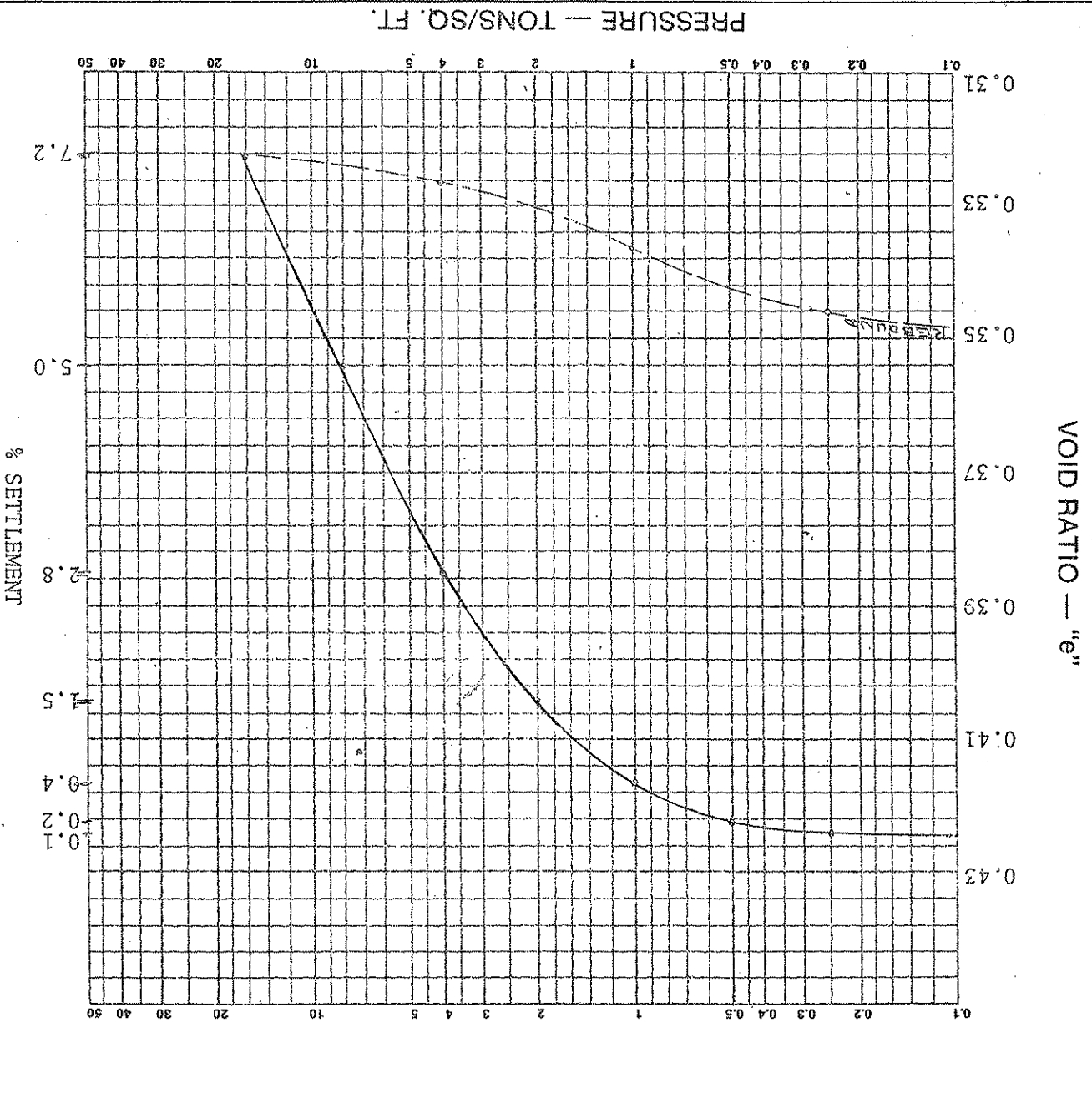
Soil Type (ASTM: D2487) CLAYEY SAND, fine grained, brown (SC)

Original Moisture Content, Dry Density 18.2 % 113.5 PCF

Liquid Limit: _____ % Plastic Limit: _____ %

Preconsolidation Pressure (Pc) 2.1 tsf

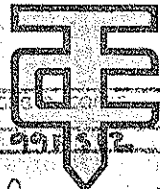
Compression & Recompression Index: C_c 0.101 C_r 0.012



VOID RATIO VS. PRESSURE
 CONSOLIDATION TEST CURVE

TWIN CITY TESTING AND
 ENGINEERING LABORATORY, INC.
 662 CROMWELL AVENUE
 ST. PAUL, MN. 55114

SEP 15 1975



twin city testing
and engineering laboratory, inc.

662 CROMWELL AVENUE
ST. PAUL, MN 55114
PHONE 612/645-3601

FILE COPY -- PLANT ENGINEERING	
Date	Project
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Comments	

September 9, 1975

Northern States Power
414 Nicollet Mall
Minneapolis, MN 55401

Attn: Mr Pete Johnson

Gentlemen

Subj: Additional Laboratory Tests - Clay
Lining Soil - Sherburne County Generating
Plant - Becker, Minnesota - D.I.N. ~~96A341~~ 99A512
Purchase Order #C1030 - TCT #9-6410

OFFICERS:

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Vice-President Chemistry

CLINTON R. EUE
Secretary-Treasurer

Attached please find the results of the additional proctor, gradation and triaxial tests performed on a sample of the clay lining soil used in the ponds at this project. The purpose of these tests was to further evaluate the effect on the soil strength when compacting the soil at a moisture content well over optimum moisture content. This work was done in accordance with verbal authorization from you.

We have previously conducted full-time inspection and testing services during the earthwork operations at this project. We refer you to our previous reports for the results of the inspection and testing.

These additional tests were conducted on a sample of brown, clayey sand soil collected by us at the site on August 13, 1975. The soil is similar to the material used for previous proctor sample #3. The gradation, or hydrometer, test specimen is designated sample #3-G-3 (the third gradation for material similar to that used for proctor #3). The proctor specimen is designated 3-CP-5, the fifth check on proctor #3. The triaxial test specimen is designated #3-T-7, the seventh triaxial test performed on material similar to sample #3. The triaxial test specimens were compacted to 90% of relative density at a compaction moisture content of 16.4% or about 8% above optimum moisture content. The samples were then saturated and the triaxial tests were run under unconsolidated,

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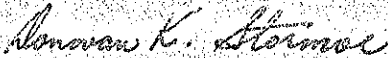
WATERLOO, IOWA

undrained conditions. The results of the tests are shown on the attached curves and data sheet.

As shown by the test results, the sample contained about 45% material finer than the #200 sieve, and the cohesion is about 0.4 - 0.45 tsf (800 - 900 psf).

If you have any questions, or desire further information, please contact us.

Very truly yours

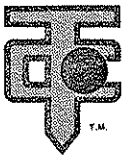


Donovan K Stormoe, P. E.

DKS:kr

Encs.

Copies: 1 - Northern States Power Company - Quality Assurance
2 - Northern States Power Company - Sherburne County Generating Plant
1 - Black and Veatch



twin city testing
and engineering laboratory, inc.

862 CHOMWELL AVENUE
ST. PAUL, MN 55114
PHONE 612/645-3601



MOISTURE - DENSITY CURVE

SAMPLE NO. 3-CP-5

PROJECT: SHERBURNE COUNTY GENERATING PLANT
BECKER, MINNESOTA - D.I.N. 96A341

DATE:

REPORTED TO: Northern States Power Co.

COPIES TO:

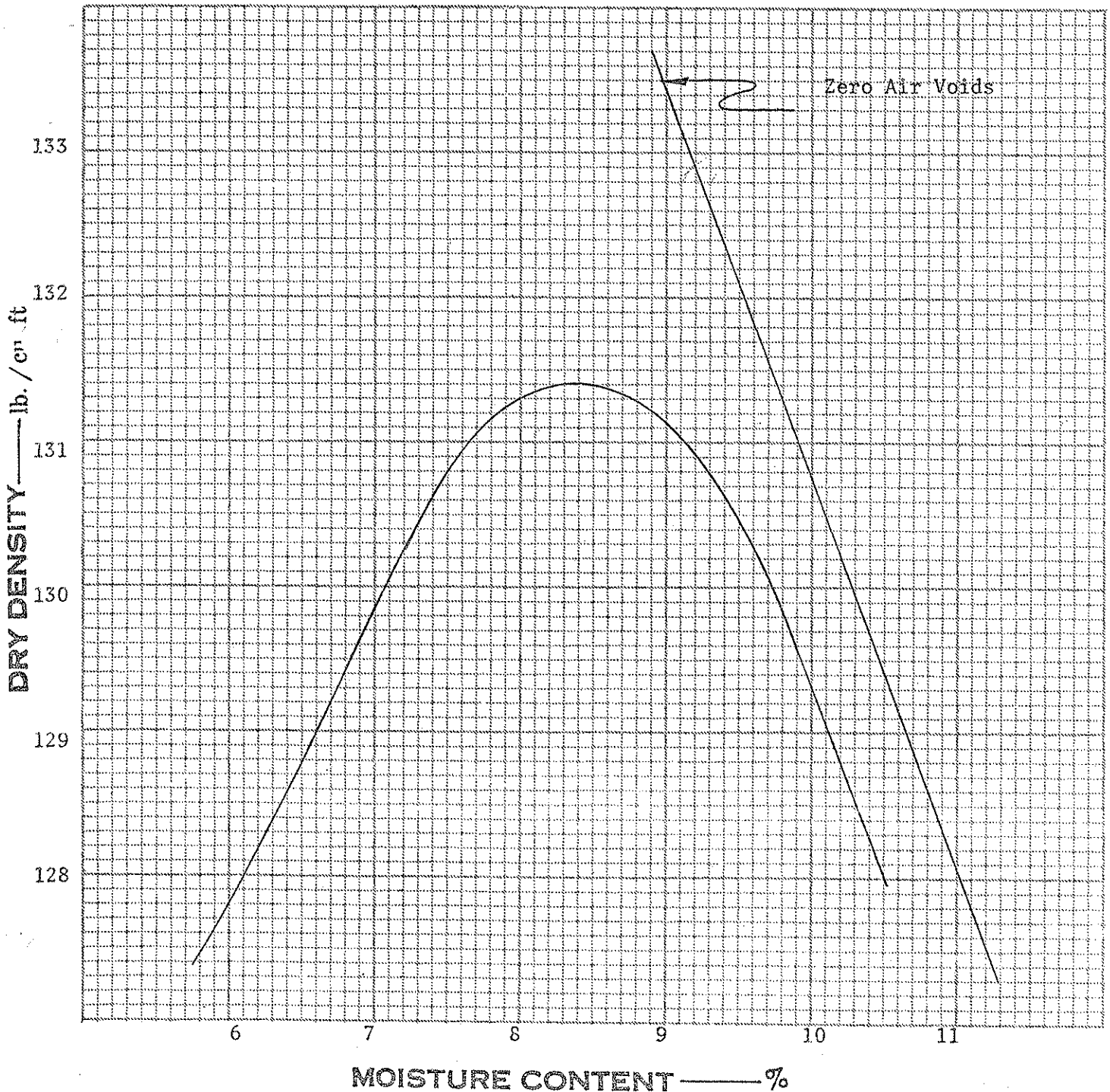
LABORATORY NO. 9-6410

METHOD OF TEST: ASTM: D 1557-70, Method A

TYPE OF MATERIAL: Clayey Sand, brown (SC)

MAXIMUM DENSITY: 131.4 lb. / cu. ft.

OPTIMUM MOISTURE: 8.4 %



TRIAxIAL TEST DATA

Date September 9, 1975

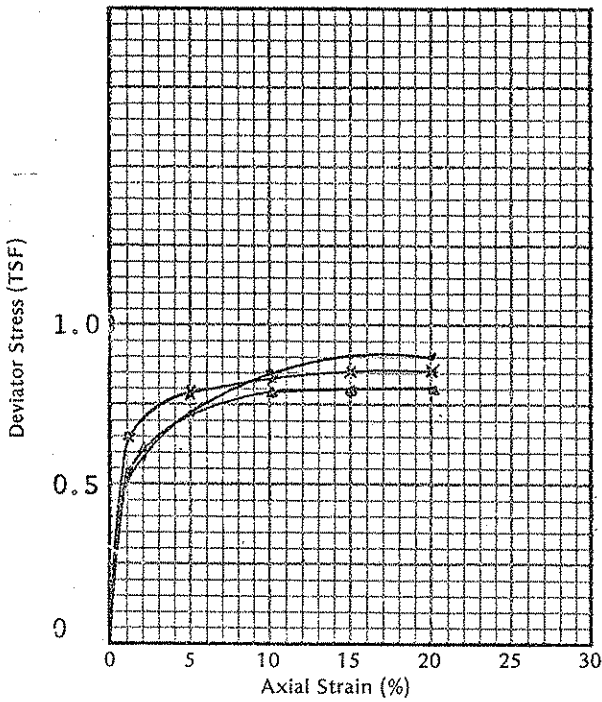
Job No. 9-6410

Project SHERBURNE COUNTY GENERATING PLANT - BECKER, MINNESOTA - D.I.N. 96A341

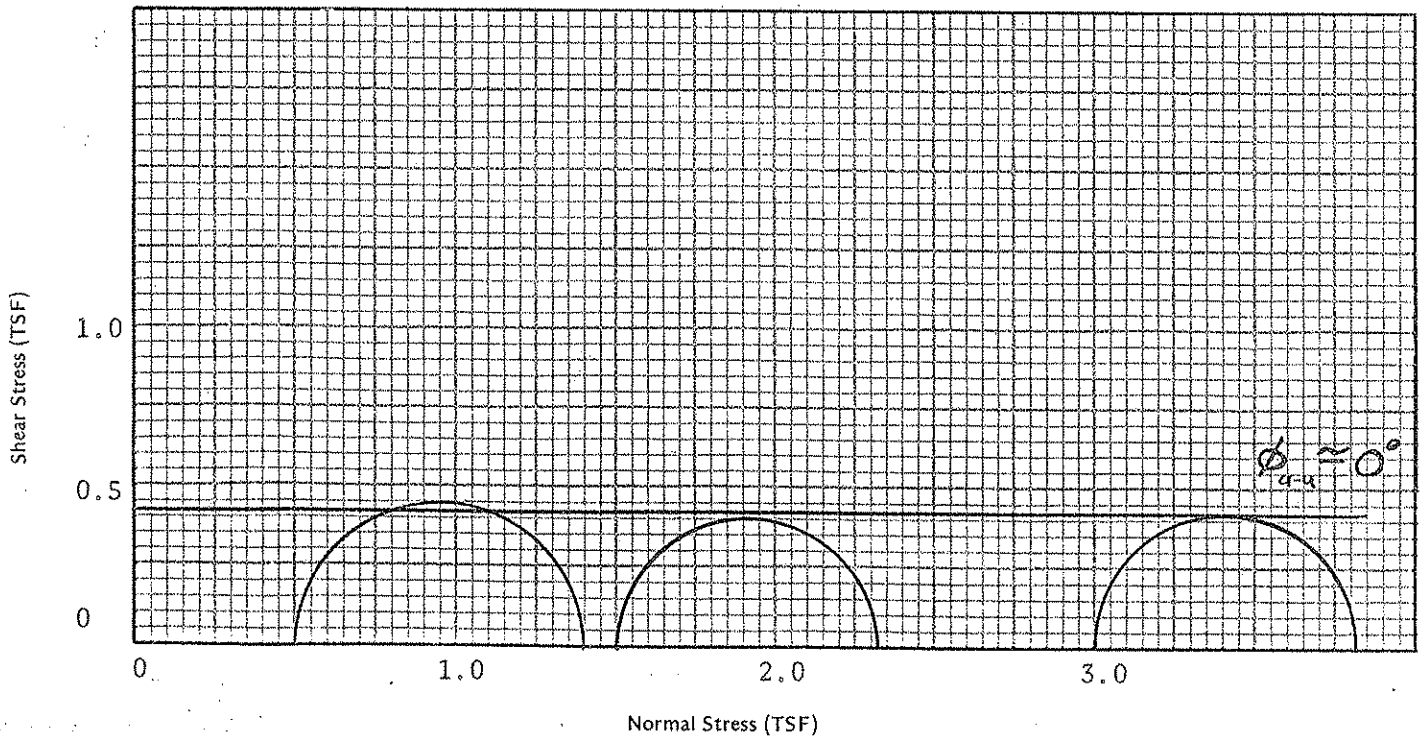
Boring No. _____ Sample No. 3-T-7 Depth (ft) _____ Type of Sample Recompacted

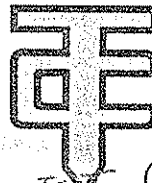
Soil Type Clayey Sand, brown (SC) Type of Test U-U Saturated

Remarks: Specimens, 2" in diameter and 4" long, were compacted to 90% relative density at a compaction moisture content of 16.4%. Specimens were then saturated for 2 days and were then strained to 20% at a rate of 0.080 in/min.



SPECIMEN NO.		1	2	3
Initial	Diameter (inches)	2.0	2.0	2.0
	Height (inches)	4.0	4.0	4.0
	Moisture Content (%)	16.4	16.4	16.4
	Dry Density (PCF)	118.3	118.3	118.3
	Saturation (%)			
Before Shear	Void Ratio			
	Moisture Content (%)			
	Dry Density (PCF)			
	Saturation (%)			
	Void Ratio			
	Back Pressure (TSF)			
	Minor Principal Stress TSF (σ_3)	0.50	1.50	3.00
	Maximum Deviator Stress TSF ($\sigma_1 - \sigma_3$)	0.90	0.81	0.86
	Ultimate Deviator Stress TSF ($\sigma_1 - \sigma_3$)	0.90	0.81	0.85
LL	PI			
PL	G _s			





Pete Johnson
twin city testing
and engineering laboratory, inc.

662 CROMWELL AVENUE
ST. PAUL, MN 55114
PHONE 612/845-3601

*Shero I. W. (E6881)
File
96A341*

July 22, 1975

Northern States Power Co
414 Nicollet Mall
Minneapolis, MN 55401

Attn: Mr J V Sullivan

Dear Mr Sullivan

Subj: Northern States Power Co
Sherburne County Generating Plant
E6881 and E7998 - P O #C1030
Becker, Minnesota
Laboratory #9-6252

This letter concerns the inspection and testing we are continuing to perform for the earthwork operations in the coal and ash storage areas at the above referenced project. This work is being performed under your purchase order #C1030.

Last year, the construction of the ash storage ponds continued into late fall. The freezing weather at that time posed a constant problem for the fill placement operations. Several areas of fill either froze during fill placement or shortly thereafter. Consequently, these areas did not receive ample compaction before freezing, and any compaction efforts after frost intrusion were ineffective.

Density tests were performed in these areas in order to maintain an accurate record of the location and a copy of these tests was sent to all parties involved. Similarly, these tests and test locations were discussed in our report #20, dated January 2, 1975. This letter, therefore, concerns the recompaction of the failing test areas, and the supplementary field density tests (designated as retests) taken this summer.

Between the dates of July 9 and July 14, 1975, the contractor recompacted the fill placed at the designated eleven failing test areas. The densification attained by the compaction operations was determined by performing thirteen density tests, and the results of these tests are attached. The results indicate the fill material in all eleven areas was satisfactorily recompacted, and

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TWIN CITY TESTING AND ENGINEERING LABORATORY, INC.**ENGINEERS AND CHEMISTS**

662 Cromwell Avenue - St. Paul, Minnesota 55114



REPORT OF: SOIL INSPECTION
 NORTHERN STATES POWER COMPANY
 SHERBURNE COUNTY GENERATING PLANT

PROJECT:

E6881 AND E7108

DATE:

October 15, 1973

REPORTED TO:

BECKER, MINNESOTA (DIN96A341)

COPIES TO: 1)

Northern States Power - QA
Attn: Mr. John MeierNorthern States Power Company
414 Nicollet Mall

1)

Northern States Power - Sherburne
County Generating Plant
Attn: Mr. Curt Sillman

Minneapolis, MN 55401

Attn: Mr. J. V. Sullivan

LABORATORY No. 9-4822

2) J. A. Danens & Son, Inc.

SUMMARY

This is the first in a series of periodic progress reports concerning the inspection and testing we are performing at the referenced project. Our inspection and testing indicates the earthwork is being performed in accordance with the project plans and specifications in all areas except the moisture content of the general embankment sand fill and the Class I clayey liner or core material. The sand moisture content is generally about 5% below the minimum specified, and the clay material is several percent above specified maximum moisture content. Additional laboratory testing is in progress to evaluate the clayey soils at lower relative densities and higher moisture contents.

INTRODUCTION

This report pertains to the inspection and testing we have performed during earthwork operations in the coal and ash storage areas at the referenced project. This report covers the period from August 16 through October 7, 1973. The purpose of this report is to summarize activities at the site, and to present the results of field and laboratory tests we performed during that period. This work is being done in accordance with verbal authorization from you.

FIELD PROCEDURES AND RESULTSReserve Coal Storage Area

Prior to the placement of the impervious earth blanket, the subgrade was compacted and tested. In all cases, the results of the field density tests indicated the specified compaction was attained by the initial compactive efforts.

The filling and compaction operations were concentrated primarily in the northern half of the site. Basically two types of soil were placed in the reserve coal storage area. A silty sand (SM) was placed in the central portion of the site, while a clayey sand (SC) was placed in ditches and in the remaining northern half of the storage area. The silty sand was found in the east dam between stations 28+00 and station 30+28 at elevation 943'. Atterberg limits, permeability tests and particle size gradations (ASTM:D421, ASTM:D423, ASTM:D424, ASTM:D1140 and ASTM:D2487-69) were performed to determine the acceptability of the materials. The results of these tests are attached.

Coal Yard Area Railroad (Track #1)

The subgrade for railroad track #1 was compacted and tested. Two gradations (4-G-1 and 4-G-2) were performed on site materials to determine suitability for use as subballast.

TWIN CITY TESTING AND ENGINEERING LABORATORY, INC.

ENGINEERS AND CHEMISTS

662 Cromwell Avenue - St. Paul, Minn. 55114

REPORT OF:

SOIL INSPECTION

DATE: October 15, 1973

PAGE: 2

LABORATORY No. 9-4822

FIELD PROCEDURES AND RESULTS
(cont.)Coal Yard Area Railroad (Track #1)
(cont.)

The test results were presented to you and the material was approved. Both the subgrade and subballast material met the specified compaction with the initial compactive efforts.

Water Cooling Tower #2

Granular fill was used to raise the area to elevation 969'. Six field density tests were taken during this construction, and the results of these tests verified the fill was satisfactorily compacted.

Coal Retaining Berms

The fill, which consisted mainly of sand, was placed and compacted in thin lifts using rappers. Since additional compaction was required near the edge of the slope, a "turtle type" hand operated compactor was utilized while placing the soil cement.

In order to aid the contractor in calibrating his soil cement equipment, gradation, modified proctor and loose density tests were performed on the sand to be used in the soil cement.

The efficiency of the soil cement compaction operation was checked by field density tests, moisture tests, compressive strength tests, and triaxial tests. The compaction of an individual lift of soil cement was primarily verified by the field density tests. However, since the soil type and the compaction effort were normally constant factors in the soil cement operations, a good check of the compaction was the moisture content of the mix. As discussed with Black and Veatch, the unconfined compressive strength tests and the unconsolidated, undrained (U-U) triaxial tests were performed to determine the actual strength of the in-place soil cement. The test results are attached.

As of October 5, 1973, the north berm was completed to elevation 979'; the center berm was completed to elevation 972'; and the south berm was completed to elevation 972'.

Bottom Ash Pond Dikes

Prior to the placement of the clay core and the impervious earth blanket, the subgrade was densified and tested. Type I material was then obtained from the borrow pit and compacted until the specified compaction was obtained. In an area between west dam station 24+00 and north dam station 3+00, the clay exceeded the maximum moisture requirements, and the specified compaction was not attained. Although additional compactive effort was applied, supplementary field tests on the recompacted area proved the soil to be below the specified density. Undisturbed samples of the soil in this area were returned to the laboratory for further testing and consideration.

TWIN CITY TESTING AND ENGINEERING LABORATORY, INC.

ENGINEERS AND CHEMISTS

662 Cromwell Avenue - St. Paul, Minn. 55114

REPORT OF:

SOIL INSPECTION

DATE: October 15, 1973

LABORATORY No. 9-4822

PAGE: 3

CONFERENCES

On October 3, 1973, J. A. Danens & Son, Inc., Twin City Testing and Northern States Power Company held a conference concerning the wet clay found in the borrow area. At the conclusion of this meeting agreement was reached upon two construction alternatives. These alternatives included either lowering the compaction requirements for the wet clay, or using a red silty sand found in the borrow pit as a substitute material. Permeability tests and triaxial tests will be run on both the silty sand and the wet clay to determine the feasibility of the alternatives.

REMARKS

As specified, the field in-place density tests were evaluated according to the moisture-density relation of soil as designated by ASTM:D1557-70. One hundred and forty-nine field density tests were taken in accordance with ASTM:D1556-64 during this period. A tabulation of the in-place density tests and summary of the test results to date is submitted. Also, a map showing the grid system used in the reserve coal storage area is included.

TWIN CITY TESTING AND
ENGINEERING LABORATORY, INC.

Michael O'Donnell
Michael O'Donnell
Civil Engineer

Donovan K. Stormoe
Donovan K. Stormoe, P.E.

MO:DKS:rs

TWIN CITY TESTING AND ENGINEERING LABORATORY, Inc.

CHEMICAL & PHYSICAL TESTS • INSPECTIONS • RESEARCH

OCT 29 1973

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ST. PAUL, MINN. 55114
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JEK	JES		JMB
GY	GS		DEL
RHF	RHS		CJR
AMK	AMS		MTO
JMN	JMS		
AEJ	AES		REH
PLS HANDLE		RETURN TO	
DESTROY			

October 24, 1973

Northern States Power Company
414 Nicollet Mall
Minneapolis, MN 55401

Attention: Mr. J. V. Sullivan

RE: Inspection and Testing
Coal and Ash Storage Areas
Sherburne County Generating Plant
Near Becker, Minnesota
Laboratory #9-4919

Gentlemen:

This is our second progress report presenting our inspection findings and test results for the referenced project. We are sending you three copies. Additional copies are being sent as noted below. This work is being done in accordance with your Purchase Order No. C 88754, dated August 23, 1973.

Additional reports will be submitted as the project progresses. If you have any questions or desire further information, please contact us.

Very truly yours,

TWIN CITY TESTING AND
ENGINEERING LABORATORY, INC.

Michael O'Donnell
Civil Engineer

Donovan K. Stormoe, P.E.

MO:DKS:rs

Copies to:

- 1) Northern States Power - Quality Assurance
Attn: Mr. John Meier
- 2) Northern States Power (Becker)
Attn: Mr. Curt Sillman
- 1) Black and Veatch
Attn: Mr. John Vines
- 2) J. A. Danens & Son, Inc.

NORTHERN STATES POWER COMPANY
SHERBURNE COUNTY GENERATING PLANT
UNIT NO. 1
NEAR BECKER, MINNESOTA

DIN 96A341
Purchase Order No. C88754
Laboratory No. 9-4919

INTRODUCTION

This report concerns the full-time inspection and testing we are continuing to perform during the earthwork operations in the coal and ash storage areas at the above referenced project. The purpose of this report is to present our inspection findings and testing results from the period of October 8 through October 14, 1973. This work is being conducted in accordance with your purchase order #C 88754 dated August 23, 1973.

The results of our work during the period from the beginning of this construction (August 16) through October 7 were included in our report #9-4822 to you dated October 15, 1973.

FIELD PROCEDURES AND RESULTS

Reserve Coal Storage Area

Operations performed in this area consisted of filling and compacting subgrade material. Two compaction tests, #163 and #164, were made in the southwest portion of the site in the compacted sand fill subgrade. The test results are attached and indicate the material was satisfactorily compacted.

Coal Retaining Berms

Work in this area consisted of placing granular embankment fill and soil cement in the center berm. The fill and soil cement were placed to approximate elevation

FIELD PROCEDURES AND RESULTS
(cont.)

Coal Retaining Berms
(cont.)

975'. A total of 2,745 cubic yards of soil cement was placed.

Five compaction tests were made in this area. The tests are #151, #157, #159, #160 and #165 and the results are attached. The test results indicated the specified compaction and moisture content were attained.

In addition to the above field tests, lab tests were performed on representative samples of the cement and asphalt being used in the soil cement process, as well as core samples of the soil cement. The tests on the cement included determining the air content, fineness and compressive strength in accordance with ASTM:C150. These tests indicated the cement meets the specifications for fineness and compressive strength, but contains a slightly higher air content (15%) than allowed for Type I cement (maximum 12%). Another sample of the cement was brought into the laboratory during this time period and additional tests are in progress. A viscosity test was performed on the asphalt sample to check compliance with AASHTO:M81 specification for RC-250 cut-back asphalt. The test results indicated the viscosity is within the range allowed by AASHTO:M81 specifications. The test on the soil cement cores, taken from field-placed material, consisted of unconfined compressive tests. These tests were made 14 days after the material was placed in the field. The test results revealed compressive strengths of 950 psi (68.5 Tsf) and 710 psi (51.0 Tsf). The lab results discussed above as well as other pertinent test information are shown on the attached data sheet.

Bottom Ash Pond Dikes

The amount of clay hauled to the dikes was limited by the heavy rains experienced during the work period. On October 8, a red silty sand was being placed on the west dam near station 22+00. However, a saturated silt was interbedded with the

FIELD PROCEDURES AND RESULTS
(cont.)

Bottom Ash Pond Dikes

silty sand causing the moisture content to be above optimum. As the results of an in-place density test (#150) indicated a low relative density, the contractor decided to return to hauling brown clayey sand. The moisture content of this clayey sand varied from 2% to 4% above optimum in the borrow area. Generally, up to 2% moisture is removed during the placement and compaction operations. Two field density tests (#154 and #155) indicated the specified compaction and moisture content was obtained.

Two gradation tests were performed on the Type I filter rock to determine the acceptability of the material. The test results indicated the filter rock was not within the specifications. However, on October 10, J. A. Danens and Son, Inc., received permission from you to place this material with the provision that additional gradation tests will be performed.

Six field density tests (#152, #153, #156, #158, #161 and #162) were taken in the granular embankment fill for the north and west dams. Since in most cases the results of the field density tests indicated the specified compaction was attained, approval for the placement of subsequent lifts was granted. However, the one remaining failing test area (indicated by test #162) will receive additional compaction and will be retested at that time.

CONFERENCES

On October 10, 1973, J. A. Danens & Son, Inc., Twin City Testing and Northern States Power held a conference concerning the wet clay found in the borrow area. On the agreement of all parties, a test program was initiated on the clay soils of average moisture content and clays of extremely high moisture content. Upon completion of the permeability, consolidation and triaxial testing, minimum

CONFERENCES
(cont.)

compaction and moisture content requirements will be assigned to the fill material placed for the dikes.

REMARKS

Our inspection and testing indicates the earthwork is being performed in accordance with the project plans and specifications in all areas except the moisture content of the general embankment sand fill. Additional laboratory testing is in progress to evaluate the clay soils at a lower relative density and a higher moisture content. Further supervision is being performed and additional reports will be forwarded as the work progresses.

Report No. 3 on

INSPECTION AND TESTING DURING EARTHWORK OPERATIONS
COAL AND ASH STORAGE AREAS

NORTHERN STATES POWER COMPANY
SHERBURNE COUNTY GENERATING PLANT
UNIT NO. 1
NEAR BECKER, MINNESOTA

Specification 5377-D-4C

DIN 96A341

Purchase Order No. C88754

Laboratory No. 9-4919

By

Twin City Testing and Engineering Laboratory, Inc.
662 Cromwell Avenue
St. Paul, Minnesota 55114

TWIN CITY TESTING AND ENGINEERING LABORATORY, Inc.

CHEMICAL & PHYSICAL TESTS • INSPECTIONS • RESEARCH

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Vice-President Chemistry
CLINTON R. EUE
Secretary-Treasurer

October 31, 1973

Northern States Power Company
414 Nicollet Mall
Minneapolis, MN. 55401

Attention: Mr. J.V. Sullivan

RE: Inspection and Testing
Coal and Ash Storage Areas
Sherburne County Generating Plant
Near Becker, Minnesota
Laboratory #9-4919

Gentlemen:

This is our third progress report presenting our inspection findings and test results for the referenced project. We are sending you three copies. Additional copies are being sent as noted below. This work is being done in accordance with your Purchase Order No. C88754, dated August 23, 1973.

Additional reports will be submitted as the project progresses. If you have any questions or desire further information, please contact us.

Very truly yours,

TWIN CITY TESTING AND
ENGINEERING LABORATORY, INC.

NOV 5 1973

Michael O'Donnell

Michael O'Donnell
Civil Engineer

Donovan K. Stormoe
Donovan K. Stormoe,

MO:DKS:rs

Copies to:

- 1) Northern States Power
Quality Assurance
Attn: Mr. John Meier
- 2) Northern States Power (Becker)
Attn: Mr. Curt Sillman
- 1) Black & Veatch
Attn: Mr. John Vines
- 2) J.A. Danens & Sons, Inc.

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JEK		FJS	PDC
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RHF		PTC	SCY
AMK		NLI	CJR
JMN		JFS	WTC
AEJ		JAN	
		VJ	REN

PLS HANDLE RETURN TO DESTROY

PAS

NORTHERN STATES POWER COMPANY
SHERBURNE COUNTY GENERATING PLANT
UNIT NO. 1
NEAR BECKER, MINNESOTA

#9-4919

INTRODUCTION

This report concerns the full-time inspection and testing we are continuously performing for the earthwork operations in the coal and ash storage areas at the above referenced project. The purpose of this report is to present our inspection findings and testing results from the period of October 15 through October 21, 1973. This work is being conducted in accordance with your Purchase Order #C88754 dated August 23, 1973.

FIELD PROCEDURES AND RESULTS

Coal Retaining Berms

The work in this area consisted of placing soil cement in the center and north berms. The soil cement was placed to approximately elevation 975.5' on the center berm and 981' on the north berm. A total of 4400 cubic yards of soil cement was placed during this report period bringing the total placed to date to 28,646 cubic yards.

Four compaction tests were made in the soil cement. The tests are #171, #182, #184 and #190, and the results are attached. The test results indicate the specified compaction was attained. However, the moisture content was low on test #171, and this condition probably developed during the stockpiling of the mixed soil cement. Adequate moisture is required for proper compaction and for hydration of the cement. Generally, it would be better to have a slight excess

FIELD PROCEDURES AND RESULTS
(cont.)

Coal Retaining Berms
(cont.)

of moisture rather than a deficiency when compaction begins. Both Northwest Bituminous and your Mr. John Wilkenson were notified of this situation, and unconfined compression tests will be made on this material to evaluate if adequate strength has been achieved for usage in the berm structure.

Bottom Ash Pond Dikes

On October 16, compaction requirements for Type I impervious fill were changed from 93% to 88% by Black and Veatch. Also, Mr. Harold Norgaarden and Mr. John Wilkenson in your field office indicated that no moisture requirements were established. However, field moisture contents of zero to 6% over optimum should be used as a guide line to avoid delaying the compaction operations. As of October 19, a clayey sand was placed in the west dam to station 17+00. The specified compaction was achieved by using a sheepsfoot roller and a vibratory sheepsfoot roller. Eleven field density tests (#169, #170, #176, #177, #180, #181, #183, #186, #187, #191 and #192) were performed on the clay core and impervious earth blanket. As indicated on the attached test results, the relative compaction meets project specifications.

Tests are in progress on samples of Type I filter material to determine gradation, specific gravity, organic content, clay content, percent lightweight particles, abrasion resistance and freeze-thaw characteristics. These test results will be included in our next progress report.

Fourteen field density tests (#166, #167, #168, #172, #173, #174, #175, #178, #179, #185, #188, #189, #193 and #194) were taken in the granular embankment fill for the north and west dam. In all cases, the results of the field density tests

FIELD PROCEDURES AND RESULTS
(cont.)

indicate the specified compaction was achieved. Where the test results indicated the specified density had not been attained on the initial effort, additional compactive effort was given to the area. Supplementary field tests were then performed in the recompacted area to verify the soils were satisfactorily compacted.

REMARKS

Our inspection and testing indicates the earthwork is being performed in accordance with the project plans and specifications in all areas except the moisture content of the general embankment sand fill. Additional laboratory testing is in progress to evaluate the clay soils at a lower relative density and at a higher moisture content. Further supervision is being performed and additional reports will be forwarded as the work progresses.

TWIN CITY TESTING AND ENGINEERING LABORATORY, Inc.

CHEMICAL & PHYSICAL TESTS • INSPECTIONS • RESEARCH

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Vice-President Chemistry
CLINTON R. EUE
Secretary-Treasurer

December 3, 1973

Northern States Power Company
414 Nicollet Mall
Minneapolis, MN 55401

Attention: Mr. J. V. Sullivan

RE: Inspection and Testing
Coal and Ash Storage Areas
Sherburne County Generating Plant
Near Becker, Minnesota
Laboratory #9-4919

Gentlemen:

This is our fourth progress report presenting our inspection findings and test results for the referenced project. We are sending you three copies. Additional copies are being sent as noted below. This work is being done in accordance with your Purchase Order No. C88754, dated August 23, 1973.

Additional reports will be submitted as the project progresses. If you have any questions or desire further information, please contact us.

Very truly yours,

TWIN CITY TESTING AND
ENGINEERING LABORATORY, INC.

Michael O'Donnell
Civil Engineer

Donovan K. Stormoe, P.E.

MO:DKS:rs
Copies to:

- 1) Northern States Power
Quality Assurance
Attn: Mr. John Meier
- 2) Northern States Power (Becker)
Attn: Mr. Curt Sillman
- 1) Black & Veatch
Attn: Mr. John Vines
- 2) J. A. Danens & Son, Inc.

NORTHERN STATES POWER COMPANY
SHERBURNE COUNTY GENERATING PLANT
UNIT NO. 1
NEAR BECKER, MINNESOTA

#9-4919

INTRODUCTION

This report concerns the full-time inspection and testing we are continuing to perform for the earthwork operations in the coal and ash storage areas at the above referenced project. The purpose of this report is to present our inspection findings and testing results from the period of October 22 to October 28, 1973. This work is being conducted in accordance with your purchase order #C88754 dated August 23, 1973.

FIELD PROCEDURES AND RESULTS

Coal Retaining Bins

The work in this area consisted of compacting granular embankment fill on the south berm and placing soil cement on the south and center berms. The soil cement was placed to approximate elevation 971.5' on the south berm. A total of 5,252 cubic yards of soil cement was placed during this report period bringing the total placed to date to 34,598 cubic yards. Except for the final grading of the slopes, the center berm was completed. The contractor decided to place a layer of Gunitite along the slopes of the center berm in order to limit the tolerance to within 1/2". The thickness of the Gunitite layer will vary from 2" to 6".

Four compaction tests were made in this area. The tests are #202, #215, #223 and #229 and the results are attached. The test results indicate the specified

compaction and moisture content were attained.

In addition to the above field tests, laboratory tests were performed on a representative sample of the cement being used in the soil cement process, as well as core and molded samples of the soil cement. The tests on the cement indicated that it meets the specifications for fineness and compressive strength, but contains a slightly higher air content (15%) than allowed for Type 1 cement (maximum 12%). Northwest Bituminous was going to contact their supplier and have this problem corrected. The tests on the soil cement cores, taken from field-placed material, consisted of unconfined compression tests. Two of these tests were made from a lift of soil cement with a low moisture content, as described in our previous report (No. 3). Both of the samples had a unit stress of 520 psi. The other six core samples had compressive strengths varying from 225 psi to 950 psi. In order to determine the ultimate strength of the soil cement mixture, compressive tests were performed on molded samples after 7 days and 28 days. The test results revealed compressive strength of 764 psi and 1195 psi. By extrapolating this early test data, the estimated ultimate strength would be adequate. The laboratory results discussed above as well as other pertinent test information are shown on the attached data sheets.

Fly Ash Pond Dikes

As of October 26, 1973, a clayey sand was placed in the west dam to Station 11+50. Eleven field density tests (#199, #200, #208, #209, #213, #214, #218, #219, #224 and #225) were performed on the core and impervious earth blanket. In all cases the results of the field density tests indicated specified compaction was achieved.

Three of the tests had a moisture content of 5% to 6% over optimum (#199, #213 and #219); yet the specified compaction was attained by the initial compactive efforts. Since the boring report (#18579) showed very little clay wetter than what they are

using now, it appears that most of the clay soils in the borrow area will be usable.

Additional laboratory tests were performed on samples of the clay soils with a higher moisture content to determine permeability, strength and consolidation properties for this material. The falling head permeability tests for a recompacted sample and an undisturbed sample taken from the clay core indicate k-values (coefficients of permeability) of 10^{-9} centimeters per second and 10^{-8} centimeters per second, respectively.

The strength and consolidation properties of the clay core material were determined by triaxial and consolidation tests, respectively. These tests were performed on samples 13, 17 and 18, which were clayey sand (SC) or sandy clay (CL) material. The reason for the additional testing was to evaluate these properties if the clay material is compacted to 85% or 88% of maximum density rather than the specified minimum 93%. Also, the tests include compacting some test specimens at moisture contents 10% over optimum or 7% above the maximum allowed by the project specifications.

The triaxial tests, performed under unconsolidated, undrained conditions, indicate the soil has a small angle of internal friction and apparent cohesion values ranging from about 1/4 tsf to 1/2 tsf for a saturated condition to about 1 tsf for an unsaturated condition. The Mohr-circle and stress-strain relationships for the tests are attached. As shown, there are some variations, or apparent discrepancies in the Mohr-circle plots, especially for sample 18-T-2. These discrepancies are very likely due to slight variation in the molded condition of the samples.

The consolidation test results indicate the clay fill is relatively incompressible under moderate loadings when in an unsaturated condition. When saturated, however, the clay apparently softens and begins to consolidate appreciably under lighter load

conditions. The test results are shown on the attached curves of percent settlement versus log of pressure and also settlement versus time. Samples 13-CS-1 and 18-CS-1 were saturated before the test loading was applied. Samples 18-CS-2 and 18-CS-3 were tested at the molded moisture contents (below saturation).

Additional tests were performed on the Type 1 filter material. These tests include specific gravity (AASHOT84 and T85), organic content (AASHOT21), clay content (AASHOT112), percent lightweight particles (AASHOT113), abrasive resistance (AASHOT96), and freeze-thaw (AASHOT103 Procedure B). The filter rock generally is in conformance with the project specifications. Two gradation tests indicate the material gradation was marginal; one test showing passing results and the other showing the material failing on the 3/4", 1/2" and #3 screens. Additional gradation tests will be performed as the work progresses.

Fourteen field density tests (#196, #197, #198, #206, #207, #210, #211, #212, #216, #217, #226, #227, #228 and #230) were taken in the granular embankment fill for the west dam. As indicated on the attached test results, the relative compaction meets project specifications. However, when the moisture content was below 8% of the optimum moisture, additional compactive effort was needed in order to obtain the specified compaction. Since the granular fill was below optimum moisture in the natural state, the contractor has been applying water to the sand prior to its placement.

The subgrade was also very dry and after wetting the subgrade, the area was proof rolled by a vibratory roller to test for uniformity. The compaction of the subgrade was verified by seven test results (#195, #201, #202, #204, #205, #221 and #222), and approval for the placement of the clay core was given.

REMARKS

Our inspection and testing indicated the earthwork is being performed in accordance with the project plans and specifications. Additional laboratory testing is in progress to evaluate the silty sand found in the borrow area for a possible impervious liner material. Further supervision is being performed and additional reports will be forwarded as the work progresses.

Report No. 5 on

INSPECTION AND TESTING DURING EARTHWORK OPERATIONS
COAL AND ASH STORAGE AREAS

Report #5

NORTHERN STATES POWER COMPANY
SHERBURNE COUNTY GENERATING PLANT
UNIT NO. 1
NEAR BECKER, MINNESOTA

96A341

Specification 5377-D-4C

DIN 96A341

Purchase Order No. C88754

Laboratory No. 9-5022

By

Twin City Testing and Engineering Laboratory, Inc.
662 Cromwell Avenue
St. Paul, Minnesota 55114

TWIN CITY TESTING AND ENGINEERING LABORATORY, Inc.

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Vice-President Engineering
ALBERT C. HOLLER, F.A.I.C.
Vice-President Chemistry
CLINTON R. EUE
Secretary-Treasurer

December 4, 1973

Northern States Power Company
414 Nicollet Mall
Minneapolis, MN 55401

Attention: Mr. J. V. Sullivan RE: Inspection and Testing
Coal and Ash Storage Areas
Sherburne County Generating Plant
Near Becker, Minnesota
Laboratory #9-5992

Gentlemen:

This is our fifth progress report presenting our inspection findings and test results for the referenced project. We are sending you three copies. Additional copies are being sent as noted below. This work is being done in accordance with your Purchase Order No. C88754, dated August 23, 1973.

Additional reports will be submitted as the project progresses. If you have any questions or desire further information, please contact us.

Very truly yours,

TWIN CITY TESTING AND
ENGINEERING LABORATORY, INC.

Michael O'Donnell
Civil Engineer

Donovan K. Stormoe, P.E.

MO:DKS:rs

Copies to:

- 1) Northern States Power
Quality Assurance
Attn: Mr. John Meier
- 2) Northern States Power (Becker)
Attn: Mr. Curt Sillman
- 1) Black & Veatch
Attn: Mr. John Vines
- 2) J. A. Danens & Son, Inc.

NORTHERN STATES POWER COMPANY
SHERBURNE COUNTY GENERATING PLANT
UNIT NO. 1
NEAR BECKER, MINNESOTA

#9-5022

INTRODUCTION

This report concerns the full-time inspection and testing we are continuously performing for the earthwork operations in the coal and ash storage areas at the above referenced project. The purpose of this report is to present our inspection findings and testing results from the period of October 29 through November 4, 1973. This work is being conducted in accordance with your purchase order #C88754 dated August 23, 1973.

FIELD PROCEDURES AND RESULTS

Coal Retaining Berm

The work in this area consisted of placing soil cement on the north and south berm and spraying a Gunite cover on the north slope of the center berm. It was agreed upon to discontinue the soil cement operations on the south berm until next spring. A total of 2,594 cubic yards of soil cement were placed during this report period bringing the total quantity placed this year to 37,192 cubic yards.

One compaction test was randomly taken in the soil cement and one test was taken in the embankment fill for the south berm. The attached test results reveal the specified compaction was attained.

Four inch test cylinders were made from the Gunite operations. After six days of laboratory curing, the seven day compressive strengths were 1490 and 1700 psi.

FIELD PROCEDURES AND RESULTS
(cont.)

Typical seven day strengths for Gunite would be in the range of 2000 to 5000 psi, however, the values recorded well exceeded the suggested soil cement strength. Quality control of the Gunite will continue and test specimens will be obtained either by coring or with test panels.

Fly Ash Pond Dikes

As of November 4, the impervious earth blanket for the west dam was completed to Station 9+00. Eleven of the twelve field density tests taken in the clay core and impervious earth blanket (#232, #235, #236, #243, #244, #247, #248, #250, #251, #255 and #257) indicated the specified compaction was attained. The failing test area (indicated by test #235) received additional compaction and was retested to verify the soils were satisfactorily compacted.

A sample of the filter rock was taken near west dam Station 20+00. A gradation test is presently being conducted and the results will be included in our next progress report.

A visual inspection was performed of a random truck load of limestone rip-rap. It appeared that 10% of the stones exceeded the 200 pound weight limitation and were greater than 15" in length. Since the material did not fulfill project specifications for rip-rap, no further tests will be performed on this material. To date, an alternate site has been selected for the procurement of rip-rap. Reports of material tests will be forthcoming.

Nine field density tests (#231, #237, #239, #240, #241, #245, #246, #249 and #256) were taken in the granular embankment fill, and two field density tests, #242 and #258, were taken in the subgrade for the west dam. As indicated on the attached test results, the relative compaction meets project specifications.

FIELD PROCEDURES AND RESULTS
(cont.)

Coal Yard Area Railroad Track #1

Three gradation tests were performed on the subballast material placed during August, 1973. The test results indicated the material still does not meet project specifications. The contractor proposed to replace this material with a granular soil found near west dam Station 7+00. Additional gradation tests (20-G-1 and 20-G-2) were conducted on samples from the area and the soil was approved for use as subballast. The unfinished portion of the railroad track was then filled with the approved subballast material placed in approximately 6" loose thickness lifts. The densification attained by the compaction operations was determined by performing field in-place density tests. Both the subgrade and subballast material met the specified compaction with the initial compactive effort. The unsuitable areas will be reworked at a later date.

REMARKS

Our inspection and testing indicates the earthwork is being performed in accordance with the project plans and specifications in all areas. Additional laboratory testing is in progress to evaluate the silty sand found in the borrow area for a possible impervious liner material. Further supervision is being performed and additional reports will be forwarded as soon as the work progresses.

TWIN CITY TESTING AND ENGINEERING LABORATORY, Inc.

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ALBERT C. HOLLER, F.A.I.C.
Vice-President Chemistry
CLINTON R. EUE
Secretary-Treasurer

December 12, 1973

Northern States Power Company
414 Nicollet Mall
Minneapolis, MN 55401

Attention: Mr. J. V. Sullivan RE: Inspection and Testing
Coal and Ash Storage Areas
Sherburne County Generating Plant
Near Becker, Minnesota
Laboratory #9-5022

Gentlemen:

This is our sixth progress report presenting our inspection findings and test results for the referenced project. We are sending you three copies. Additional copies are being sent as noted below. This work is being done in accordance with your Purchase Order No. C88754, dated August 23, 1973.

Additional reports will be submitted as the project progresses. If you have any questions or desire further information, please contact us.

Very truly yours,


TWIN CITY TESTING AND
ENGINEERING LABORATORY, INC.


Michael O'Donnell
Civil Engineer

MO:DKS:rs

Copies to:

- 1) Northern States Power
Quality Assurance
Attn: Mr. John Meier
- 2) Northern States Power (Becker)
Attn: Mr. Curt Sillman
- 1) Black & Veatch
Attn: Mr. John Vines
- 2) J. A. Danens & Son, Inc.


Donovan K. Stormoe, P.E.

NORTHERN STATES POWER COMPANY
SHERBURNE COUNTY GENERATING PLANT
UNIT NO. 1
NEAR BECKER, MINNESOTA

#9-5022

INTRODUCTION

This report concerns the full-time inspection and testing we are continuing to perform for the earthwork operations in the coal and ash storage areas at the above referenced project. The purpose of this report is to present our inspection findings and test results from the period of November 5 to November 11, 1973. This work is being conducted in accordance with your Purchase Order No. C88754, dated August 23, 1973.

FIELD PROCEDURES AND RESULTS

The cold weather during this report period limited the earthwork operations. Only on November 7, were the ambient temperatures suitable to place a Gunitite cover on the north slope of the center berm. The quality of the soil cement placed during the previous report period was evaluated by means of unconfined compression tests. The test results revealed compressive strengths of 620 psi, 780 psi and 830 psi.

On November 11, a clayey sand fill had been placed on the west dam to Station 5+50. Nine field density tests (#262, #263, #265, #266, #269, #275, #276, #277 and #278) were taken in the clay core and impervious earth blanket. One area (indicated by test #275) presented problems in obtaining the specified density. The placement and compaction operations in this area were conducted during freezing weather on November 8. As the soil temperature dropped below 30°F, the compactive effort necessary to achieve specified density increased. As the temperature

FIELD PROCEDURES AND RESULTS
(cont.)

reached 25°F, the soils were beginning to freeze during the time of testing. In most cases the material was compacted to the proper density before freezing. However, some frozen material was encountered and a detailed visual examination of the frozen material generally revealed an ice coating up to 1/32" thick on the underside of the stones in the fill. At a few locations, segregated ice in the form of thin isolated horizontal lenses up to 1/16" thick were noted. For the most part, the ice appeared to be within the natural voids in the soil. Each morning before adding a new lift of fill, any frozen cohesive material in the dam was removed. All frozen granular embankment fill was broken into small pieces and recompacted.

Eleven field density tests (#259, #260, #261, #264, #270, #271, #272, #273, #274, #279 and #280) were taken in the granular embankment fill and two density tests (#267 and #268) were taken in the subgrade soils for the west dam. In all cases, the results of the field density tests indicated the specified compaction was achieved. Where the test results indicated specified density had not been attained on the initial compactive efforts, additional compaction was performed. Compaction retests were then performed on a recompacted area to verify that the soils were satisfactorily compact.

In the addition to the above field tests, a gradation test was performed on a representative sample of the rip-rap bedding used on the north dam. The test indicated the aggregate meets the project specifications.

REMARKS

Our inspection and testing indicates the earthwork is being performed in accordance with the project plans and specifications in all areas. Additional laboratory

REMARKS
(cont.)

testing is in progress to evaluate the permeability of the silty sand found in the borrow area for usage as an impervious lining. Further supervision is being performed and additional reports will be forwarded as the work progresses.

Report No. 7 on

INSPECTION AND TESTING DURING EARTHWORK OPERATIONS
COAL AND ASH STORAGE AREAS

NORTHERN STATES POWER COMPANY
SHERBURNE COUNTY GENERATING PLANT
UNIT NO. 1
NEAR BECKER, MINNESOTA

Specification 5377-D-4C

DIN 96A341

Purchase Order No. C88754

Laboratory No. 9-5022

By

Twin City Testing and Engineering Laboratory, Inc.
662 Cromwell Avenue
St. Paul, Minnesota 55114

NORTHERN STATES POWER COMPANY
SHERBURNE COUNTY GENERATING PLANT
UNIT NO. 1
NEAR BECKER, MINNESOTA

#9-5022

INTRODUCTION

This report concerns the full-time inspection we are continuing to perform of the earthwork operations in the coal and ash storage areas at the above referenced project. The purpose of this report is to present our inspection findings and test results for the period of November 12 to November 18, 1973. This work is being conducted in accordance with your Purchase Order No. C88754, dated August 23, 1973.

FIELD PROCEDURES AND RESULTS

Coal Retaining Berms

The work in this area consisted of placing a Gunité concrete cover on a section of the north slope of the center berm and on a section of the south slope of the north berm. The cover was placed on the center berm eastward to approximately Grid 2027660 East and for approximately 50' along the north berm in the area of Grid 2027600 East. Test panels, which will be cured in the field for 28 days, will be used for unconfined compression strength tests to determine the strength and quality of the Gunité material.

River Intake Road

A granular subgrade fill was placed on the River Intake Road and compacted with a vibration roller. Two in-place field density tests were taken to determine the degree of compaction achieved. As indicated on the attached test results, the relative compaction meets project specifications.

FIELD PROCEDURES AND RESULTS
(cont.)

Fly Ash Pond Dikes

The work performed by the grading contractor in this area consisted of placing impervious dike core and blanket material, rip-rap bedding, filter material, and granular embankment fill. Tests were performed to determine if the work was performed in compliance with project specifications. Tests were also conducted to further evaluate the strength and permeability characteristics of the red till found in the borrow area. The till is a reddish-brown silty sand capped with a very dense, red silty sand. Since layers of silt were interbedded with the silty sand, the test sample of this material was comprised of three separate samples taken from three different locations. Strength of the silty sand was determined by tri-axial testing under unconsolidated-undrained conditions. The test results show a angle of internal friction of 10^0 and a cohesion of 1100 psf. These results indicate the soil has adequate strength properties. Three permeability tests were performed on the sample to check compliance with the design parameters. Two of the samples were molded at optimum moisture content and the other sample was molded at 3% over optimum moisture content. The coefficient of permeability for the reddish-brown silty sand was 10^{-5} centimeters per second. This material should not be used in the impervious earth blanket. The very dense, red silty sand had coefficients of permeability above the design parameter with values of 10^{-6} and 10^{-7} centimeters per second. However, the Minnesota Pollution Control Agency is now requiring a more stringent seepage loss criteria for the ponds than was required for the present design. Keeping this in mind, the feasibility of using the material as an impervious earth blanket for the ponds is quite doubtful. The material tested was very similar to the silty sand used on October 8, 1973. Since the silty sand contained a large quantity of silt, the high moisture content made this material unusable. The dense, red silty sand could possibly be used, but

FIELD PROCEDURES AND RESULTS
(cont.)

difficulties in obtaining the specified density could be expected.

On November 18, clayey sand fill for the clay core and impervious earth blanket material have been placed on the west dam Station 2+50. Fourteen field density tests (#285, #286, #287, #290, #291, #292, #295, #297, #298, #299, #305, #306, #310, and #311) were taken in this fill. The test results, which are attached, indicate the relative compaction meets project specification.

Granular embankment fill was being placed on the west dam. Three density tests (#281, #290 and #308) were taken on compacted subgrade and fifteen tests (#282, #283, #284, #288, #289, #293, #294, #300, #302, #303, #304, #309, #312, #313, and #314) were taken in the granular embankment fill. In most cases, the results of the field density tests indicated the specified compaction was obtained by the initial compactive efforts. Where the test results revealed the specified density had not been attained, additional compactive efforts were applied. Supplementary field tests were then performed on the recompacted areas to verify the soils were satisfactorily compacted.

Bottom Ash Pond Dikes

Rip-rap bedding was being placed on the south slope of the north dam. Five gradation tests were performed on samples of this material. As previously indicated, the material gradation is marginal with the material at the lower limit of the #6 sieve requirement. As the rip-rap would be susceptible to segregation, one gradation test on a small quantity sample should not be considered representative of the suitability of the material. Random variations and occasional failures to comply with the gradation requirements could be expected. An average of three samples indicated the material gradation was within the range allowed by the

FIELD PROCEDURES AND RESULTS
(cont.)

specifications. Once the rip-rap bedding was dumped on the edge of the prepared slope, the material was spread to the full specified thickness. Caution was taken by the contractor, but because the material is easily segregated, a few small clusters of stones can be noticed along the slopes.

REMARKS

Our inspection and testing indicate the earthwork is being performed in accordance with the project plans and specifications in all areas. Additional laboratory testing is in progress to evaluate the granite rip-rap to be used on the north dam. Further supervision is being performed and additional reports will be forwarded as the work progresses.

JAN 4 1978

TWIN CITY TESTING AND ENGINEERING LABORATORY, Inc.

CHEMICAL & PHYSICAL TESTS • INSPECTIONS • RESEARCH

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	WVJ		56
	RA	MS	28
	RPH	PHI	24
	R-D	R	
	MI	S	FDC
	JFK		15B
	GV		JEL
	RH		CJR
	AMK	JIS	MTD
	JMN	JR	
	ASJ	VJ	REHLY

Northern States Power Company
414 Nicollet Mall
Minneapolis, MN 55401



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JOHN F. GISLASON, P.E.
Executive Vice-President

NORMAN E. HENNING, P.E.
Vice-President Engineering

ALBERT C. HOLLER, F.A.I.C.
Vice-President Chemistry

CLINTON R. EUE
Secretary-Treasurer

December 26, 1973

Attn: Mr. J. V. Sullivan

RE: Inspection and Testing
Coal and Ash Storage Areas
Sherburne County Generating Plant
Near Becker, Minnesota
Laboratory #9-5022

Gentlemen:

This is our eighth progress report presenting our inspection findings and test results for the referenced project. We are sending you three copies. Additional copies are being sent as noted below. This work is being done in accordance with your Purchase Order No. C88754, dated August 23, 1973.

Additional reports will be submitted as the project progresses. If you have any questions or desire further information, please contact us.

Very truly yours,

TWIN CITY TESTING AND ENGINEERING LABORATORY, INC.

Michael O'Donnell
Michael O'Donnell
Civil Engineer

Donovan K. Stormoe
Donovan K. Stormoe, P.E.

MO:DKS:rs
Copie to:

- 1) Northern States Power
Quality Assurance
Attn: Mr. John Meier
- 2) Northern States Power (Becker)
Attn: Mr. Curt Sillman
- 1) Black & Veatch
Attn: Mr. John Vines
- 2) J. A. Danens & Sons, Inc.

NORTHERN STATES POWER COMPANY
SHERBURNE COUNTY GENERATING PLANT
UNIT NO. 1
NEAR BECKER, MINNESOTA

#9-5022

INTRODUCTION

This report concerns the full-time inspection and testing we are continuing to perform during the earthwork operations in the coal and ash storage areas at the above referenced project. The purpose of this report is to present our inspection findings and test results from the period of November 19 to December 2, 1973.

FIELD PROCEDURES AND RESULTS

Coal Retaining Berms

A Gunite concrete cover was placed on the center half of the south side of the north coal retaining berm on November 19, 21 and 30. Due to freezing weather during this report period, the amount of Gunite concrete placed was very limited.

Fly Ash Pond Dike

Construction of the impervious earth blanket was also limited during this report period. As of December 2, the impervious earth blanket was completed to the west dam station 1+50. Four density tests were performed on the clay core and the impervious earth blanket. One of these test areas (indicated by test #332) had a high moisture content resulting in low compaction results, and this area will be retested next spring when work in this area resumes.

Excavation of the holding pond area was still in progress, and the sand and silty sand removed from this area were being used on the west and south dams. A few

FIELD PROCEDURES AND RESULTS
(cont.)

boulders were uncovered and used in the southern edge of the south dam. A total of 21 density tests (#315, #316, #319, #321, #322, #323, #324, #325, #326, #327, #328, #329, #330, #331, #334, #336, #337, #338, #339, #340 and #341) were taken in the granular embankment fill for the west and south dams. Test #323 indicated low compaction results. After recompaction of the test area, retests indicated the specified density was attained.

Bottom Ash Pond Dike

Several truck loads of Class A rip-rap were placed on the south slope of the north dam and Class B rip-rap was placed for the bottom ash discharge structure. A gradation test was performed on the Class A rip-rap to determine the acceptability of this material. The test results indicated the rip-rap contains an excess of large blocks (greater than 15") and an insufficient amount of intermediate boulders (50 to 80 pounds). A conference was held between J. L. Shiely Company, J. A. Danens & Son, Inc., Barton Construction Company and your field representatives to discuss problems in fulfilling project specifications. Subsequently, it was agreed to discontinue hauling rip-rap until next spring.

Coal Yard Area Railroad (Track #1)

The subballast material placed during August was removed and replaced with an approved material. Since the gradation of the on-site material was not within the project specifications, Class 5 gravel base was blended at a ratio of 1:3 with on-site material. As indicated by the two gradation tests (23-G-1 and 23-G-2), the blended material was suitable for use as subballast. Five field density tests (#342, #343, #344, #345 and #346) verify the compaction of the subballast meets project specifications and results are attached.

FIELD PROCEDURES AND RESULTS
(cont.)

River Intake Road

Prior to the placement of the aggregate base, the subgrade was compacted and tested. However, during the placement of the Class 5 base, the top 4" of the subgrade became frozen. The specifications require that embankments shall not be constructed on frozen ground. It should be noted that a few state highway departments permit placement of base courses on frozen subgrade, when the subgrade consisted of adequately compacted unfrozen material before time of freezing. Since this road is necessary for the construction of the river intake, you have allowed the road work to continue during freezing weather. Along with field density tests taken during placement, several compaction density tests will be taken in the spring to assure adequate density after thawing.

REMARKS

Our inspections and testing indicate the earthwork is being performed in accordance with the project specifications. Additional laboratory testing is in progress to evaluate the granite rip-rap. Further supervision is being performed and additional reports will be forwarded as soon as the work progresses.

Report No. 9

INSPECTION AND TESTING DURING EARTHWORK OPERATIONS
COAL AND ASH STORAGE AREAS

Report #9

NORTHERN STATES POWER COMPANY
SHERBURNE COUNTY GENERATING PLANT
UNIT NO. 1
NEAR BECKER, MINNESOTA

COAL & ASH STORAGE

Specification 5377-D-4C

DIN 96A341

Purchase Order No. C88754

Laboratory No. 9-5107

By

Twin City Testing and Engineering Laboratory, Inc.
662 Cromwell Avenue
St. Paul, Minnesota 55114

NORTHERN STATES POWER COMPANY
SHERBURNE COUNTY GENERATING PLANT
UNIT NO. 1
NEAR BECKER, MINNESOTA

#9-5107

INTRODUCTION

This report concerns the inspection and testing we are continuing to perform for the earthwork operations in the coal and ash storage areas at the above referenced project. This report covers the period from December 2 through December 14, 1973. The purpose of this report is to summarize activities at the site and to present the results of field and laboratory tests performed during that period.

FIELD PROCEDURES AND RESULTS

Reserve Coal Storage Area

Compaction operations resumed on the reserve coal storage area, and three density tests were taken randomly to verify the compactive efforts. After the test results revealed the specified density was attained in the impervious earth blanket, six inches of embankment fill cover was placed primarily in the northern portion of the reserve coal storage area. The unfrozen fill was placed, compacted and tested for adequate density before freezing had occurred. Twenty-nine density tests (347, 348, 349, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 383, 385, 387, 389, 391, 393, 394, 395, 398, 401 and 406) were taken in the granular fill and the test results are attached. In most cases, the results of the density tests indicated the specified compaction was obtained by initial compactive efforts. However, in one area (indicated by test #374) the fill froze before the specified compaction was achieved. The contractor has been informed

FIELD PROCEDURES AND RESULTS
(cont.)

of this area, and he will recompact this area next spring when the construction resumes. The compaction will then be retested.

Railroad Access Road

Four inches of gravel base were placed on the railroad access road for track #1. Two density tests (#352 and #353) taken in the compacted subgrade had satisfactory results. Since the subgrade was frozen north of Station 155+00, density tests were not taken in this area. Several additional density tests will be taken on the subgrade next spring after the ground thaws. The specifications do not allow fill soils to be placed on frozen material. However, the contractor received special permission from your field representatives to complete the access road with the provision that specified density will be attained in the spring. The Class 5 gravel base was tested to determine the compaction achieved (tests #361, #396 and #403). The test results, which are attached, indicated the relative compaction meets project specifications.

River Intake Road

During this report period, Class 5 gravel base was placed and compacted on the river intake road. The densification obtained by the compaction operations was determined by performing two in-place density tests. The results of these tests (#357 and #358) verified the material was satisfactorily compacted.

Coal Retaining Berm

No work was performed on the coal retaining berm during this report period. Laboratory tests were performed on representative samples of the fine aggregate used in the Guniting process, as well as on test panels of the Guniting concrete. The tests conducted on the fine aggregate included determining gradation, deleterious material, soundness, specific gravity and absorption in accordance with ASTM:C33.

FIELD PROCEDURES AND RESULTS
(cont.)

These tests indicated the aggregate meets the specifications for fine aggregate. Two test panels were brought into the laboratory after being cured in the field for 28 days. Unconfined compressive strength tests were performed on cubical sections cut from the test panels and the test results revealed compressive strengths varying from 4960 psi to 6540 psi. The amount of time required for concrete to obtain the desired strength varies with the temperature at which the concrete is cured. The hydration of the cement could cease at any time because of freezing temperatures and would resume when the temperatures are favorable. In order to obtain a reasonable ultimate strength value, several cubical specimens of the test panel were cured for an additional 14 days in our laboratory. The strength of the Gunitite concrete increased to an average value of 6940 psi. The laboratory tests discussed above as well as other pertinent test information are shown on the attached data sheet.

Ash Pond Dikes

The filling and compaction operations were concentrated primarily near the discharge structures. Type I clay material was placed near the fly ash discharge structure. This material was compacted to the specified density (as verified by tests #397 and #403), but it began to freeze during the installation of the membrane. Artificial heat was applied to this area prior to the placement of additional lifts and several hand auger borings were made to a depth of 3'. Since none of these borings encountered frozen materials, approval for the placement of subsequent lifts was granted. Class B rip-rap was approved and placed for both the fly and bottom ash discharge structures.

Twenty-three field density tests (350, 351, 354, 355, 356, 359, 360, 362, 363, 364, 365, 366, 382, 384, 385, 388, 390, 392, 400, 402, 407, 408 and 409) were taken

FIELD PROCEDURES AND RESULTS
(cont.)

in the granular embankment fill for the south and west dams. Three of these tests had low compaction results. Upon recompaction of tests areas, retests indicated specified compaction was obtained in the fill.

REMARKS

Our inspection and testing indicates the earthwork is being performed in accordance with the project plans and specifications in all areas. Laboratory testing is in progress to evaluate the permeability of the fly ash sludge from the Black Dog Northern States Power Plant. Also a search is in progress to locate additional clay deposits in the vicinity of the present clay borrow area.

TWIN CITY TESTING AND ENGINEERING LABORATORY, Inc.

CHEMICAL & PHYSICAL TESTS • INSPECTIONS • RESEARCH

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Vice-President Chemistry
CLINTON R. EUE
Secretary-Treasurer

May 22, 1974

Northern States Power Co
414 Nicollet Mall
Minneapolis, MN 55401

Attn: Mr J V Sullivan

Dear Mr Sullivan

Subj: Inspection & Testing
Coal and Ash Storage Areas
Sherburne County Generating Plant
Near Becker, Minnesota - Laboratory #9-5314

This is our tenth progress report presenting our inspection findings and test results for the referenced project. We are sending you three copies. Additional copies are being sent as noted below. This work is being done in accordance with your Purchase Order No. C88754, dated August 23, 1973.

Additional reports will be submitted as the project progresses. If you have any questions or desire further information, please contact us.

Very truly yours

Michael O'Donnell
Civil Engineer

Donovan K Stormoe, P.E.

MO/DKS/rs

Copies to

- 1) Northern States Power - Quality Assurance
Attn: Mr John Meier
- 2) Northern States Power (Becker)
Attn: Mr Curt Sillman
- 1) Black & Veatch - Attn: Mr John Vines
- 2) J A Danens & Son Inc

NORTHERN STATES POWER COMPANY
SHERBURNE COUNTY GENERATING PLANT
UNIT NO. 1
NEAR BECKER, MINNESOTA

#9-5314

INTRODUCTION

This report concerns the full-time inspection and testing we are continuing to perform for the earthwork operations in the coal and ash storage area at the above referenced project. The purpose of this report is to present our inspection findings and test results from the period of May 1 through May 12, 1974. This work is being conducted in accordance with your purchase order #C88754, dated August 23, 1974.

FIELD PROCEDURES AND RESULTS

Coal Retaining Berms

On April 18, Northwest Bituminous Company resumed the Gunite facing operations on the north side of the stacker-reclaimer berm. During the time period between April 18 and May 12, Gunite was placed on the north side of the stacker-reclaimer berm and the top half of the south side of the north berm. Work is presently taking place along the south side of the north berm. Quality control of the Gunite will continue and test specimens will be obtained either as cylinders or panels.

Fly Ash Pond Dikes

On May 1, J A Danens and Son Inc began earthwork operations on the west fly ash pond dike by removing the top 12" of clay along the core near station 1+50. Since this material was wet, it was allowed to dry by placing a thin cover of this material over the subgrade sand. This material was then compacted and

FIELD PROCEDURES AND RESULTS
(cont.)

became part of the impervious earth blanket within the south dam embankment. Prior to placing the additional lift on the clay core, the test area from last year (indicated by test #429) was retested to assure the soil was compacted to adequate density.

Most of the clay fill placed during this period was hauled from the southwest corner of the borrow pit. This material met the project's original moisture specifications with a moisture content between zero to 3% over optimum. A gradation test was also performed on the clay material to aid in determining sand and clay contents. The results of the gradations revealed the impervious material contains 58% sand and gravel compared to 52% recorded for the impervious material used last year. Samples of the impervious fill placed on the clay core were returned to the laboratory for permeability testing and consideration.

After proofrolling the subgrade for the south dam, four density tests were performed (#411, #412, #439 and #448). As indicated on the attached test results, the relative compaction meets project specifications.

In an area between west dam station 5+50 and south dam station 10+00, a total of 23 density tests (#410, #413, #416, #417, #422, #423, #424, #425, #426, #427, #428, #429, #432, #434, #435, #436, #443, #446, #447, #449, #451, #452 and #454) were taken of the clay fill. In all but one case, the results of the field density tests indicated the compaction was attained during the initial compactive efforts. In fact, the average relative compaction of the passing tests was 93% of the maximum density. The failing test area (indicated by tests #425), received additional compaction and was retested to verify the soils were satisfactorily compacted.

FIELD INVESTIGATION PROCEDURES
(cont.)

Twenty-one tests (#414, #415, #418, #419, #420, #421, #430, #431, #433, #437, #438, #440, #441, #442, #444, #445, #450, #453, #455, #456, and #457) were taken in the granular embankment fill placed on the fly ash pond dikes to south dam station 11+00. The embankment fill was a mixture of brown, fine-grained sand (SP) and reddish-brown silty sand (SM). Five of the density tests failed, and all of the failing tests were in the silty sand material. The silty sand possesses a high maximum density and is more sensitive to variations in moisture content. Thus, additional compactive effort was necessary to obtain the specified density.

Bottom Ash Pond Dikes

A crusher has been used this year for producing Class A rip-rap material. Several gradations of this material have been conducted and previously reported to J L Shiely Company. The last two gradations are included in this progress report. The gradation results for both samples were quite similar. The samples contained a lower percentage of 50-80 pound rock than last year; yet, the test results indicated the rip-rap still does not meet project specifications by exceeding the allowable 50-80 pound weight variation. However, the material was approved by the project representative for you and Black and Veatch as outlined in FEM-66. On May 8, J L Shiely Company began placing rip-rap in the north dam near station 4+00. Gradation tests and visual inspections of the rip-rap material will be performed on a continuing basis in order to assure uniformity.

REMARKS

Our inspection and testing indicates the earthwork is being performed in accordance with the project plans and specifications in all areas. Forty-eight field density tests were taken in accordance with ASTM:D1556-64 during this period.

REMARKS
(cont.)

A tabulation of the in-place density tests and a summary of the test results are submitted. Further supervision is being performed and additional reports will be forwarded as the work progresses.

Report No. 11 on

INSPECTION AND TESTING DURING EARTHWORK OPERATIONS
COAL AND ASH STORAGE AREAS

COAL & ASH STORAGE

NORTHERN STATES POWER COMPANY
SHERBURNE COUNTY GENERATING PLANT
UNIT NO. 1
NEAR BECKER, MINNESOTA

*REPORT #11
5.13/15.26-74*

Specification 5377-D-4C

DIN 96A341

Purchase Order No. C88754

Laboratory No. 9-5314

By

Twin City Testing and Engineering Laboratory Inc
662 Cromwell Avenue
St Paul, Minnesota 55114

TWIN CITY TESTING AND ENGINEERING LABORATORY, Inc.

CHEMICAL & PHYSICAL TESTS • INSPECTIONS • RESEARCH

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Vice-President Engineering
ALBERT C. HOLLER, F.A.I.C.
Vice-President Chemistry
CLINTON R. EUE
Secretary-Treasurer

June 5, 1974

Northern States Power Co
414 Nicollet Mall
Minneapolis, MN 55401

Attn: Mr J V Sullivan

Dear Mr Sullivan

Subj: Inspection and Testing
Coal and Ash Storage Areas
Sherburne County Generating Plant
Near Becker, Minnesota
Laboratory #9-5314

This is our 11th progress report presenting our inspection findings and test results for the referenced project. We are sending you three copies. Additional copies are being sent as noted below. This work is being done in accordance with your Purchase Order No. C88754, dated August 23, 1973.

Additional reports will be submitted as the project progresses. If you have any questions or desire further information, please contact us.

Very truly yours

Michael O'Donnell
Michael O'Donnell
Civil Engineer

Donovan K Stormoe
Donovan K Stormoe, P.E.

MO/DKS/rs
Copies to

- 1) Northern States Power - Quality Assurance
Attn: Mr John Meier
- 2) Northern States Power (Becker)
Attn: Mr Curt Sillman
- 1) Black & Veatch
Attn: Mr John Vines
- 2) J A Danens & Son Inc

NORTHERN STATES POWER COMPANY
SHERBURNE COUNTY GENERATING PLANT
UNIT NO. 1
NEAR BECKER, MINNESOTA

#9-5314

INTRODUCTION

This report concerns the full-time inspection and testing we are continuing to perform for the earthwork operations in the coal and ash storage areas at the above referenced project. The purpose of this report is to present our inspection findings and test results from the period of May 13 to May 26, 1974. This work is being conducted in accordance with your purchase order #C88754 dated August 23, 1973.

FIELD PROCEDURES AND RESULTS

Coal Retaining Berm

Work in this area consisted of placing a Gunite cover on the north berm and protecting the exposed finished surfaces of the stacker-reclaimer berm and north berm with a bituminous curing material. Gunite is presently being placed on the north side of the north berm. According to Northwest Bituminous Company, the Gunite used on the coal retaining berms contains approximately 800 pounds of Portland Cement per cubic yard of Gunite. Tests are in progress to evaluate the compressive strength of this material, and the results of these tests will be included in our next progress report. Also, a sample of asphalt, which is being used for curing, was brought into the laboratory for viscosity testing.

FIELD PROCEDURES AND RESULTS
(cont.)

Fly Ash Pond Dikes

The amount of clay material placed on the fly ash pond dikes was limited primarily by sustained rainy and cloudy weather during the work period. The other factor affecting the quantity of clay placed was the reinstatement of the original compactive specifications. On May 14, Black and Veatch changed the compaction requirements for the Type I impervious fill material from 88% to 93% of maximum density. The requirements further stated that during compaction of the clay core and impervious earth blanket, the moisture content should be within a range of zero to 3% over optimum moisture content.

As of May 24, 1974, the impervious earth blanket was completed in the south dam to station 9+00. Nine field density tests (#476, #477, #479, #480, #483, #485, #488, #489 and #490) were performed on the core and impervious earth blanket material. All of these tests show results below the specified compaction of 93%. An average of these tests indicates a relative density of 91% with an average moisture content of 6% over optimum. Both your field representative and J A Danens and Son Inc were notified of these test results, and a meeting was held to discuss possible corrective action. Two suggestions were made at the conclusion of the meeting. First, additional testing will be performed to determine the strength and permeability of the impervious liner material at various densities and moisture contents. Secondly, the contractor will make an increased effort to dry and compact the material so the specified density can be achieved.

The early part of this year, two representative clay samples were taken from the core area for permeability testing by the Constant Head Method. The results of the two recompacted samples indicated k values (coefficients of permeability) of 10^{-9} centimeters per second and 10^{-8} centimeters per second. These k values

FIELD PROCEDURES AND RESULTS
(cont.)

are similar to those determined by similar tests performed last year and indicate k values lower than original design values.

Two field density tests (#467 and #486) were taken in the subgrade, and 23 field density tests (#460, #461, #462, #463, #464, #465, #466, #472, #473, #474, #475, #478, #481, #482, #484, #487, #491, #492, #493, #494, #495, #496 and #497) were taken in the granular embankment fill for the west dam and south dam. Most of the granular material tested contained over 50% gravel (GM & GP). As indicated on the attached test results, the relative compaction meets or exceeds the project compaction specifications. Although, the material specified for placement as embankment fill material is limited to sandy soils (SM, SP and SW), these gravelly soils were approved by your field representative for placement in the intermediate and outer portions of the embankment.

Except in an area between the bottom ash discharge structure and the fly ash discharge structure, Class A rip-rap material was placed to west dam station 6+00.

Railroad Access Road

North of station 155+00, four density tests (#468 through #471) were taken in the subgrade to check compaction. This area was graded late last year, however, no compaction tests were taken at that time since the subgrade was frozen. The test results, which are attached, indicate the relative compaction now meets the project specifications.

REMARKS

Thirty-nine field density tests were taken in accordance with ASTM:D1556-64 (Sand-Cone Method) during this period. A tabulation of the in-place density tests and a summary of the test results are attached. Additional laboratory

REMARKS
(cont.)

testing is in progress to evaluate the strength and permeability of the impervious liner material. Further supervision is being performed and additional reports will be forwarded as the work progresses.

Report No. 12 on

INSPECTION AND TESTING DURING EARTHWORK OPERATIONS
COAL AND ASH STORAGE AREAS

DIN
51PH 96A341

NORTHERN STATES POWER COMPANY
SHERBURNE COUNTY GENERATING PLANT
UNIT NO. 1
NEAR BECKER, MINNESOTA

Specification 5377-D-4C

DIN 96A341

Purchase Order No. C88754

Laboratory No. 9-5625

by

Twin City Testing and Engineering Laboratory Inc
662 Cromwell Avenue
St Paul, Minnesota 55114

TWIN CITY TESTING AND ENGINEERING LABORATORY, Inc.

CHEMICAL & PHYSICAL TESTS • INSPECTIONS • RESEARCH

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Vice-President Engineering
ALBERT C. HOLLER, F.A.I.C.
Vice-President Chemistry
CLINTON R. EUE
Secretary-Treasurer

August 19, 1974

Northern States Power Co
414 Nicollet Mall
Minneapolis, MN 55401

Attn: Mr J V Sullivan

Dear Mr Sullivan

Subj: Inspection and Testing
Coal and Ash Storage Areas
Sherburne Co Generating Plant
Becker, Minnesota - Laboratory #9-5625

This is our 12th progress report presenting our inspection findings and test results for the referenced project. We are sending you three copies. Additional copies are being sent as noted below. This work is being done in accordance with your purchase order number C88754, dated August 23, 1973.

Additional reports will be submitted as the project progresses. If you have any questions or desire further information, please contact us.

Very truly yours

Michael O'Donnell
Civil Engineer

Norman E Henning, P.E.

MO/NEH/rs

Copies to

- 1) Northern States Power - Quality Assurance
Attn: Mr David V Collings
- 2) North States Power (Becker)
Attn: Mr Curt Sillman
- 1) Black & Veatch
Attn: Mr John Vines
- 2) J A Danens & Son Inc

NORTHERN STATES POWER COMPANY
SHERBURNE COUNTY GENERATING PLANT
UNIT NO. 1
NEAR BECKER, MINNESOTA

#9-5625

INTRODUCTION

This report concerns the full-time inspection and testing of the earthwork operations in the coal and ash storage areas that we are continuing to perform at the above referenced project. The purpose of this report is to present our inspection findings and testing results for the period of May 27 through July 31, 1974. This work is being conducted in accordance with your purchase order number C88754, dated August 23, 1973.

FIELD PROCEDURES AND RESULTS

Coal Retaining Berms

The work in this area consisted of spraying a Gunite concrete cover on the north berm and placing soil cement on the south berm. As of June 14, the Gunite facing operations were completed on the north and center berms. Tests were performed to check the strength properties of the Gunite material after 7 days and 28 days. The results of eight compressive strength tests indicate an average compressive strength of 5900 psi after 7 days and 8800 psi after 28 days. A total of 9,635 cubic yards of soil cement was placed during this report period, and the south berm was completed to elevation 987'.

Twenty-four compaction tests were taken in the soil cement, and the attached test results show the relative compaction ranges from 100% to 105%. A vibratory

FIELD PROCEDURES AND RESULTS
(cont.)

roller was initially used to attain the specified density. However, to avoid weakening the initial chemical bond of the cement from the previous lift, the compaction operations were restricted to static rollers. This type of equipment has proven to be capable of producing densities that exceed the specified compaction. In-place soil cement samples were cored and returned to the laboratory for compressive strength tests. When over 1' of soil cement was placed in one day, the rate of curing would vary. Test results indicate the top 6" of soil cement has 14 day strengths of 1980 psi and 1210 psi compared to 288 psi for the lower 6". Visual observations made during the sampling procedure indicated the lower 6" of soil cement was still moist. This moisture is more than likely responsible for the lower compression test results. We anticipate that higher compression values will be realized with the dissipation of the moisture. When only one 6" lift was placed in a day, the compressive strengths were approximately 2400 psi for cube samples and approximately 1800 psi for cylinder cores. The cube samples were cut from cores with improper length-to-diameter ratios for testing. Testing is in progress to evaluate the cohesion of the slower curing soil cement, and the results of these tests will be included in our next progress report.

The quality of the soil cement was verified by performing laboratory tests on representative samples of asphalt and on cement used in the soil cement process. A viscosity test was conducted on the cut-back asphalt used for curing the soil cement. The asphalt was classified as RC-250, which is approved for curing soil cement as outlined in the project specifications. A physical determination indicated the cement meets ASTM:C150 specification allowed for Type I Cement. The laboratory results discussed above are shown on the attached data sheets.

FIELD PROCEDURES AND RESULTS
(cont.)

Fourteen in-situ density tests were taken in the embankment fill for the south berm. The test results indicate the specified compaction was attained.

Coal Storage Area

The filling and compaction operations were conducted primarily in the area west of the coal retaining berm. After the subgrade was proofrolled and tested, a wet clayey sand (SC) layer was placed over the area. The clayey sand was then compacted, tested and covered with 6" of sand. Four out of seven field density tests taken after the initial compaction operations indicated relative compaction below 90% with an average moisture content of 19%. After additional compaction and drying, supplementary field density tests were performed with satisfactory results. During this report period, a total of 14 density tests were taken in the subgrade and sand cover, and 11 density tests were taken in the clayey sand impervious blanket.

Cooling Tower #1

Granular fill was used to raise the area north of Cooling Tower #1 to a 6:1 slope away from the structure. Seven field density tests were taken during the construction, and the results of these tests verified the fill was satisfactorily compacted.

Coal Yard Area Railroad Track #1

Samples of the ballast material used to support the railroad tracks were brought into the laboratory for physical testing. The tests on the ballast material included mechanical analysis, soundness tests, abrasion tests, specific gravity and absorption. These tests indicate the ballast material meets project specifications and AREA Specifications as shown for prepared stone ballast. The test results have previously been reported and are also attached with this report.

FIELD PROCEDURES AND RESULTS
(cont.)

Fly Ash Pond Dam

Prior to the placement of the impervious earth blanket, the subgrade for the dam was proofrolled, and 31 field density tests were taken. In all cases, the results of the field density tests indicated the specified compaction was attained by the initial compactive effort.

On July 31, we received a copy of the letter by your consultants, Black & Veatch, describing the compaction and moisture requirements of both the cohesive and granular fill materials. The letter modified the minimum density of the impervious cohesive material from 93% to 90% and increased the allowable moisture content at the time of compaction to a range of zero to 6% above optimum. The density requirements of the granular fill will remain unchanged, while the minimum moisture content was established at 3%.

As of July 31, the impervious earth blanket for the east dam and the center dike was completed to station 10+00 and station 9+00, respectively. One hundred thirty-nine of the 160 field density tests taken in the clay core and impervious earth blanket indicate a relative compaction of 90% or higher. The remaining test areas received additional compaction and were retested to verify the soils were satisfactorily compacted. As indicated on the attached test results, the passing tests had moisture contents that varied from 1% to 9% above optimum moisture with an average of 5.7% over optimum. A tabulation of the density tests, which shows passing density with moisture contents greater than the specified 6% over optimum, is submitted. The average moisture content of the 65 tests was 6.83% over optimum. As discussed with you, additional testing is in progress to evaluate the compressibility and permeability of the cohesive material at high moisture contents. A supplemental report will be prepared

FIELD PROCEDURES AND RESULTS
(cont.)

discussing the material and test results in greater detail.

Three hundred eleven density tests were taken in the granular embankment fill. As indicated on the attached test results, five of these tests failed to meet the relative compaction required in the project specifications. The failing tests areas were recompacted and retested to verify the soils were satisfactorily compacted. Thirteen of the three hundred eleven tests taken in the embankment fill have moisture contents below the 3% minimum described in the letter from Black & Veatch, dated July 30, 1974.

In order to determine the permeability of the cohesive material used to construct the impervious earth blanket and clay dike cores, four, 2" diameter thin-wall tube samples were taken from the impervious earth blanket and returned to the laboratory for falling head permeability tests. The test results show relatively uniform k (coefficient of permeability) values ranging between 2×10^{-8} centimeters per second to 1×10^{-7} centimeters per second.

Riprap and riprap bedding were placed on the south and west dam to elevation 975', and filter rock is presently being installed on the center dike and east dam. Four gradation tests were conducted on the riprap bedding material and Type I filter rock. The first test indicated the rock did not comply with the gradation specification since the percentage passing the #3 and #6 sieves is less than specified. Three additional gradations were performed and showed that the material sampled did then meet the project specifications.

Report No. 13 on

INSPECTION AND TESTING DURING EARTHWORK OPERATIONS
COAL AND ASH STORAGE AREAS

Report #13

NORTHERN STATES POWER COMPANY
SHERBURNE COUNTY GENERATING PLANT
UNIT NO. 1
NEAR BECKER, MINNESOTA

DIN 96A341

Specification 5377-D-4C

DIN 96A341

Purchase Order No. C88754

Laboratory No. 9-5625

by

Twin City Testing and Engineering Laboratory Inc
662 Cromwell Avenue
St Paul, Minnesota 55114

TWIN CITY TESTING AND ENGINEERING LABORATORY, Inc.

CHEMICAL & PHYSICAL TESTS • INSPECTIONS • RESEARCH

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Vice-President Chemistry
CLINTON R. EUE
Secretary-Treasurer

September 10, 1974

Northern States Power Co
414 Nicollet Mall
Minneapolis, MN 55401

Attn: Mr J V Sullivan

Dear Mr Sullivan

Subj: Inspection and Testing
Coal and Ash Storage Areas
Sherburne County Generating Plant
Near Becker, Minnesota
Laboratory #9-5625

This is our 13th progress report presenting our inspection findings and test results for the referenced project. We are sending you three copies. Additional copies are being sent as noted below. This work is being done in accordance with your purchase order number C88754, dated August 23, 1973.

Additional reports will be submitted as the project progresses. If you have any questions or desire further information, please contact us.

Very truly yours,

Michael O'Donnell
Civil Engineer

Donovan K Stormoe, P.E.

MO/DKS/rs

Copies to

- 1) Northern States Power, QA
Attn: Mr David V Collins
- 2) Northern States Power (Becker)
Attn: Mr Curt Sillman
- 1) Black & Veatch
Attn: Mr John Vines
- 2) J A Danens & Son Inc

NORTHERN STATES POWER COMPANY
SHERBURNE COUNTY GENERATING PLANT
UNIT NO. 1
NEAR BECKER, MINNESOTA

#9-5625

INTRODUCTION

This report concerns our continuing full-time inspection and testing of the earth-work operations in the coal and ash storage areas at the above referenced project. The purpose of this report is to present our inspection findings and testing results from the period of August 1 through August 16, 1974. This work is being conducted in accordance with your purchase order number C88754, dated August 23, 1973.

FIELD PROCEDURES AND RESULTS

Coal Retaining Berms

The work in this area consisted of placing soil cement on the south berm to approximate elevation 997'. Six compaction tests were made in the soil cement. The tests are numbers 1096, 1121, 1179, 1180, 1184, and 1215, and the results are attached. Test #1179, which was taken near the outside edge of the south berm, indicated the specified compaction was not attained during the initial compaction operations. By recompacting this area and by intensifying the compactive effort near the edge of the berm, adequate density was attained.

Also during this time period, granular fill was being placed in the center of the south berm. One test (#1122) was taken in the sand fill, and the test had passing results. Northwest Bituminous, J A Danens & Son Inc and Northern States Power Co agreed to replace the remaining portion of the embankment fill, between

FIELD PROCEDURES AND RESULTS
(cont.)

elevation 995' to elevation 1000', with soil cement.

Clay Borrow Pit

We were asked by your field representative, Mr John Wilkenson, to place three additional borings in the newly purchased borrow pit (Carl Johnson's property) in order to better define the quantity of the available cohesive soils. The borings were placed in a winter wheat field at the following grid coordinates:

<u>Boring Number</u>	<u>Grid Coordinates</u>	
1	2040900E	881300N
2	2040900E	882000N
3	2040900E	882700N

The borings indicated a general profile consisting of a thin veneer of topsoil and and weathered soil overlying clayey material, which is in turn underlain by dense silty sand. The topsoil, which was a dark brown silty sand, was found in most borings to a depth of 6" to 2'. The cohesive material encountered below the topsoil consisted mainly of sandy clay and clayey sand. The thickness of this soil stratum tapered from 8.5' in the southeast corner of the borrow pit to 14' in the northeast corner.

Fly Ash Pond Dams

On August 13, a meeting was held to discuss the moisture requirements presently being used on the Type I impervious fill. Since difficulties are expected this fall in drying the clayey soils to proper moisture content, a warning zone of 6% to 6.5% over optimum moisture content was established to enable the contractor to work at the upper limit of the specifications. However, only occasional density tests having a 6% to 6.5% over optimum moisture content will be accepted.

FIELD PROCEDURES AND RESULTS
(cont.)

As of August 16, the impervious earth blanket was completed in the east dam to station 14+50 and in the center dike to station 14+00. Moisture contents were performed frequently to check and control the quality of the clay soils being used during the construction. The test results are reported directly to the contractor to aid him in the aeration operations and in effectively utilizing the available cohesive materials in the borrow pit. Thirty-three field density tests were performed on the clay core and impervious earth blanket. As indicated on the attached test results, only one area (indicated by test #1086 and #1088) had either high moisture content or low density. The clayey material in the area was removed, replaced with a dry material, and recompactd to specified density.

One hundred and fifteen field density tests were taken in the granular embankment fill, and five density tests were performed in subgrade for the dam. In all cases, the results of the field density tests indicated the specified compaction was achieved on the initial compactive effort.

Fly Ash Pond

Two density tests (#1117 and #1118) were taken in the prepared subgrade for the fly ash pond, and both tests had satisfactory results. However, a density test (#1179) taken of the impervious clay liner indicated high moisture content and low density. This area is presently being recompactd, and supplemental tests will be taken in the near future.

REMARKS

Our inspection and testing indicates the earthwork is being performed in accordance with the project plans and specifications in all areas. Further supervision

REMARKS
(cont.)

is being performed, and additional reports will be forwarded as the work progresses.

Report No. 14 on

INSPECTION AND TESTING DURING EARTHWORK OPERATIONS
COAL AND ASH STORAGE AREAS

Report #14

NORTHERN STATES POWER COMPANY
SHERBURNE COUNTY GENERATING PLANT
UNIT NO. 1
NEAR BECKER, MINNESOTA

DIN 96A341

Specification 5377-D-4C

DIN 96A341

Purchase Order No. C88754

Laboratory No. 9-5625

by

Twin City Testing and Engineering Laboratory Inc
662 Cromwell Avenue
St Paul, Minnesota 55114

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ALBERT C. HOLLER, F.A.I.C.
Vice-President Chemistry
CLINTON R. EUE
Secretary-Treasurer

September 11, 1974

Northern States Power Co
414 Nicollet Mall
Minneapolis, MN 55401

Attn: Mr J V Sullivan

Dear Mr Sullivan

Subj: Inspection and Testing
Coal and Ash Storage Areas
Sherburne County Generating Plant
Near Becker, Minnesota
Laboratory #9-5625

This is our 14th progress report presenting our inspection findings and test results for the referenced project. We are sending you three copies. Additional copies are being sent as noted below. This work is being done in accordance with your purchase order number C88754, dated August 23, 1973.

Additional reports will be submitted as the project progresses. If you have any questions or desire further information, please contact us.

Very truly yours

Michael O'Donnell
Civil Engineer

Donovan K Stormoe, P.E.

MO/DKS/rs

Copies to

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Attn: Mr David V Collins
- 2) Northern States Power (Becker)
Attn: Mr Curt Sillman
- 1) Black & Veatch
Attn: Mr John Vines
- 2) J A Danens & Son Inc

NORTHERN STATES POWER COMPANY
SHERBURNE COUNTY GENERATING PLANT
UNIT NO. 1
NEAR BECKER, MINNESOTA

#9-5625

INTRODUCTION

This report concerns our continuing full-time inspection and testing of the earth-work operations in the coal and ash storage areas at the above referenced project. The purpose of this report is to present our inspection findings and testing results for the period of August 19 through August 30, 1974. This work is being conducted in accordance with your purchase order number C88754 dated August 23, 1973.

FIELD PROCEDURES AND RESULTS

Coal Retaining Berms

On August 20, the south berm was finished to elevation 1000', and the entire soil cement operations were completed. The work in this area presently consists of patching with grout and refinishing with cutback asphalt on several small areas along the faces of the south berm. A total of 865 cubic yards of soil cement was placed during this report period, bringing the total soil cement placed this year on the coal retaining berms to 17,415 cubic yards.

Two compaction tests were taken during the final two lifts placed on the south berm. The tests are #1244 and #1261, and the results are attached. The test results indicated the specified compaction was attained at the proper moisture content.

FIELD PROCEDURES AND RESULTS
(cont.)

Reserved Coal Storage Area

The granular materials used to build a hauling ramp for the south berm are being replaced in an area just north of the north berm. Seven density tests were taken during the fill placement to verify that the material was compacted to an adequate density.

Ash Pond Dams

As of August 30, the impervious earth blanket was completed to east dam station 26+00. Thirty-eight density tests were performed on the clay core and dam impervious earth blanket. Three of these tests had moisture contents above the required moisture content (maximum 6.5% over optimum). By discing and blending with a drier material, two of the recompacted areas were retested with satisfactory results. The remaining failing test area will be retested, and the results will be included in our next report.

By examining the moisture content of the density tests, 40% of the passing tests had moisture contents falling in the established warning zone of 6% to 6.5% over optimum. As discussed in a meeting that was described in report #13, only a few tests of this type were expected. It is quite apparent that the moisture content, not the density, is the critical factor as to the amount of material which can be placed this fall.

Ninety-five field density tests were taken in the granular embankment fill, and six density tests were taken in the subgrade soils for the dams. All of the tests taken in the subgrade indicated a sufficient density; however, five of the tests taken in the embankment fill revealed either a low moisture content or low density. After water and additional compactive effort was applied,

FIELD PROCEDURES AND RESULTS
(cont.)

designated retests were performed on the recompacted areas, and the results of the retests indicated the areas were satisfactorily compacted.

In addition to the above field tests, three gradation tests were performed on samples of riprap used on the dams. An average of the tests indicated the processed rock meets the revised project specifications.

Fly Ash Pond

Test #1277 was taken in the prepared subgrade for the southeast corner of the fly ash pond, and the results are attached. Since a wet clayey soil was placed upon the fly ash pond, difficulties were encountered in attaining the specified density and moisture content. Five separate areas were tested to determine the effectiveness of the compactive operations. Only one area (designated by test #1336) was approved after initial compactive effort. After aeration and recompaction operations, three of the remaining four areas showed passing density and moisture contents as indicated by tests #1315, #1334, and #1335. As discussed with the contractor, the clayey soils in the failing test area (indicated by test #1337) will be removed and replaced with a drier material. This area will be retested at that time.

REMARKS

One hundred and sixty field density tests were taken in accordance with ASTM:D1556-64 (Sand-Cone Method) during this period. A tabulation of the in-place density tests and a summary of the test results are attached. Our inspection and testing indicates the earthwork is being performed in accordance with the project plans and specifications. Further supervision is being performed and additional reports will be forwarded as the work progresses.

Report No. 15 on

INSPECTION AND TESTING DURING EARTHWORK OPERATIONS
COAL AND ASH STORAGE AREAS

NORTHERN STATES POWER COMPANY
SHERBURNE COUNTY GENERATING PLANT
UNIT NO. 1
NEAR BECKER, MINNESOTA

Report #15

Specification 5377-D-4C

DIN 96A341

Purchase Order No. C88754

Laboratory No. 9-5696

By

Twin City Testing and Engineering Laboratory Inc
662 Cromwell Avenue
St Paul, Minnesota 55114

TWIN CITY TESTING AND ENGINEERING LABORATORY, Inc.

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Vice-President Engineering
ALBERT C. HOLLER, F.A.I.C.
Vice-President Chemistry
CLINTON R. EUE
Secretary-Treasurer

September 30, 1974

Northern States Power Co
414 Nicollet Mall
Minneapolis, MN 55401

Attn: Mr J V Sullivan

Dear Mr Sullivan

Subj: Inspection and Testing
Coal and Ash Storage Areas
Sherburne County Generating Plant
Near Becker, Minnesota - Laboratory #9-5696

This is our 15th progress report presenting our inspection findings and test results for the referenced project. We are sending you three copies. Additional copies are being sent as noted below. This work is being done in accordance with your purchase order #C88754, dated August 23, 1973.

Additional reports will be submitted as the project progresses. If you have any questions or desire further information, please contact us.

Very truly yours

Michael O'Donnell
Civil Engineer

Donovan K Stormoe, P.E.

MO/DKS/rs

Copies to

- 1) Northern States Power - QA
Attn: Mr David V Collins
- 2) Northern States Power - Becker
Attn: Mr Curt Sillman
- 1) Black & Veatch
Attn: Mr John Vines
- 2) J A Danens & Son Inc

NORTHERN STATES POWER COMPANY
SHERBURNE COUNTY GENERATING PLANT
UNIT NO. 1
NEAR BECKER, MINNESOTA

#9-5696

INTRODUCTION

This report concerns our continuing full-time inspection and testing of the earth-work operations in the coal and ash storage areas at the above referenced project. The purpose of this report is to present our inspection findings and testing results for the period of August 31 through September 13, 1974. This work is being conducted in accordance with your purchase order #C88754 dated August 23, 1973.

FIELD PROCEDURES AND RESULTS

Reserve Coal Storage Area

Granular fill continued to be placed in the southeast corner of the reserve coal storage area during the first day of this report period. After compaction was applied and the subgrade elevation was reached, a compaction test (#1410) was taken at a random location. The attached test results revealed the specification compaction was obtained.

Holding Basin

Work in this area consisted of compacting subgrade soils. A total of six field density tests were performed on the subgrade material, and five of these tests revealed adequate density. The one failing test area in the south end of the holding basin (indicated by test #1475) will receive additional compaction and will be retested at that time.

Holding Basin Pump House

Project representatives from Black & Veatch and Northern States Power Co jointly

FIELD PROCEDURES AND RESULTS
(cont.)

decided to add a small amount of impervious material on top of the prepared subgrade soils between the inside sheet piling for the holding pond pump house. One density test (#1448) taken in the subgrade showed adequate compaction; while another density test (#1458) taken in the impervious material indicated additional compaction was necessary. After the area was recompacted, a designated retest (#1464) was performed to verify the specified density was attained.

Cooling Tower #2

Filling and compacting operations took place on the northern, southern and eastern sides of cooling tower #2. However, these operations were concentrated primarily in an area east of the cooling tower and north of the substation, where an average of 2' of fill was placed and compacted. Fourteen field density tests were taken during this report period, and in all cases, the test results indicated the specified density was attained.

Fly Ash Pond

Two density tests (#1420 and #1431) were performed on the impervious material placed in the southeast corner of the fly ash pond. As discussed in our previous report, portions of this area were essentially replaced with a drier clay soil. The two density test results verify the compacted material meets the specified density and moisture content requirements.

Bottom Ash Pond

The bottom ash pond was completed during this report period. The granular subgrade was proofrolled and checked for density by performing four field density tests (#1402, #1403, #1404 and #1405). Seven of the eight in-place density tests taken in the 18" impervious earth blanket (#1440, #1442, #1457, #1461, #1468, #1472 and #1474) indicated the specified density and moisture content was obtained during the initial

FIELD PROCEDURES AND RESULTS
(cont.)

compactive efforts. The failing test area (indicated by test #1429) received additional compaction and was retested by test #1438, which verified the soil was satisfactorily compact.

Ash Pond Dams

Due to continuous rainy weather during the week of September 7 through September 13, the aeration, filling and compacting operations of clay soils ceased during this time, and these operations were limited to the first week of the report period. As of September 13, with the exception of the east side of the east dam between station 25+00 to station 27+00, the impervious earth blanket was completed for the dams.

One density test (#1471) was performed on the subgrade soils near the east dam station 28+00. The test results indicated the specified compaction was attained, and approval for the continued placement of the impervious earth blanket was granted.

A total of twelve density tests were performed on the clay core and impervious earth blanket for the dams. The impervious material was found to be excessively wet on the clay core near west dam station 24+00, where three failing tests (#1409, #1417 and #1432) were recorded. After aeration and blending operations failed to lower the moisture content to an acceptable level, the contractor replaced the failing area with drier, compacted clay soils. Test #1459 was then performed, and the results verify the drier material was compacted to the specified density.

Sixty-eight density tests were taken in the granular embankment fill. As indicated on the attached test results, three of these tests (#1407, #1411, and #1455) failed to meet the minimum moisture requirement, and one test, #1467, had substandard density. The failing test areas were sprayed with water, recompact, and retested to verify the soils comply with the project specifications.

FIELD PROCEDURES AND RESULTS
(cont.)

The permeability of the cohesive soils used to construct the impervious earth blanket is randomly checked by performing a falling head permeability test on in-place material, that was sampled with thin-wall tubes (Shelby tubes). The most recent test results show a coefficient of permeability value of 6.51×10^{-8} centimeters per second. This type of testing will continue during the construction, and test results will be included in our forthcoming reports.

REMARKS

A tabulation of the in-place density tests and a summary of the test results are attached. Our inspection and testing indicates the earthwork is being performed in accordance with the project plans and specifications. Further supervision is being performed and additional reports will be forwarded as the work progresses.

Report No. 16 on

INSPECTION AND TESTING DURING EARTHWORK OPERATIONS
COAL AND ASH STORAGE AREAS

Report #16

NORTHERN STATES POWER COMPANY
SHERBURNE COUNTY GENERATING PLANT
UNIT NO. 1
NEAR BECKER, MINNESOTA

SIPH 96A341

Specification 5377-D-4C

DIN 96A341

Purchase Order No. C88754

Laboratory No. 9-5696

by

Twin City Testing and Engineering Laboratory Inc
662 Cromwell Avenue
St Paul, Minnesota 55114

TWIN CITY TESTING AND ENGINEERING LABORATORY, Inc.

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NORMAN E. HENNING, P.E.
Vice-President Engineering
ALBERT C. HOLLER, F.A.I.C.
Vice-President Chemistry
CLINTON R. EUE
Secretary-Treasurer

October 9, 1974

Northern States Power Co
414 Nicollet Mall
Minneapolis, MN 55401

Attn: Mr J V Sullivan

Dear Mr Sullivan

Subj: Inspection and Testing
Coal and Ash Storage Areas
Sherburne County Generating Plant
Near Becker, Minnesota
Laboratory #9-5696

This is our 16th progress report presenting our inspection findings and test results for the referenced project. We are sending you three copies. Additional copies are being sent as noted below. This work is being done in accordance with your Purchase Order No. C88754, dated August 23, 1973.

Additional reports will be submitted as the project progresses. If you have any questions or desire further information, please contact us.

Very truly yours

Michael O'Donnell
Civil Engineer

Donovan K Stormoe, P.E.

MO/DKS/rs
Copies to

- 1) Northern States Power - QA
Attn: Mr David V Collins
- 2) Northern States Power (Becker)
Attn: Mr Curt Sillman
- 1) Black & Veatch
Attn: Mr John Vines
- 2) J A Danens & Son Inc

NORTHERN STATES POWER COMPANY
SHERBURNE COUNTY GENERATING PLANT
UNIT NO. 1
NEAR BECKER, MINNESOTA

#9-5696

INTRODUCTION

This report concerns our continuing full-time inspection and testing of the earth-work operations in the coal and ash storage areas at the above referenced project. The purpose of this report is to present our inspection findings and testing results for the period of September 14 through September 27, 1974. This work is being conducted in accordance with your Purchase Order No. C88754 dated August 23, 1973.

FIELD PROCEDURES AND RESULTS

Cooling Tower #2

Eight density tests (1528, 1529, 1536, 1537, 1543, 1544, 1556 and 1557) were taken in the granular embankment fill placed east of Cooling Tower #2. In all cases, the test results indicated the specified compaction was attained by the initial compactive efforts.

Holding Basin

Work in this area consisted of placing an 18" impervious liner on the northern half of the holding basin. After spraying water on the southwest slope of the holding basin, a retest of test #1475 was performed on the granular subgrade soils with satisfactory results. The liner material, which is a clayey sand, was placed on a 2:1 slope in thin lifts with a D-8 dozer. The slopes were then compacted

FIELD PROCEDURES AND RESULTS
(cont.)

by a vibratory sheepsfoot roller, which was pushed up the slopes by a D-5 dozer. Two of the six field density tests taken of the clay liner showed failing density results. After recompacting the slopes of the holding basin, test #1662 and #1685 verified adequate density was attained.

Flyash Pond

In order to prevent freezing of the clay liner this winter and to check the circuitry of the plant, Northern States Power Co is scheduling to fill the pond with 4' of water on October 15, 1974.

The pond subgrade soils are prepared for liner placement by compacting a thin lift of silty sand to elevation 944.5'. The silty sand retains a higher moisture content and compacts to a higher density than the natural, granular subgrade soils. The purpose in using this material is to establish a solid base which would not bulk or loosen under construction traffic. Sixteen field density tests were performed on the subgrade soil, and in all cases, the test results indicated the specified compaction was attained.

Twenty-one density tests were performed in the impervious liner. Four test results revealed either the specified density was not attained or the specified moisture content was not maintained. After additional compactive effort was applied, two areas (indicated by tests #1580 and #1602) were retested with satisfactory results. The clay material in the remaining failing test area (indicated by tests #1619 and #1624) was removed, replaced with dry material, and recompacted to the specified density.

Ash Pond Dams

The impervious earth blanket for the ash pond dams and dikes was completed. One

FIELD PROCEDURES AND RESULTS
(cont.)

density test (#1524) was performed on the subgrade soils during this report period, and the test results indicated the specified density was attained. A total of twenty-three density tests were performed on the clay core and impervious earth blanket. As shown on the attached results, three of the areas (indicated by tests #1593, #1605 and #1626) had a high moisture content which caused a low density. By blending the existing substandard areas with a drier material and then recompact, the contractor was able to lower the moisture content enough to attain specified density as verified by tests #1603, #1613 and #1632.

Granular embankment fill was placed primarily above elevation 975' on the west dam, south dam, east dam and center dike. One hundred one density tests were taken in the granular embankment fill, and only three tests (#1591, #1620, and #1643) revealed the specified density was not attained. Additional compactive effort was applied to these areas with satisfactory results.

LABORATORY TESTING

In addition to the above field tests, a 3" thin-wall tube sample and a bag sample of clay soils were brought into the laboratory for permeability tests. Falling head permeability tests conducted on both samples indicated K-values (coefficient of permeability) of 10^{-8} centimeters per second.

Since the ballast material, which recently arrived on the job, appeared to have changed from the material tested in June, 1974, we were requested by your field representative for the railroad construction to perform a series of tests, including mechanical analysis, soundness, abrasion, specific gravity and absorption. The test results show a slight variation in material; yet the tests indicated the ballast material meets the project specifications and AREA specifications for prepared stone ballast. The actual test results are attached with this report.

REMARKS

A tabulation of the in-place density tests and a summary of the test results are attached. Our inspection and testing indicates the earthwork is being performed in accordance with the project plans and specifications. Further supervision is being performed and additional reports will be forwarded as the work progresses.

Report No. 17 on

INSPECTION AND TESTING DURING EARTHWORK OPERATIONS
COAL AND ASH STORAGE AREAS

Report # 17

NORTHERN STATES POWER COMPANY
SHERBURNE COUNTY GENERATING PLANT
UNIT NO. 1
NEAR BECKER, MINNESOTA

DIN 96A341

Specification 5377-D-4C

DIN 96A341

Purchase Order No. C88754

Laboratory No. 9-5786

by

Twin City Testing And Engineering Laboratory Inc
662 Cromwell Avenue
St Paul, Minnesota 55114

TWIN CITY TESTING AND ENGINEERING LABORATORY, Inc.

CHEMICAL & PHYSICAL TESTS • INSPECTIONS • RESEARCH

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Vice-President Engineering
ALBERT C. HOLLER, F.A.I.C.
Vice-President Chemistry
CLINTON R. EUE
Secretary-Treasurer

October 21, 1974

Northern States Power Co
414 Nicollet Mall
Minneapolis, MN 55401

Attn: Mr J V Sullivan

Dear Mr Sullivan

Subj: Inspection and Testing
Coal and Ash Storage Areas
Sherburne County Generating Plant
Becker, Minnesota - Laboratory #9-5786

This is our 17th progress report presenting our inspection findings and test results for the referenced project. We are sending you three copies. Additional copies are being sent as noted below. This work is being done in accordance with your purchase order #C88754, dated August 23, 1973.

Additional reports will be submitted as the project progresses. If you have any questions or desire further information, please contact us.

Very truly yours

Michael O'Donnell
Michael O'Donnell
Civil Engineer

Donovan K Stormoe
Donovan K Stormoe, P.E.

MO/DKS/rs

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- 2) J A Danens & Son Inc

NORTHERN STATES POWER COMPANY
SHERBURNE COUNTY GENERATING PLANT
UNIT NO. 1
NEAR BECKER, MINNESOTA

#9-5786

INTRODUCTION

This report concerns our continuing full-time inspection and testing of the earth-work operations in the coal and ash storage areas at the above referenced project. The purpose of this report is to present our inspection findings and testing results for the period of September 28 through October 11, 1974. This work is being conducted in accordance with your purchase order #C88754 dated August 23, 1973.

FIELD PROCEDURES AND RESULTS

Coal Storage Area

Filling operations resumed in the coal storage area during the last day of this report period. Two density tests (#1854 and #1855) were performed on the sub-grade soil east of the coal retaining berms. Both test results showed the specified density was attained.

Holding Basin

The holding basin was essentially completed during this report period. The densification obtained by the compaction operations was determined by performing two density tests on the impervious liner and five tests on the overlying embankment fill. The results of these tests verified the material was satisfactorily compacted.

FIELD PROCEDURES AND RESULTS
(cont.)

Recycling Basin

Work in this area consisted of placing an 18" clay liner on the slopes of the recycling basin and then covering this material with a 1' of granular fill, 5" of riprap bedding, and 1' of Class A riprap.

The natural sands on the slopes were shaped to grade and tested for density prior to placement of the impervious liner. Eight density tests were performed on the subgrade soils and the results verified adequate density was attained.

Three of the seven density tests taken in the clay liner showed insufficient density. Additional compaction effort was applied, and tests #1735, #1753 and #1776 were performed in the recompacted areas to verify the soils were satisfactorily compacted.

The protective cover of granular fill, which was placed on the clay liner, was compacted to the specified density as verified by tests #1781, #1787, #1806, #1818, #1844 and #1853.

Flyash Pond

The 18" impervious clay liner for the bottom of the flyash pond was completed. Eight field density tests were performed on the subgrade soils, and the test results indicated the relative compaction meets project specifications. Six density tests (#1733, #1746, #1757, #1763, #1803 and #1842) out of twenty-nine tests taken in the clay liner had either low density or high moisture content. When the clay material had insufficient density, additional compactive effort was applied. However, when the material was too wet, as in most cases, a combination of spreading the wet material over a large area of prepared subgrade, blending it with drier material, and discing the two together provided a lower overall moisture content. The areas were then recompacted and retested with favorable results.

FIELD PROCEDURES AND RESULTS
(cont.)

Ash Pond Dam

The filling and compaction operations were concentrated primarily on the south dam, east dam and center dike. All of the 92 field density tests taken in the embankment fill revealed the specified density was attained with an adequate moisture content.

Thirteen field density tests were taken in the clay core. Only one test, #1817, showed a failing density. Upon recompaction of this area, the specified density was attained.

REMARKS

A tabulation of the in-place density tests and a summary of the test results are attached. Our inspection and testing indicates the earthwork is being performed in accordance with the project plans and specifications. Further supervision is being performed and additional reports will be forwarded as the work progresses.

Report No. 18 on

INSPECTION AND TESTING DURING EARTHWORK OPERATIONS
COAL AND ASH STORAGE AREAS

#18

NORTHERN STATES POWER COMPANY
SHERBURNE COUNTY GENERATING PLANT
UNIT NO. 1
NEAR BECKER, MINNESOTA

96A341

Specification 5377-D-4C

DIN 96A341

Purchase Order No. C88754

Laboratory No. 9-5786

by

Twin City Testing and Engineering Laboratory Inc
662 Cromwell Avenue
St Paul, Minnesota 55114

TWIN CITY TESTING AND ENGINEERING LABORATORY, Inc.

CHEMICAL & PHYSICAL TESTS • INSPECTIONS • RESEARCH

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Vice-President Engineering
ALBERT C. HOLLER, F.A.I.C.
Vice-President Chemistry
CLINTON R. EUE
Secretary-Treasurer

November 26, 1974

Northern States Power Co
414 Nicollet Mall
Minneapolis, MN 55401

Attn: Mr J V Sullivan

Dear Mr Sullivan

Subj: Inspection and Testing
Coal and Ash Storage Areas
Sherburne County Generating Plant
Near Becker, Minnesota - Laboratory #9-5786

This is our 18th progress report presenting our inspection findings and test results for the referenced project. We are sending you three copies. Additional copies are being sent as noted below. This work is being done in accordance with your purchase order #C88754, dated August 23, 1973.

Addition reports will be submitted as the project progresses. If you have any questions or desire further information, please contact us.

Very truly yours

Michael O'Donnell
Michael O'Donnell
Civil Engineer

Donovan K Stormoe
Donovan K Stormoe, P.E.

MO/DKS/rs

Copies to

- 1) Northern States Power - QA
Attn: Mr David V Collins
- 2) Northern States Power - Becker
Attn: Mr Curt Sillman
- 1) Black & Veatch
Attn: Mr John Vines
- 2) J A Danens & Son Inc

NORTHERN STATES POWER COMPANY
SHERBURNE COUNTY GENERATING PLANT
UNIT NO. 1
NEAR BECKER, MINNESOTA

#9-5786

INTRODUCTION

This report concerns our continuing full-time inspection and testing of the earth-work operations in the coal and ash storage areas at the above referenced project. The purpose of this report is to present our inspection findings and testing results for the period of October 12 through October 31, 1974. This work is being conducted in accordance with your purchase order #C88754 dated August 23, 1973 and revised on June 18, 1974.

FIELD PROCEDURES AND RESULTS

Coal Storage Area

The filling and compaction operations were completed in the northern area of the reserve coal storage areas. The north ditch in this area was repaired, and a berm was constructed to allow drainage and prevent erosion of the north ditch. After smooth rolling the granular subgrade in the coal storage area, 14 density tests were performed (#1874, #1875, #1891, #1892, #1893, #1894, #1910, #1911, #1930, #1931, #1945, #1946, #1953 and #1954). As indicated on the attached test results, the relative compaction meets project specifications.

Two of the 14 density tests taken in the impervious liner had low density (86% compaction compared to the specified 90%). By discing and recompacting the existing material in the failing test areas, the dry density of the fill soils

FIELD PROCEDURES AND RESULTS
(cont.)

was raised to comply with the specifications as verified by tests #1928 and #1976.

The sand cover was placed in various areas of the active coal storage area. In the completed areas, the results of our field density tests (#1936, #1957, #1981 and #1982) indicated the specified compaction was attained by the initial compactive efforts. One density test (#2035) was taken in the Type III material used for the top erosion resistance cover in the north ditch, and six density tests (#2011, #2018, #2025, #2047, #2049 and #2050) were performed in the protective berm. All of the tests revealed the specified density was attained with an adequate moisture content.

Coal Yard Road

Subgrade preparation began in the coal yard road in the northeast portion of the coal storage area during the last week of this report period. Three density tests (#2055, #2056 and #2060) were taken of the subgrade soils, and two of these tests had insufficient compaction. The grading contractor assured us the failing test areas will be recompacted for retesting before the placement of aggregate road base.

Recycle Basin

The bottom of the recycle basin is presently being constructed. Four field density tests, #1956, #1986, #1993 and #2046, were performed on the impervious earth blankets; and as indicated on the attached test results, only one area (#1956) had a low relative compaction. The cohesive material in the area was recompacted and retested with satisfactory results.

Ash Pond Dam

As of October 31, the clay core south of west dam station 19+00 to south dam

FIELD PROCEDURES AND RESULTS
(cont.)

station 0+00 was completed. The clay cores along the east dam and center dike are presently being constructed in relatively horizontal lifts and are at approximate elevation 987' and 992', respectively. Twenty-six compaction tests were taken along the various clay cores. Three separate areas had tests that showed the specified compaction was not attained (indicated by tests #1879, #1918, #1920 and #1927). After recompacting the failing test areas, two of these areas were retested with satisfactory results as verified by tests #1884 and #1926. The impervious material in the remaining area was spread over a larger portion of the core, recompacted, and retested by test #1933 to verify adequate density was attained.

Only three tests out of the 115 density tests taken of the embankment fill revealed unsatisfactory compaction. These areas were immediately recompacted and retested by tests #1907, #1969 and #1997. The test results indicated the material in these areas was compacted to the project specifications.

Toe Drain Ditches

Four gradations were performed on the Type II filter rock before the material was brought on the job site. As indicated on the attached test results, the first two gradation tests failed to meet the project specifications, while the last two gradations passed. The first two passing gradations, FR2-G-3 and FR2-G-4, were performed on a gray granite, and the two failing gradations, FR2-G-1 and FR2-G-2, were performed on a pink granite and a mixture of pink and gray granite, respectively. The crusher is often proven to be the key unit as to whether the rock meets specifications. This does not appear to be the case, since tests FR2-G-1 and FR2-G-4 were sampled from the riprap scalping pile, and tests FR2-G-2 and FR2-G-3 were sampled from a separate crusher. The margin of difference between the passing

FIELD PROCEDURES AND RESULTS
(cont.)

and failing is best explained by the variation in the texture and mineral hardness of the rocks tested. All of the rocks tested were granite; however, granites often possess variable crushing qualities. The gray granite is finer and more uniformly grained than the pink granite. Rock specimens of both types of granite were brought into the laboratory for further examination. The most significant difference between the two is grain size. The pink granite is coarse grained and thus has different breakage characteristics than the corresponding fine grained rocks. The more secondary breakage of the pink granite can also be related to the better developed cleavage planes found throughout the pink granite.

REMARKS

A tabulation of the in-place density tests and a summary of the test results are attached. Our inspection and testing indicates the earthwork is being performed in accordance with the project plans and specifications. Further supervision is being performed and additional reports will be forwarded as the work progresses.

Report No. 19 on

INSPECTION AND TESTING DURING EARTHWORK OPERATIONS
COAL AND ASH STORAGE AREAS

19

NORTHERN STATES POWER COMPANY
SHERBURNE COUNTY GENERATING PLANT
UNIT NO. 1
NEAR BECKER, MINNESOTA

96 A 341

Specification 5377-D-4C

DIN 96A341

Purchase Order No. C88754

Laboratory No. 9-5828

By

Twin City Testing and Engineering Laboratory, Inc.
662 Cromwell Avenue
St. Paul, Minnesota 55114

TWIN CITY TESTING AND ENGINEERING LABORATORY, Inc.

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Vice-President Engineering
ALBERT C. HOLLER, F.A.I.C.
Vice-President Chemistry
CLINTON R. EUE
Secretary-Treasurer

December 23, 1974

Northern States Power Co
414 Nicollet Mall
Minneapolis, MN 55401

Attn: Mr J V Sullivan

Dear Mr Sullivan

Subj: Inspection and Testing
Coal and Ash Storage Areas
Sherburne Co Generating Plant
Becker, Minnesota - Laboratory #9-5828

This is our 19th progress report presenting our inspection findings and test results for the referenced project. We are sending you three copies. Additional copies are being sent as noted below. This work is being done in accordance with your purchase order #C88754, dated August 23, 1973.

Additional reports will be submitted as the project progresses. If you have any questions or desire further information, please contact us.

Very truly yours

Michael O'Donnell
Michael O'Donnell
Civil Engineer

Donovan K Stormoe
Donovan K Stormoe, P.E.

MO/DKS/rs

Copies to

- 1) Northern States Power Co - QA
Attn: Mr David V Collins
- 2) Northern States Power Co - Becker
Attn: Mr Curt Sillman
- 1) Black & Veatch
Attn: Mr John Vines
- 2) J A Danens & Son Inc

NORTHERN STATES POWER COMPANY
SHERBURNE COUNTY GENERATING PLANT
UNIT NO. 1
NEAR BECKER, MINNESOTA

#9-5828

INTRODUCTION

This report concerns our continuing full-time inspection and testing of the earth-work operations in the coal and ash storage areas at the above referenced project. The purpose of this report is to present our inspection findings and testing results for the period of November 1 through November 15, 1974. This work is being conducted in accordance with your purchase order #C88754, dated August 23, 1973, and revised on June 18, 1974.

FIELD PROCEDURES AND RESULTS

Coal Storage Area

The filling and compaction operations were concentrated primarily in the southeast area of the coal yard. The sand protective cover for the impervious liner was completed, and ten density tests were taken to verify the compactive efforts. In all cases, the test results indicated the specified compaction and moisture content were maintained.

Eight density tests were taken randomly on the backfill used to upgrade the area south of the coal retaining berms, and two density tests (#2111 and #2112) were taken in the exterior backfill used for the Car Dumper Building. The results of these tests verified adequate densification was obtained by the compaction operations.

FIELD PROCEDURES AND RESULTS
(cont.)

Coal Yard Road

The subgrade for the coal yard road was redensified and tested (#2065, #2066 and #2082) for compaction prior to the placement of the stabilized road base. The two failing tests (#2055 and #2056) taken during the last report period were retested with satisfactory results. The project plans show either Class 1 or Class 2 surface aggregate as acceptable for the roadway construction. However, the contractor received special permission to substitute Class 5 aggregate road base for Class 1 surfacing aggregate. A gradation test was performed on the material presently being placed on the roadway, and the results indicate the material meets Minnesota Highway Department requirements for Class 5 aggregate. By comparing the fraction limitations of the different classes of aggregate on the attached gradation results, the Class 5 material is coarser than Class 1 by allowing material greater than 3/4" and restricting the percentage passing the #200 sieve to 10%. Various systems are available which assign factors to relate the strength and wearing qualities of the different classes of aggregate and bituminous mixes. One such system is the "granular equivalent" which values each material or combinations of materials in terms of the thickness of gravel base (Class 5) necessary to supply equal support. Since these factors for Class 1 or Class 2 varied between 1.0 and 1.2, no very specific statements can be made with regard to the overall performance of the Class 5. The roads constructed with Class 5 will be observed next spring for any unusual wearing.

A total of five density tests (#2129, #2130, #2131, #2132 and #2133) were performed on the aggregate base during this report period. The test results indicated the relative compaction meets the project specifications.

Railroad Access Road

Construction of the railroad access road for track 1 resumed during the report

FIELD PROCEDURES AND RESULTS
(cont.)

period. Two density tests (#2183 and #2184) were performed on the subgrade, and six density tests (#2126, #2127, #2128, #2190, #2191 and #2197) were performed on the aggregate base. As indicated on the attached testing results, the relative compaction meets the project specifications.

Recycle Basin

The recycle basin was completed during this report period. Three field density tests (#2071, #2077 and #2086) were performed on the impervious earth blanket, and 6 tests (#2089, #2097, #2098, #2099, #2101 and #2117) were performed on the overlying protective sand cover. In all cases, the specified compaction and moisture content were attained.

Fuel Oil Storage Area

The earthwork operations in the fuel oil storage area were completed, and the slopes of the berms were prepared for seeding. Three density tests (#2167, #2169 and #2170) were performed in this area with satisfactory results.

Toe Drain Ditches

As of November 15, the toe drain ditches were completed on the west dam. Construction of the toe drain ditches is presently in progress along the north dam and east dam. Fourteen density tests (#2093, #2094, #2095, #2096, #2102, #2103, #2113, #2125, #2137, #2161, #2162, #2196 and #2198) were performed in either the subgrade or the impervious liner. Three of the initial tests taken in the subgrade showed the specified compaction was not attained. The ditch areas were densified with a small, vibratory roller, and two of these areas were retested with satisfactory results as verified by tests #2102 and #2103. The remaining area is still under construction and will be retested when completed.

FIELD PROCEDURES AND RESULTS
(cont.)

Ash Pond Dam

As of November 15, the clay cores were completed for the flyash pond and bottom ash pond. Eight density tests (#2100, #2109, #2110, #2115, #2123, #2174, #2177 and #2179) out of the 22 tests taken in the clay cores revealed unsatisfactory results. Upon recompaction of the failing test areas, retests indicated specified compaction was attained.

The placement of granular embankment fill is nearly complete on the dams with the east dam at elevation 1000'. Fifty-two density tests were performed on the east dam and center dike. Only two of these tests had low compaction results. One of the failing test areas (indicated by #2116) was recompacted and retested with satisfactory results. The other failing test area, indicated by number 2201, is under construction and will be retested, and the results included in our next report.

Construction of the road located on top of the dams began on the south dam and continued in a clockwise direction. Four density tests were performed on the aggregate base, and the test results indicated the specified compaction was attained.

Laboratory Tests

Periodic permeability tests were performed on the clayey sand (SC) used to construct the impervious earth blanket and liner. These tests were taken to assure a continuous impermeable clay liner is maintained. Three permeability tests results are attached with this report. Two of the tests, 17-P-4 and 17-P-5, were performed on clayey sand, which was sampled with a thin-wall tube, and test number 28-P-6 was performed on a sample which was remolded in the laboratory. As shown, the k-values (coefficient of permeability) varied between 10^{-7} and 10^{-9} centimeters per second. These variations are caused by the slightly different soil texture, density and moisture content of the materials tested. A more complete summary and discussion

FIELD PROCEDURES AND RESULTS
(cont.)

on the permeability tests performed during the entire construction period will be described in a later report.

REMARKS

A tabulation of the in-place density tests and a summary of the test results are attached. Our inspection and testing indicates the earthwork is being performed in accordance with the project plans and specifications. Further supervision is being performed and additional reports will be forwarded as the work progresses.

Report No. 20 on

INSPECTION AND TESTING DURING EARTHWORK OPERATIONS
COAL AND ASH STORAGE AREAS

NORTHERN STATES POWER COMPANY
SHERBURNE COUNTY GENERATING PLANT
UNIT NO. 1
NEAR BECKER, MINNESOTA

Report # 20

Specification 5377-D-4C

DIN 96A341

Purchase Order No. C88754

Laboratory No. 9-5899

Twin City Testing and Engineering Laboratory, Inc.
662 Cromwell Avenue
St. Paul, Minnesota 55114

TWIN CITY TESTING AND ENGINEERING LABORATORY, Inc.

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Vice-President Engineering
ALBERT C. HOLLER, F.A.I.C.
Vice-President Chemistry
CLINTON R. EUE
Secretary-Treasurer

January 2, 1975

Northern States Power Co
414 Nicollet Mall
Minneapolis, MN 55401

Attn: Mr J V Sullivan

Gentlemen

Subj: Inspection and Testing
Coal and Ash Storage Areas
Sherburne County Generating Plant
Near Becker, Minnesota - Laboratory #9-5899

This is our twentieth progress report presenting our inspection findings and test results for the referenced project. We are sending you three copies. Additional copies are being sent as noted below. This work is being done in accordance with your Purchase Order No. C88754, dated August 23, 1973.

Additional reports will be submitted as the project progresses. If you have any questions or desire further information, please contact us.

Very truly yours

Michael O'Donnell
Civil Engineer

Donovan K Stormoe, P.E.

MOD/DKS/gt

Copies to:

- 1) Northern States Power
Quality Assurance
Attn: Mr David V Collins
- 2) Northern States Power (Becker)
Attn: Mr Curt Sillman
- 1) Black & Veatch
Attn: Mr John Vines
- 2) J A Danens & Son Inc

NORTHERN STATES POWER COMPANY
SHERBURNE COUNTY GENERATING PLANT
UNIT NO. 1
NEAR BECKER, MINNESOTA

#9-5899

INTRODUCTION

This report concerns the full-time inspection and testing we performed for the earthwork operations in the coal and ash storage areas at the above referenced project during the period from November 18 through December 6, 1974. The purpose of this report is to present our inspection findings and testing results for this period. This work was conducted in accordance with your Purchase Order Number C88754 dated August 23, 1973 and revised on June 18, 1974.

FIELD PROCEDURES AND RESULTS

County Road #67

County Road #67 was refinished with Class 5 aggregate base. Fill placement began in the northern edge of the borrow pit and extended to the intersection with County Road #4. The thickness of the road base varied, being substantially thicker in the northern portion of the road. Four density tests (#2202, 2205, 2209 and 2210) were performed on the Class 5 aggregate base. The test results indicated the relative compaction meets project specifications for roadways.

Coal Yard Road

The construction of the coal yard road continued into the first week of this

FIELD PROCEDURES AND RESULTS

(Cont.)

report period. One density test (#2217) was performed, and the results verified the material placed was satisfactorily compacted.

Class 5 gravel base was placed and compacted on the parking lot east of the Car Dumper Building. The densification obtained by the compaction operations was determined by performing two in-place density tests. The results of these tests (#2218 and 2219) indicated the material was satisfactorily compact.

Recycle and Holding Basin Road

During this report period, the subgrade for the Recycle and Holding Basin Road was proofrolled, and a 6" lift of road base was placed and compacted. Twenty-two density tests were taken in the subgrade and the road base. In most cases, the test results indicated the specified compaction was obtained by initial compactive efforts. However, four of the tests taken in the road base (#2228, 2229, 2269 and 2270) had low compaction results. Recomposition of the failing test areas raised the dry density to comply with the specifications in the area of test #2269.

Continuous freezing weather made redensification of the remaining failing test areas impossible for the rest of this year. The contractor has been informed of the failing test areas, and he will recompact these areas next spring when the construction resumes. The compaction at the location of the failures will then be retested.

Toe Drain Ditches

The Toe Drain Ditches were completed during this report period. Six density tests (#2204, 2207, 2211, 2227, 2230 and 2237) taken in the compacted subgrade had satisfactory results. The freezing weather and wet clay caused difficulties in attaining the specified compaction for the impervious clay liner. Five of the

FIELD PROCEDURES AND RESULTS
(Cont.)

eleven density tests taken in the impervious clay liner had failing results. Upon recompaction and retesting of the failing test areas, only one area (indicated by test #2216) remained with a substandard density. The contractor assured us that these areas will be recompacted next spring, when the construction resumes.

Ash Pond Dams

As of December 3, the ash pond dams were completed. Granular embankment fill was placed during the first two days of this report period. Four density tests (#2203, 2206, 2212 and 2213) performed in the embankment fill verified adequate compaction was attained.

Class 5 aggregate base was placed on the Ash Pond Access Road and the Ash Pond Road. Thirteen density tests were taken in the road base. Except for test number 2252, the test results revealed the material was satisfactorily compact. The road base in the failing test areas froze before redensification was applied. This area, along with the previous mentioned areas, will be recompacted and retested next spring.

Miscellaneous Areas

Granular fill was placed in the vicinity of the Recycle Basin, Holding Basin and Cooling Tower #1. These areas were upgraded to the designated elevation shown on the project plans. The densification attained by the compaction operations was determined by performing 20 density tests. Five test areas (indicated by test #2250, 2251, 2255, 2260 and 2262) were recorded with unsatisfactory results. All redensification procedures were ineffective in each of these areas. The main reason for the failing tests was the cold weather, which caused the fill to freeze

FIELD PROCEDURES AND RESULTS

(Cont.)

during the compaction operations. Another contributing factor was the contractor concentrated his fill placement in a small area in order to minimize the frost penetration. Consequently, some failing test areas were covered with several feet of fill before the areas were recompacted. The overlying fill thus reduced the effectiveness of the compacting equipment. Rather than continue, the contractor agreed to correct the failing test areas next spring when the ground thaws.

REMARKS

The earthwork operations for the coal and ash storage areas were terminated due to freezing weather. Eighty-three field density tests were taken in accordance with ASTM:D1556-64 (Sand-Cone Method) during this period. As discussed with the contractor, J A Danens and Son Inc. test areas will receive additional compaction effort next spring when the construction resumes. A tabulation of the in-place density tests and a summary of the test results are attached. Our inspection and testing indicates the earthwork operations have been performed in accordance with the project plans and specifications.

Report No. 22 on

INSPECTION AND TESTING DURING EARTHWORK OPERATIONS
COAL AND ASH STORAGE AREAS

NORTHERN STATES POWER COMPANY
SHERBURNE COUNTY GENERATING PLANT
BECKER, MINNESOTA

Specification 5377-D-4C

DIN 96A341

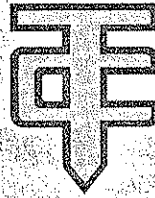
Purchase Order No. C1030

Laboratory No. 9-6252

Twin City Testing and Engineering Laboratory Inc
662 Cromwell Avenue
St Paul, Minnesota 55114



TWIN CITY TESTING
and engineering laboratory, inc.



twin city testing
and engineering laboratory, inc.

662 CROMWELL AVENUE
ST. PAUL, MN 55114
PHONE 612/645-3601

August 21, 1975

Northern States Power Co
414 Nicollet Mall
Minneapolis, MN 55401

Attn: Mr J V Sullivan

1030

Gentlemen

Subj: Inspection and Testing
Coal and Ash Storage Areas
Sherburne County Generating Plant
Becker, Minnesota - Laboratory #9-6252

This is our twenty-second progress report presenting our inspection findings and test results for the referenced project. We are sending you three copies. Additional copies are being sent as noted below. This work is being done in accordance with your purchase order number C3070, dated January 1, 1975.

Additional reports will be submitted as the project progresses. If you have any questions or desire further information, please contact us.

Very truly yours

Michael O'Donnell

Michael O'Donnell
Civil Engineer

Donovan K. Stormoe
Donovan K Stormoe, P.E.

MOD/DKS/rs

Copies to

- 1) Northern States Power - Quality Assurance
Attn: Mr David Collins
- 2) Northern States Power - Becker
Attn: Mr Curt Sillman
- 1) Black and Veatch
Attn: Mr John Vines
- 2) J A Danens & Son Inc

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Vice-President Engineering
ALBERT C. HOLLER, F.A.I.C.
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SIOUX FALLS, S.D.
WATERLOO, IOWA

NORTHERN STATES POWER COMPANY
SHERBURNE COUNTY GENERATING PLANT
BECKER, MINNESOTA

#9-6252

INTRODUCTION

This report concerns our continuing full-time inspection and testing of the earthwork operations in the coal and ash storage areas at the above referenced project. The purpose of this report is to present our inspection findings and testing results for the period of July 15 through July 31, 1975. This work is being conducted in accordance with your purchase order #CI030.

FIELD PROCEDURES AND RESULTS

Cooling Tower #1

During the above mentioned time period, the earthwork operations were on a much smaller scale in comparison with last year. Due to scheduling difficulties, the earthwork operations were limited to an area outside the company fence as defined by Cooling Tower #2 to the west, Cooling Tower #1 to the east and the Holding Basin to the south. This area was being upgraded in order to allow for proper drainage. Two scrapers were hauling the granular material primarily to the area immediately surrounding Cooling Tower #1.

Fourteen density tests were performed in the area defined above. Due to the dry weather this month, water was continuously being added to the fill before applying compaction. However, much of the water migrated through the fill, and as verified

FIELD PROCEDURES AND RESULTS
(cont.)

by tests #2304 and #2305, where 1.8% moisture content was recorded, the contractor was having difficulty maintaining water in the fill during compaction. Three of the density tests (#2298, #2305 and #2306) revealed a substandard density was attained by the initial compaction efforts. Subsequently, the area was recompacted and two of the three failing test areas were retested with satisfactory results. The one remaining failing test area, as designated by test #2305, is an area of low moisture content which will be recompacted after a period of precipitation.

Holding Basin

On July 22, Solidification Inc began injecting chemical grout into the soil outside the sheet piling which surrounds the Discharge Outlet Foundation and Discharge Water Monitoring Building. Daily inspections of this operation were made to assure the grout was placed near each pile seam, and daily quantities of chemicals used were recorded. The PWG chemical grout, which is chemically equivalent to AM-9 but a different trademark, was the principle agent in producing the stiff gel. Our records to date indicate approximately three gallons of the gel is being pumped for every linear foot of pile seam. Assuming proper displacement of the grout, this rate should adequately fill the air voids in the soils outside the sheet piling.

REMARKS

A tabulation of the in-place density tests and a summary of the test results are attached. Our inspection and testing indicates the earthwork is being performed in accordance with the project plans and specifications. Further supervision is being performed and additional reports will be forwarded as the work progresses.

Report No. 23 on

INSPECTION AND TESTING DURING EARTHWORK OPERATIONS
COAL AND ASH STORAGE AREAS

NORTHERN STATES POWER COMPANY
SHERBURNE COUNTY GENERATING PLANT
BECKER, MINNESOTA

#23

Specification 5377-D-4C

DIN 96A341

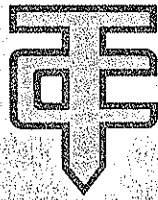
Purchase Order No. C1030

Laboratory No. 9-6359

Twin City Testing and Engineering Laboratory Inc
662 Cromwell Avenue
St Paul, Minnesota 55114



TWIN CITY TESTING
and engineering laboratory, inc.



twin city testing
and engineering laboratory, inc.

662 CROMWELL AVENUE
ST. PAUL, MN 55114
PHONE 612/645-3601

September 3, 1975

Northern States Power Co
414 Nicollet Mall
Minneapolis, MN 55401

Attn: Mr J V Sullivan

Gentlemen

Subj: Inspection and Testing
Coal and Ash Storage Areas
Sherburne County Generating Plant
Becker, Minnesota - Laboratory #9-6359

This is our 23rd progress report presenting our inspection findings and test results for the referenced project. We are sending you three copies. Additional copies are being sent as noted below. This work is being done in accordance with your purchase order number C1030, dated January 1, 1975.

Additional reports will be submitted as the project progresses. If you have any questions or desire further information, please contact us.

Very truly yours

Michael O'Donnell
Michael O'Donnell
Civil Engineer

Donovan K Stormoe
Donovan K Stormoe, P.E.

MOD/DKS/rs

Copies to

- 1) Northern States Power - Quality Assurance
Attn: Mr David Collins
- 2) Northern States Power - Becker
Attn: Mr Curt Sillman
- 1) Black and Veatch
Attn: Mr John Vines
- 2) J A Danens & Son Inc

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WATERLOO, IOWA

NORTHERN STATES POWER COMPANY
SHERBURNE COUNTY GENERATING PLANT
BECKER, MINNESOTA

#9-6359

INTRODUCTION

This report concerns our continuing full-time inspection and testing of the earthwork operations in the coal and ash storage areas at the above referenced project. The purpose of this report is to present our inspection findings and testing results for the period of August 1 through August 21, at which time the earthwork operations were postponed to September, 1975. Our work is being conducted in accordance with your purchase order number C1030.

FIELD PROCEDURES AND RESULTS

Coal Yard

The earthwork in this area consisted of upgrading the area south of the South Coal Retaining Berm and north of Railroad Track #1 and preparing the subgrade for the Coal Yard Access Road. The central and eastern portions of these areas were brought up to or very near finished grade. Six density tests (#2317, #2318, #2319, #2320, #2325 and #2326) were taken to verify the densification attained by the compaction operations. As indicated by the results of these tests, the fill material placed was satisfactorily compacted.

Miscellaneous Roadways

Much of the earthwork during this report period consisted of placing and compacting granular fill in various areas of the proposed roadways, which lie within the plant.

FIELD PROCEDURES AND RESULTS
(cont.)

All of the fill placed was granular material used to upgrade the roadway to top of subgrade elevation. All of our 15 in-place density tests, which were performed in this subgrade, have passing results.

The portion of the Coal Yard Access Road directly south of the South Coal Retaining Berm was filled to top of subgrade. Test numbers 2321, 2322, 2327, 2331 and 2332 indicate the specified compaction was attained. A small area of the Railroad Track #1 Access Road, east of the Car Dumper Building and as located by test numbers 2323, 2324, 2336 and 2337, was also filled to subgrade elevation. The subgrade for the Fuel Oil Access Road was finished, and two tests (#2330 and #2333) performed along this short roadway indicate adequate compaction. The northern portion of the Ash Trench Access Road, located by test numbers 2328, 2329 and 2334, was raised to subgrade elevation. The above mentioned completed areas were properly prepared for the placement of Class 5 road base.

Gatehouse Parking Lot

The Gatehouse Parking Lot and access driveway were stripped of organic soil and subsequently filled and compacted in relatively thin lifts to bottom of base elevation. Of the two density tests initially taken, one indicated passing results, while the other revealed substandard density. The failing test area (indicated by test #2313) was recompacted, and as verified by test #2314, the fill in this area was successfully recompacted to the specified compaction. Two additional density tests were performed as the filling and compaction operations resumed. The results of both of these tests showed the specified compaction was attained.

Cooling Tower #1

The failing test area, which was listed in report #22 and as located by test #2305, was recompacted and retested with satisfactory results.

REMARKS

A tabulation of the in-place density tests and a summary of the test results are attached. Our inspection and testing indicates the earthwork is being performed in accordance with the project plans and specifications. Further supervision will be performed when the work progresses.



FINAL REPORT

INSPECTION AND TESTING DURING EARTHWORK OPERATIONS
COAL AND ASH STORAGE AREAS

C-1030
NORTHERN STATES POWER COMPANY
SHERBURNE COUNTY GENERATING PLANT
BECKER, MINNESOTA

#24

Specification 5377-D-4C

DIN 96A341

Purchase Order No. C1030

Laboratory No. 9-6410

Twin City Testing and Engineering Laboratory Inc
662 Cromwell Avenue
St Paul, Minnesota 55114



twin city testing
and engineering laboratory, inc.

662 CROMWELL AVENUE
ST. PAUL, MN 55114
PHONE 612/645-3601

November 3, 1975

Northern States Power Co
414 Nicollet Mall
Minneapolis, MN 55401

Attn: Mr J V Sullivan

Gentlemen

Subj: Inspection and Testing
Coal and Ash Storage Areas
Sherburne County Generating Plant
Becker, Minnesota - Laboratory #9-6410

This is our 24th and final report presenting our inspection findings and test results for the referenced project. We are sending you three copies. Additional copies are being sent as noted below. This work was done in accordance with your purchase order number 1030, dated January 1, 1975.

If you have any questions or desire further information, please contact us.

Very truly yours

Michael O'Donnell
Michael O'Donnell
Civil Engineer

Donovan K. Stormoe
Donovan K Stormoe, P E

MOD/DKS/bm

cc: 1 - Northern States Power - Quality Assurance
Attn: Mr David Collins
2 - Northern States Power - Becker
Attn: Mr Curt Sillman
1 - Black and Veatch
Attn: Mr John Vines
2 - J A Danens & Son Inc

OFFICERS:

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Vice-President Engineering
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MANKATO, MINN.
ROCHESTER, MINN.
SIOUX FALLS, S.D.
WATERLOO, IOWA

NORTHERN STATES POWER COMPANY
SHERBURNE COUNTY GENERATING PLANT
BECKER, MINNESOTA

Laboratory No. 9-6410

INTRODUCTION

This report concludes our full-time inspection and testing of the earthwork operations in the coal and ash storage areas at the above referenced project. The purpose of this report is to present our inspection findings and testing results for the period of September 1 through October 8, 1975. Our work was being conducted in accordance with your Purchase Order #C1030.

TEST RESULTS

The earthwork during this report period consisted of placing and compacting granular fill in various uncompleted areas. These areas included the remaining portions of the original contract and several additional fill areas at the request of Northern States Power. The location and number of the density tests define the approximate location and extent of the contractor's work.

Three parking lots were completed to the grades specified in the plans of the contract. These areas included the Gatehouse parking lot and two separate parking lots for the Maintenance Garage and Car Dumper Building. Thirteen density tests (8 in the Gatehouse parking lot, two in the Car Cumper Building parking lot and three in the Maintenance Garage parking lot) were performed in either the subgrade or Class 5 roadbase. Only test #2355, which was performed in the Maintenance Building parking lot, revealed failing density. This area of subgrade was recompacted and retested with successful results.

A small area between the sheet piling for the Discharge Outlet Foundation was brought up to design grade. Test #2363 revealed the specified density was attained by using a small vibratory compactor.

Two retaining berms and drainage ditches were specified for construction by Northern States Power to allow for proper drainage in the Coal Yard. A total of eight tests were taken for these projects. Except for Test #2364, the test results revealed a suitable density was attained. Supplementary compaction was applied to the failing test area, and as indicated by Test #2367, the fill soils were satisfactorily compacted.

The surrounding area of Cooling Tower #2 was upgraded to or very near finished grade. Tests #2397, 2398, 2400, 2404 and 2405, were performed on the fill material employed in this area. In all cases, the specified compaction was attained during the initial compactive efforts.

Subgrade preparation and Class 5 placement also took place along the access roads for Cooling Tower #1 and the eastern third of the road for Cooling Tower #2. Five density tests were taken in the access road encircling Cooling Tower #1, and two tests were taken in the completed section of roadway near Cooling Tower #2. The tests results indicated the material was placed and compacted in accordance with the project specifications.

The Fuel Oil Access Road was completed with the placement of Class 5 road base to the designated grade. Of the two density tests initially taken; one indicated passing results, while the other revealed substandard density. Subsequently, the entire roadway was recompacted and retested by Test #2394, which indicated the specified degree of compaction was attained.

The Coal Yard Access Road was completed from its origin in the western side of the Coal Yard and near the Transfer House to the Gatehouse parking lot. With the exception of a small area near the eastern edge of the Stacker-Reclaimer Berm, the subgrade and Class 5 material were properly compacted as verified by the results of eight density tests. In this area, approximately 70' of roadway was not compacted due to electrical cable storage.

The western connection between the Coal Yard Access Road and the Ash Trench Access Road was relocated to the east side of the Car Dumper Building parking lot, having a centerline grid location of 2028417E. Seven density tests were performed along the Ash Trench Access Road, which was completed from the Gatehouse parking lot to the Plant Access Road. All of these tests have passing results.

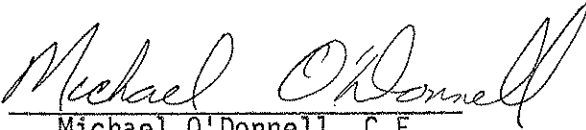
Since the placement of the Railroad Track #1 Access Road, several small areas have badly eroded, making the roadway nearly unusable. At the request of Northern States Power, the problem was rectified by sloping the roadway toward the railroad track and installing catchbasins and culverts at regular interval spacings. To assure the proper degree of compaction in the granular fill and Class 5 materials was attained, fourteen density tests were performed along the corrected roadway. In all cases, the test results revealed the specified compaction was attained.

REMARKS

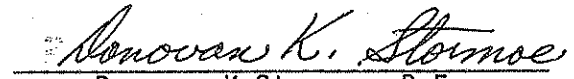
A total of 67 field density tests were taken in accordance with ASTM: D 1556-64 during this report period, and a tabulation of these tests and a summary of the test results are attached. It is our opinion the earthwork operations performed under our technical supervision and reported herein were accomplished

in accordance with the provisions of the project earthwork specification, with the exception of the above mentioned portion of the Coal Yard Access Road.

This report was prepared by:


Michael O'Donnell, C E

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Registered Professional Engineer under the laws of the State of Minnesota.


Donovan K Stormoe, P E

Date 11-4-75 Reg.No. 10493

BLACK & VEATCH
CONSULTING ENGINEERS

AREA CODE 816
TEL. 361-7000

1500 MEADOW LAKE PARKWAY
MAILING ADDRESS: P.O. BOX NO. 8408
KANSAS CITY, MISSOURI 64114

86459

Northern States Power Company
Sherburne County Generating Plant
Units No. 1 & 2 (E-6881 & E-7108)
Review of Ash Pond Dike Design
PH99A500

March 31, 1973
Project 5377/5619
File B-4J.2

Danes & Moore
1550 Northwest Highway
Park Ridge, Illinois 60068

Attention: Mr. William B. Paratore

Gentlemen:

FILE COPY	
PLANNING ENGINEERING & CONSTRUCTION DEPT.	
DATE	FILE
✓	1973
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✓	1971
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✓	1900

APR 2 1973

We are transmitting under separate cover in two packages one copy of the following information for your use in reviewing the design of earth containment structures for coal, water and ash storage:

1. Plans for Coal and Ash Storage Area Construction - Specification 5377 D-4C.
2. Coal and Ash Storage Area Construction - Specifications 5377 D-4C.
3. Final Report of Soil and Bedrock Investigation by Soil Exploration Company dated September 15, 1971.
4. Geological Investigation of Clay Deposits by Twin City Testing and Engineering Laboratory, Inc. dated February 22, 1972.
5. Clay Sources Investigation - Phase II by Twin City Testing and Engineering Laboratory, Inc. dated June 26, 1972.
6. Interim Report dated March 23, 1972 by Twin City Testing and Engineering Laboratory, Inc.
7. Soil Investigation - Proposed Clay Borrow Report by Soil Exploration Company dated February 26, 1973.
8. Black & Veatch Supporting Analysis II-K - Seepage Control dated November 10, 1972. (Three Volumes)

Mr. William G. Paratore

-2-

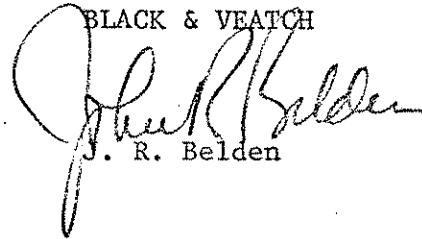
March 31, 1973

This data should allow you to proceed with your review of the design for the ash pond dikes as requested by Northern States Power Company. We are presently preparing a summary report covering design of coal, water and ash storage area facilities. A copy will be provided to you when it is completed.

Please contact us if you have any questions.

Very truly yours,

BLACK & VEATCH



J. R. Belden

JRB:11b

CC: Mr. J. R. Zylkowski (3)

1000 AVENUE
 ATLANTA
 BOSTON
 CHICAGO
 DENVER
 HOUSTON
 LOS ANGELES
 NEW YORK
 PORTLAND
 SALT LAKE CITY
 SAN FRANCISCO
 SEATTLE
 WASHINGTON D.C.

DAMES & MOORE
 CONSULTING ENGINEERS IN THE APPLIED EARTH SCIENCES

GUAM
 LONDON SYDNEY
 MADRID TEHRAN
 PERTH TORONTO
 SINGAPORE VANCOUVER, B.C.

1550 NORTHWEST HIGHWAY • PARK RIDGE, ILLINOIS 60068 • (312) 297-6120
 CABLE: DAMEMORE TELEX: 28-2491

February 22, 1973

Northern States Power Company
 414 Nicollet Avenue
 Minneapolis, Minnesota 55401

FEB 26 1973

Attention: Mr. Pete A. Johnson
 Senior Civil Engineer

86459

Gentlemen:

Proposal-Review of Design Criteria
 and Project Specifications
 Proposed Ash Pond
 Sherburne County Generating Plant
 Sherburne County, Minnesota
 For Northern States Power Company

99A500 12M300

PRM

FILE COPY		PLANT ENGINEERING & CONSTRUCTION DEPT.			
DATE		FILE			
	CITY	NO.	VS.	AGG.	
20	REH	121	VS	AGG	OWH
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					UGS
					WJM
					ZSC
2					ZDC
					INL
					DEL
					CIR
					MTC
3					REN

100 PJ

In accordance with our recent discussions with Messrs. Jerry Zylkowski, Roger Hertzberg, Pete Johnson, and Richard McGinnis with Northern States Power Company we are pleased to submit this proposal for engineering studies to be performed by Dames & Moore for the Proposed Ash Pond to be constructed at the location of your proposed fossil fuel plant to be constructed in Sherburne County, Minnesota.

We understand that the proposed plant has been designed by the firm of Black & Veatch, located in Kansas City. We have been provided with certain information regarding the Proposed Ash Pond. We understand that additional information regarding the Ash Pond will be provided to us in the near future. The required additional information will include the design report prepared by Black & Veatch which will be submitted to you on or about March 15, 1973. Project specifications and contract drawings will also be provided in the near future to us.

Northern States Power Company
February 22, 1973
Page - 2

We understand that you would like to receive our report by April 8, 1973.

The purposes of our engineering studies will be as follows:

- 1 - To review, in detail, the foundation design of the presently proposed Ash Pond as designed by Black & Veatch.
- 2 - To review the project specifications for the Proposed Ash Pond.
- 3 - To review the construction drawings for the Proposed Ash Pond.
- 4 - To evaluate the stability, settlement, and seepage losses of the Proposed Ash Pond.
- 5 - To submit a written report presenting our comments and recommendations for the presently Proposed Ash Pond.

We are in a position to commence our engineering review within approximately one week after authorization. Because of the time limitation for this project, we would like to commence our engineering services as soon as possible. We will contact you during the course of our engineering studies to inform you of our progress. It is anticipated that a meeting will be held in the offices of Northern States Power Company sometime in early April to present our comments and recommendations. We understand that at this meeting representatives of Northern States Power Company, Black & Veatch and Dames & Moore will be present.

We propose that our fee for the performance of our engineering studies be determined on a time-and-expense basis in accordance with the attached "Schedule of Charges." On this basis, we estimate that our fee will be on the order of \$8,500.

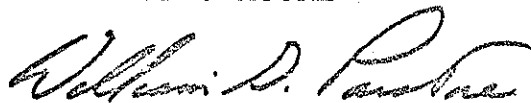
Northern States Power Company
February 22, 1973
Page - 3

During the course of our work we will provide Workmen's Compensation Insurance as required by law and Public Liability and Property Damage Insurance in excess of \$1,000,000.

Should you have any questions regarding the contents of this proposal, please contact us. We look forward to again assisting Northern States Power Company on this very interesting project.

Yours very truly,

DAMES & MOORE



William G. Paratore
Associate

WGP:mf
Five Copies Submitted
Attachment - Schedule of Charges

SCHEDULE OF CHARGES AND GENERAL CONDITIONS

DAMES & MOORE

UNITED STATES & CANADA

The compensation to Dames & Moore for our professional services is based upon and measured by the following elements, which are computed as set forth below.

PERSONNEL CHARGES

Charges for employees are computed by multiplying the total direct salary cost of our personnel by two and one-half. The total direct salary cost shall be a sum equal to the direct payroll cost (computed on a typical annual basis and expressed as an average hourly rate) plus 25 percent of same to cover payroll taxes, insurance incident to employment, holidays, sick leave vacations, etc. The time of a partner or retained consultant devoted to the project is charged at an assigned billing rate.

The 25 percent employee benefit factor is used for work performed by personnel assigned to offices in the United States and Canada. For work performed by personnel in our offices in other countries, it will vary depending on the employee benefits paid in the particular location.

When outside the United States, employees' and partners' total direct salary cost will be increased by the premium customarily paid by other organizations for work at that location.

Time spent in either local or inter-city travel, when travel is in the interest of the work, will be charged for in accordance with the foregoing schedule; when traveling by public carrier, a maximum charge of eight hours per day will be made.

EQUIPMENT CHARGES

Computer control of project costs will be billed at a rate of \$1.25 per each \$50 of job charges. Other Dames & Moore equipment, if used, will be billed at the rates noted in the Appendix.

OTHER SERVICES AND SUPPLIES

Charges for services, equipment and facilities not furnished directly by Dames & Moore, and any unusual items of expense not customarily incurred in our normal operations, are computed on the basis of cost plus ten percent. Such items include:

Rental and operation of drilling equipment	Rental vehicles
Erecting facilities for the performance of field tests	Printing and photographic reproductions
Surveying services	Long distance communications
Shipping charges for equipment or samples	Special fees, insurance, permits and licenses
Subsistence	Services of testing laboratories
Fares of public carriers	Services of explosives technicians

BILLING

Statements will be issued every four weeks, payable upon receipt, unless otherwise agreed.

Interest of 1½% per month (but not exceeding the maximum rate allowable by law) will be payable on any amounts not paid within 30 days, payment thereafter to be applied first to accrued interest and then to the principal unpaid amount. Any attorney's fees or other costs incurred in collecting any delinquent amount shall be paid by the Client.

In the event that the Client requests termination of the work prior to completion of a report, we reserve the right to complete such analyses and records as are necessary to place our files in order and, where considered by us necessary to protect our professional reputation, to complete a report on the work performed to date. A termination charge to cover the cost thereof in an amount not to exceed 30 percent of all charges incurred up to the date of the stoppage of the work may, at the discretion of Dames & Moore, be made.

Rates are subject to change upon notification.

WARRANTY AND LIABILITY

Dames & Moore warrants that our services are performed, within the limits prescribed by our Clients, with the usual thoroughness and competence of the engineering profession. No other warranty or representation, either expressed or implied, is included or intended in our proposals, contracts or reports.

Our liability to the Client for injury or damage to persons or property arising out of work performed for the Client and for which legal liability may be found to rest upon us, other than for professional errors and omissions, will be limited to our general liability insurance coverage, which we maintain in limits in excess of \$3,000,000. For any damage on account of any error, omission or other professional negligence, our liability will be limited to a sum not to exceed \$50,000 or our fee, whichever is greater. In the event that the Client does not wish to limit our professional liability to this sum, we will waive this limitation upon the Client's written request provided that the Client agrees to pay for this waiver an additional consideration of 4% of our total fee or \$200, whichever is greater.

In the event the Client makes a claim against Dames & Moore, at law or otherwise, for any alleged error, omission or other act arising out of the performance of our professional services, and the Client fails to prove such claim, then the Client shall pay all costs incurred by Dames & Moore in defending itself against the claim.

REPORT
REVIEW OF DESIGN CRITERIA AND PROJECT
SPECIFICATIONS

PROPOSED COAL AND ASH STORAGE AREA
SHERBURNE COUNTY GENERATING PLANT -
UNIT 1
SHERBURNE COUNTY, MINNESOTA
FOR
NORTHERN STATES POWER COMPANY

DAMES & MOORE

CONSULTING ENGINEERS IN THE APPLIED EARTH SCIENCES

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1550 NORTHWEST HIGHWAY • PARK RIDGE, ILLINOIS 60068 • (312) 297-6120
CABLE DAMEMORE TELEX: 28-2491

July 17, 1973

Northern States Power Company
414 Nicollet Mall
Minneapolis, Minnesota 55401

Attention: Mr. Pete A. Johnson
Senior Civil Engineer

Gentlemen:

Eight copies of our "Report of Review of Design Criteria and Project Specifications, Proposed Coal and Ash Storage Area, Sherburne County Generating Plant - Unit 1, Sherburne County, Minnesota for Northern States Power Company" are herewith submitted.

The scope of our services were planned in collaboration with Messrs. Jerry Zylkowski, Roger Hertzberg, Pete Johnson, and Richard McGinnis of Northern States Power Company and were outlined in our proposal dated February 22, 1973. This work was authorized by your purchase order No. C-86459.

Preliminary copies of the project specifications, construction drawings, supporting analyses, boring logs, and laboratory test data were submitted for review by Black & Veatch, Consulting Engineers. Following our review of the preliminary project plans and documents, a joint meeting attended by representatives of Northern States Power Company, Black & Veatch, and Dames & Moore was held in Minneapolis on May 1, 1973. During the meeting, agreement was reached regarding certain modifications of the project documents and the need for additional laboratory tests to substantiate assumptions used in the supporting analyses.

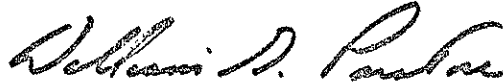
Northern States Power Company
July 17, 1973
Page - 2

Subsequent to the May 1 meeting, additional laboratory tests were performed and Black & Veatch prepared final versions of the project documents. We have completed our review of these documents and are in agreement with the final version. However, we have noted that the revised gradation requirements and lift thickness for filter blankets and proof-rolling of the clay blankets prior to filling had not been incorporated in the project specifications at the time of our review. All modifications noted in Memorandum 519 by Black & Veatch, dated June 18, 1973 should be incorporated in the specifications before issuing the project documents in final form.

Please do not hesitate to contact us if you have any questions pertaining to the contents of this report. It has been a pleasure to be of service to you on this project.

Yours very truly,

DAMES & MOORE


William G. Paratore
Partner

WGP:RWC:sb

REPORT
REVIEW OF DESIGN CRITERIA AND PROJECT SPECIFICATIONS
PROPOSED COAL AND ASH STORAGE AREA
SHERBURNE COUNTY GENERATING PLANT - UNIT 1
SHERBURNE COUNTY, MINNESOTA
FOR
NORTHERN STATES POWER COMPANY

INTRODUCTION

This report presents the results of our review of design criteria and project specifications performed for the proposed coal and ash storage area for the Sherburne County Generating Plant - Unit 1 in Sherburne County, Minnesota.

The purposes of our engineering studies were as follows:

1. To review the design and supporting analysis, including stability, settlement, and seepage, for the Proposed Coal and Ash Storage Area submitted by Black & Veatch, Consulting Engineers.
2. To review the project specifications and construction drawings for the proposed construction.
3. To provide an evaluation of the design, supporting analysis, project specifications, and construction drawings for the proposed construction.

DESIGN CRITERIA

SOIL PARAMETERS

The relevant soil parameters for design of the earth retaining structures for the coal and ash storage facilities include:

- 1 - In-Situ Natural Soils and On-Site Cohesionless Embankment Fill Material
 - Density
 - Angle of Internal Friction
 - Permeability
- 2 - Impervious Core and Impervious Blanket
 - Density
 - Shear Strength
 - Permeability
- 3 - Filter Blankets
 - Density
 - Gradation
 - Angle of Internal Friction
 - Permeability

Soil parameters used in the analyses are based on the results of field and laboratory tests performed on the in-situ natural soils and borrow materials by Dames & Moore and by Soil Exploration Company, Inc. as documented in the report of "Supporting Analysis II-M" by Black & Veatch dated

June 27, 1973. The borrow materials selected for construction of the dikes, impervious core and blankets, filter blankets, and slope protection are suitable for the proposed construction. The soil parameters used for the analyses are, in each case, reasonable and consistent with conservative practice.

SETTLEMENT

The natural granular soils underlying the embankments are relatively incompressible and free-draining. Settlements may be expected to be relatively minor and will occur simultaneously with the application of the loads. A maximum settlement of approximately two inches under the dikes was computed. The compression parameters used in the calculations and the magnitude of settlement have been verified by independent calculations performed by Dames & Moore.

SEEPAGE

The coefficients of permeability of the embankment and foundation soils used in the seepage analyses appear to be conservative but reasonable in view of possible unforeseen variations in the natural soils and compacted fill. The seepage calculations have been verified by Dames & Moore. The computed seepage losses are well within tolerable limits. Filter blankets have been provided to control seepage paths and to carry seepage water to collection ditches. The gradation characteristics, permeability, and thickness requirements of the filter blankets have been checked and found to be adequate.

SLOPE STABILITY

Stability analyses of the slopes have been performed for all conditions which could be reasonably anticipated during the service life of the structures. The soil parameters and loading conditions used in these analyses have been conservatively chosen. Selected critical cases, including full reservoir with earthquake loading, have been verified by Dames & Moore. Those cases which were not specifically verified are less critical and the computed factors of safety appear to be reasonable and consistent.

The factors of safety for the slopes used in the design are adequate to ensure the safety of the structures. Moreover, the computed factors of safety probably represent lower bound values in view of the conservative assumptions of soil parameters and loading conditions used in the analyses.

CONSTRUCTION

COMPACTION CRITERIA

Granular Soils. It is specified that granular soils will be compacted to at least 95 percent of the maximum dry density as determined by the ASTM 1557 Method of Compaction. This compaction requirement is considered satisfactory for the proposed construction and is consistent with the density, permeability, and shear strength parameters used in the supporting analyses.

Impervious Soils. The clay core and impervious earth blankets will be compacted to at least 93 percent of the maximum dry density as determined by the ASTM 1557 Method of Compaction at a moisture content between optimum and three percent wet of optimum. This degree of compaction should be obtainable under field conditions and is consistent with the permeability and shear strength parameters used in the analyses of seepage losses and slope stability.

PROOF-ROLLING

Proof-rolling of the exposed natural soils to a dry density of at least 95 percent of the maximum prior to construction of the dikes and impervious earth blankets is required. This compaction criterion is sufficient to restore the exposed natural soils to a condition equal or superior to the in-situ condition and should be readily obtainable in the field.

Proof-rolling of the clay blankets within the ash ponds immediately prior to filling is also required to knead the surface and close any shrinkage cracks that may develop. This requirement is essential for the prevention of excessive seepage losses and piping.

PLACEMENT OF FILTER BLANKETS

The required thickness of filter blankets is 18 inches. This thickness is adequate to carry the anticipated seepage quantities, if it is properly constructed. Placement of the

filter blankets should be closely supervised to ensure that particle size segregation and contamination of the filter material by the adjacent embankment fill material is prevented and that proper compaction is achieved. The filter material should be placed in lifts no greater than 12 inches in thickness.

--oOo--

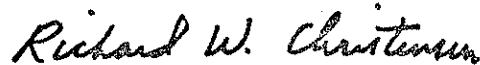
If you have any questions concerning the information contained in this report, please do not hesitate to contact us.

Respectfully Submitted,

DAMES & MOORE



William G. Paratore
Partner



Richard W. Christiansen
Project Engineer

WGP:RWC:sb

Eight Copies Submitted

PROJECT Seepage Control
SUBJECT Supporting Analysis II-K

E NO. _____
SHEET NO. _____ OF _____
DATE 12-22-92
COMP. BY SZB CK'D BY _____

• Copy filed in Sheco Plant files (currently in box with other supporting analysis documents - ~~the~~ Room in NW corner of Doc Control)

Title: Sheco 122 Project Outline (3 Volume Set)
Seepage Control
Supporting Analysis II-K
File 5377/5619
PH11A600 - PH12K700 - PH12M300 - PH14M000

By: BoV

Date: 11/10/72

PROJECT Earth Retaining Structures for coal, Water and Ash Storage E NO. _____
SHEET NO. _____ OF _____
SUBJECT Supporting Analysis II - M DATE 12-22-92
COMP. BY SLB CK'D BY _____

• Copy filed in Sherco Plant files (currently in box with other supporting analysis documents) (Room in NW corner of Doc control)

Title : Sherco 1 & 2 Project Outline
Earth Retaining Structures for coal, Water and Ash Storage
Supporting Analysis II - M
File 5377/5619
~~PH12K700, PH12M300~~
96A 286

By : Bev

Date : 6/27/13

SHERBURNE COUNTY GENERATING PLANT UNIT NO. 1 & 2
 E 6881 - E 7108
 TRANSMITTAL MANIFEST

Date July 6, 1973

To: G.V. Weik
 P.A. Johnson
 File

DATE		FILE	
GRJ		KGE	
KUJ		INS	
WVI		3-TRM	
PAH		JYS	
RLA		WY	
RPR		MJR	
MNS		JFS	
JEK			
BY			
KY		RLI	
AMK		JFS	
JMN		JH	
AEJ		VI	

PLS HANDLE REMARK TO 278

Description:

"SPECIFICATIONS" FOR COAL, ASH AND WATER STORAGE
 AREA SEALING

Remarks:

ATTACHED ARE THE "SUMMARY SPECIFICATIONS" FOR THE
 CONSTRUCTION OF SEALED AREAS AT SHERCO FOR YOUR
 USE WITH PCA.

PAJ/kmg

FROM

NORTHERN STATES POWER COMPANY
 PLANT ENGINEERING & CONSTRUCTION DEPARTMENT

JAZ

July 19, 1973

Mr C A Johannes, Director
Division of Water Quality
Minnesota Pollution Control Agency
717 Delaware Street Southeast
Minneapolis, Minnesota 55440

Attn: George R Koonce

SHERBURNE COUNTY GENERATING PLANT E-6881
Coal, Ash and Water Storage Areas
Sealing Specifications
DIN 97E290

In accordance with Condition No. 8 of Exhibit A (Water), of Permit dated July 11, 1972, we have enclosed two (2) copies of the final design features and construction plans for the coal storage area, recycle basin, holding basin, bottom ash pond and fly ash pond at our Sherburne County Generating Plant. The attachments are identified as follows:

- 1) "Summary Specification for Coal, Ash and Water Storage Area Sealing" dated June 20, 1973.
- 2) Drawing No. NF-53266-B
"Ground Sealing the Coal, Ash and Water Storage Areas - General Plan for Information"

Construction will proceed with this phase of the project upon receipt of your approval of the attached plans and specifications.

Your cooperation in expediting this matter will be greatly appreciated.


G V WELK, Director
Regulatory Activities

lfa

Att.

Bcc: J V Sullivan
L J R Zylkowski

Northern States Power Company
Sherburne County Generating Plant
Units Nos. 1 and 2 (E-6881 and E-7108)
S1PH97F240

June 20, 1973
B&V Project 5377/5619
B&V File A-10

SUMMARY SPECIFICATION FOR
COAL, ASH AND WATER STORAGE AREA SEALING

A. AREAS TO BE SEALED.

Seals are to be placed in all coal, water and ash storage areas where the quality of natural ground water could be affected by seepage. The areas to be sealed with compacted earth blankets are shown on attached Drawing NF-53266-B and as follows:

Coal Storage Area

Recycle Basin

Holding Basin

Bottom Ash Pond

Fly Ash Pond

B. SPECIFICATION REQUIREMENTS FOR EARTH BLANKETS.

1. Earth Blanket Material. The earth blanket material shall be obtained from a borrow area located about 6 miles northeast of the Sherburne County Generating Plant. The material shall have a permeability of 1×10^{-7} cm/sec or less when compacted. The classification, thickness, and placement location of materials shall be as follows:

Northern States Power Company
 Summary Specification for Coal, Ash and
 Water Storage Area Sealing

2

B&V Project 5377/5619
 June 13, 1973

<u>Material Description</u>	<u>*Unified Soil Classification</u>	<u>Compacted Thickness</u>	<u>Designated Use At Plant Site</u>
Clay Core	CL	Varies 20'-0" at Base to 10'-0" at Top	Embankment at Ash Ponds
Earth Blanket			
Type 1	CL	4'-0"	Within Embankment at Ash Ponds
Type 1	CL	1'-6"	Holding & Recycle Basins
Type 2	CL, SC	1'-6"	Bottom of Ash Ponds
Type 2	CL, SC	1'-0"	Bottom 12" in Ditches in Coal Storage Area
Type 3	SC	0'-6"	Top 6" in Ditches in Coal Storage Area
Type 4	SC, SC-SM CL-SC	1'-0"	Coal Storage Area

*See attached Table 1, Unified Soil Classification

2. Subgrade Preparation. Prior to placement of the clay core and earth blankets, the subgrade shall be cleared and grubbed, organic material removed, thoroughly compacted to 95 per cent of maximum density, at optimum moisture content and proof rolled.

3. Embankment and Earth Blanket Construction. The clay core for the embankments and earth blankets shall be compacted to 93 per cent of maximum density at optimum moisture content. During compaction the moisture content shall be within a range of 0 to 3 per cent above optimum.

4. Recompaction of Earth Blankets. All compacted earth blankets within the bottom ash pond, fly ash pond, holding basin and recycle basin shall be recompacted and sealed just prior to being filled.

Table 1

UNIFIED SOIL CLASSIFICATION			Including Identification and Description		Information Required for Describing Soils		Laboratory Classification Criteria	
Major Divisions	Group Symbols	Typical Names	Field Identification Procedures (excluding particles larger than 3 inches and sanding fractions on estimated weights)		For undisturbed soils add information on structure, stratification, color, moisture content, and drainage characteristics.		Laboratory Classification Criteria	
1	2	3	4	5	6	7	8	
Coarse-grained soils	GW, GP, GM, GC, SM, SP, SW, SC	Well-graded gravels, gravel-sand mixtures, little or no fines; Poorly-graded gravels, gravel-sand mixtures, little or no fines; Silty gravels, gravel-sand-silt mixtures; Clayey gravels, gravel-sand-clay mixtures; Well-graded sands, gravelly sands, little or no fines; Poorly-graded sands, gravelly sands, little or no fines; Silty sands, sand-silt mixtures; Clayey sands, sand-clay mixtures.	Wide range in grain sizes and substantial amounts of all intermediate particle sizes. Predominantly one size or a range of sizes with some intermediate sizes missing. Nonplastic fines or fines with low plasticity (for identification procedures see M. below). Plastic fines. (For identification procedures see C. below). High range in grain size and substantial amounts of all intermediate particle sizes. Predominantly one size or a range of sizes with some intermediate sizes missing. Nonplastic fines or fines with low plasticity (for identification procedures see M. below). Plastic fines (for identification procedures see C. below).	Give typical name; indicate approximate percentages of sand and gravel, size, angularity, surface condition, and silt content. Give typical name and other pertinent descriptive information; and symbol in parentheses. Example: Silty sandy gravelly, about 20% sand, maximum size; rounded and subangular sand grains, coarse to fine, about 10% silt and silt fines, with 10% to 15% well compacted and sand in place; alluvial sands; (SM).	$C_u = \frac{D_{60}}{D_{10}}$ Greater than 6 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between one and 3 Not meeting all gradation requirements for SM Atterberg limits below "A" line or PI less than 4 Above "A" line with PI between 4 and 7 are Nonclayey cases requiring use of dual symbols. $C_u = \frac{D_{60}}{D_{10}}$ Greater than 4 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between one and 3 Not meeting all gradation requirements for SM Limits plotting in hatched zone with PI between 4 and 7 are Nonclayey cases requiring use of dual symbols. Atterberg limits above "A" line with PI greater than 7	Determine percentages of gravel and sand from grain-size curve. Depending on percentages of fines (fractions finer than No. 200 sieve size) coarse-grained soils are classified as follows: GW, GP, GM, GC, SM, SP, SW, SC Less than 5% 5% to 15% 15% to 35% More than 35% Use grain-size curve in identifying the fractions as given under field identification.	For laboratory classification of fine-grained soils PLASTICITY CHART For laboratory classification of fine-grained soils PLASTICITY CHART For laboratory classification of fine-grained soils PLASTICITY CHART	
Fine-grained soils	ML, CL, OL, MH, CH, OH, PT	Inorganic silty and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity. Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. Organic silts and organic silty clays of low plasticity. Inorganic silts, silty clays, elastic silts. Inorganic clays of high plasticity, fat clays. Organic clays of medium to high plasticity, organic silts. Peat and other highly organic soils.	None to slight Quick to slow None to very slow Medium to high Slight to medium Slight to medium High to very high Medium to high Medium to high	Give typical name, indicate degree and character of plasticity, amount and maximum size of coarse grains, color in wet condition, odor, if any, local or descriptive information; and symbol in parentheses. For undisturbed soils add information on structure, stratification, color, moisture content, and drainage characteristics. Example: Silt with very low plasticity, medium to coarse sand, silty, firm, and dry in place, loose, (CL).	For laboratory classification of fine-grained soils PLASTICITY CHART For laboratory classification of fine-grained soils PLASTICITY CHART For laboratory classification of fine-grained soils PLASTICITY CHART			

(1) Boundary classifications: Soils possessing characteristics of two groups are designated by combinations of group symbols. For example GP-OL, well-graded gravel-sand mixture with clay binder. (2) All sieve sizes on this chart are U. S. standard.

These procedures are to be performed on moist soil which is approximately 1/2 in. for field classification purposes, screening is not intended, simply remove by hand the coarse particles that interfere with the tests.

Dilatancy (Reaction to shaking)
 After removing particles larger than No. 40 sieve size, prepare a test of moist soil with a volume of about one-half cubic inch. Add enough water to saturate the soil and mix thoroughly. Place the soil in the open palm of one hand and shake horizontally, striking vigorously against the other hand several times. A positive reaction consists of the appearance of water on the surface of the soil which changes to a livery consistency and becomes slippery. When the soil is shaken the particles are seen to move and the soil becomes very stiff and lumpy. The rapidity of appearance of water during shaking and of its disappearance during squeezing assist in identifying the character of the fines in a soil.
 Very fine clean sand gives the whitest and most distinct reaction whereas flour, show a moderately quick reaction.

Dry Strength (Crushing characteristics)
 After removing particles larger than No. 40 sieve size, mold a pat of soil to the consistency of putty, adding water if necessary. Roll the pat between the fingers of both hands until it is about 1/4 in. thick, and then test its strength by breaking and crumbling between the fingers. This strength is a measure of the character and quantity of the colloidal fraction contained in the soil. The dry strength increases with increasing plasticity.
 High dry strength is characteristic for clays of the OH group. A typical inorganic silt possesses only very slight dry strength. Silty fine sands and silts have about the same strength as silts, but can be distinguished by the soil's reaction to shaking. The soil's reaction to shaking is gritty whereas a typical silt has the smooth feel of flour.

Toughness (Consistency near plastic limit)
 After removing particles larger than the No. 40 sieve size, a specimen of soil about one-half cubic inch in size is prepared. The specimen should be spread out in a thin layer and allowed to lose some moisture by evaporation. Then the specimen is rolled out by hand on a smooth surface or between the palms into a thread about one-eighth inch in diameter. The thread is then folded and rolled repeatedly. During this manipulation the moisture content is gradually reduced until the specimen is stiff, thickly above its plasticity, and crumbles when the plastic limit is reached.
 After the thread crumbles, the pieces should be lumped together and a slight kneading action continued until the lump crumbles. The tougher the threads near the plastic limit and the stiffer the lump when it finally crumbles, the higher the soil's toughness. The soil's toughness is a measure of the amount of water at the plastic limit and of the quantity of the colloidal fraction. Organic clays which occur below the A-line, highly organic clays have a very weak and spongy feel at the plastic limit.

MINNESOTA POLLUTION CONTROL AGENCY

717 Delaware Street S.E./ Minneapolis, Minnesota 55440

November 8, 1973

Mr. G. V. Welk, Director Regulatory Activities
 Northern States Power Company
 Minneapolis, Minnesota 55401

Re: Northern States Power
 Company
 Sherburne County Generat-
 ing Plant

Dear Mr. Welk:

Confirming my discussion with Mr. Schenzel, the sealant specified for the fly ash and bottom ash basins at the Sherburne County Generating Plant is not adequate to prevent contamination of the ground water. The Agency requires that such basins be sufficiently sealed so that the maximum amount of water lost by percolation does not exceed 50 gallons per acre per day. We expect that the plans and specifications of the basins will be modified so that the water lost by percolation does not exceed this value.

We also require plans and specifications of the cooling towers that include a detailed typical tower cross section and the tower performance characteristic.

If you have any questions, please contact us.

Yours very truly,

Robert Kaiser

Robert A. Kaiser
 Staff Engineer
 Section of Industrial & Other
 Wastes
 Division of Water Quality

*John Hall is preparing
 second set of specifications
 12/1/73*

STAFF DEPARTMENT #0327			
AVD		BWC	
ECW		TRC	
MLA		EAH	
JLB		LJJ	
RSM			
HWM			
EFS			
GVV			
PLEASE HANDLE	FILE		
RETURN TO			

DATE

January 31, 1974

FROM Mr. J. A. Noer

LOCATION

TO Mr. G. V. Welk, Director - Regulatory Activities

LOCATION

Attention: Mr. E. H. Schentzel

SHERBURNE COUNTY GENERATING PLANT

SUBJECT Units 1 and 2 E-6881/E-7108

Ash Pond Design

Twin City Testing & Engineering Laboratory, Inc. has reviewed the permeability of fly ash sludge and the clay soils used to line the fly ash pond. Attached is a copy of their report, dated January 23, 1974. As you know, the fly ash pond is under construction and is scheduled for completion in 1974. The design includes earthen dikes with a clay core and an 18 inch clay liner for sealing the 68 acre pond. It is anticipated that the pond would be filled to a level of 4 feet as soon as the clay liner has been placed to maintain the integrity of the clay. Anticipated operation of the pond is to maintain an average of 6 to 10 feet of water above the sludge. As sludge is deposited, the water elevation will increase. After the ultimate elevation of the pond is reached (996' msl), the amount of water will be gradually decreased until only fly ash sludge remains. A new pond would then be placed in service. The expected life of the first pond is 10 to 12 years.

Twin City Testing used Darcy's relationship for seepage calculations. Ignoring any effect of fly ash sludge, the 18 inch clay liner has a predicted seepage rate of 20 gallons per acre per day at a minimum water elevation and a seepage rate of 340 to 680 gallons per acre per day at the ultimate water elevation. This is based on a permeability of 0.5×10^{-8} centimeters per second and 2.2×10^{-8} centimeters per second respectively.

Black & Veatch calculated seepage rates by a finite element method analysis. These calculations result in a seepage rate of 5 gallons per acre per day at elevation 950', 46 gallons per acre per day at 970' (the average elevation), and 108 gallons per acre per day at 996' (the ultimate elevation). These calculations were based on a permeability of 1×10^{-8} centimeters per second. The average permeability of clay tested to date is 1.1×10^{-8} centimeters per second.

Black & Veatch also investigated seepage rates for various thicknesses of clay. Very little improvement is predicted for a thicker clay lining. For example, a 36" clay liner could reduce the seepage 7% at the average elevation of 970' and 17% at the ultimate elevation of 996'. The approximate cost of doubling the thickness approaches \$400,000. Also, it would be difficult to obtain a large increase in the required quantity of clay.

Please contact us if we can be of further assistance.

JAN/jr

Attachment

cc: P A Johnson

J A Smith

J R Zylkowski

J A Noer

J. A. Noer, P. E.

Supervising Engineer - Mechanical

PERMEABILITY TESTS OF SOIL

PROJECT: PROPOSED CLAY BORROW AREA
NEAR BECKER, MINNESOTA

REPORTED TO: Black and Veatch

LABORATORY NUMBER: 18579

SAMPLE DESIGNATION: Composite sample from borings 88, 91,
92, 93 and 94

UNIFIED SOIL CLASSIFICATION: Sandy Clay, Brown (CL)

ATTERBERG LIMITS:

Liquid Limit (%)	26
Plastic Limit (%)	12

MOISTURE - DENSITY RELATION (ASTM: D 1557-70):

Maximum Dry Density (pcf)	128.7
Optimum Moisture Content (%)	10.7

PERMEABILITY TEST:

Trial	1	2	3
Type Test	Falling Head	Falling Head	Falling Head
Type Speciman	Remolded	Remolded	Remolded
Sample Diameter (in.)	2.81	2.81	2.93
Sample Length (in.)	3.00	2.95	3.11
Molded Dry Density (pcf)	124.8	124.8	124.8
Molded Moisture Content (%)	7.0	10.0	15.0
Effective Sample	4	4	4
Confining Pressure (psi)			
Head Differential (cm)	71	78	184
Coefficient of Permeability (cm/sec at 20° C)	1.2×10^{-7}	7.8×10^{-8}	5.0×10^{-9}

PERMEABILITY TESTS OF SOIL

REPORTED TO: Northern States Power Company

October 10, 1973

LABORATORY NUMBER: 9-4919

SAMPLE NUMBER	13-P-1	13-P-2
UNIFIED SOIL CLASSIFICATION	SC	SC
LOCATION	50'S of north dam, Sta. 3+00	50'S of north dam, Sta. 3+00
ELEVATION	944'	944'
MOISTURE-DENSITY RELATION (ASTM:D1557-70)		
Maximum Dry Density (pcf)	124.5	124.5
Optimum Moisture Content (%)	12.0	12.0

PERMEABILITY TEST

Type Test	Falling Head	Falling Head
Type Specimen	Undisturbed	Remolded
Sample Diameter (in.)	2.86	2.86
Sample Height (in.)	2.95	2.95
Dry Density of Test Specimen (pcf)	111.5	109.6
Molded Moisture Content (%)	15.3	14.6
Confining Pressure (psi)	4	4
Water Head (in.)	38	38
Water Temperature	22	22
Coefficient of Permeability - k (cm/sec @ 20°C)	2.27 X 10 ⁻⁸	5.5 X 10 ⁻⁹

PERMEABILITY TESTS OF FLYASH

PROJECT: SHERBURNE COUNTY GENERATING PLANT, NEAR BECKER, MINNESOTA

REPORTED TO: Northern States Power Company

LABORATORY NUMBER: 9-5107

DATE: January 15, 1974

SAMPLE CLASSIFICATION:

Flyash, gray

PERMEABILITY TEST:

Trial	1	2
Type Test	Falling Head	Falling Head
Type Specimen	Hydraulically Placed	Hydraulically Placed
Sample Diameter (in.)	4	2.8
Sample Length (in.)	4.5	3.25
Effective Sample Confining Pressure (psi)	None	2.5
Head Differential (cm)	55	225
Coefficient of Permeability (cm/sec at 20° C)	1.2×10^{-4}	1.8×10^{-4}

TWIN CITY TESTING AND ENGINEERING LABORATORY, INC.

ENGINEERS AND CHEMISTS

662 Cromwell Avenue - St. Paul, Minn. 55114

REPORT OF: PERMEABILITY TESTS ON FLY ASH MATERIAL



DATE: January 23, 1974

LABORATORY No. 9-5107

PAGE: 2

TEST PROCEDURES AND RESULTS

The recent testing program consisted of conducting two permeability tests on hydraulically-placed specimens of fly ash. Samples of the fly ash were obtained from your Black Dog Plant on November 9, 1973. We understand the fly ash obtained from that plant is similar to the material expected to be produced at the Becker site.

The falling head permeability test results indicate k-values (coefficient of permeability) of 1.2×10^{-4} cm per second and 1.8×10^{-4} cm per second. The test results, along with other pertinent test information are shown on the attached permeability test data sheet.

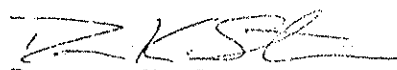
ANALYSIS AND CONCLUSIONS

The permeability tests performed to date indicate the fly ash has a permeability rate about 1000 to 10,000 times larger than the permeability rate for the clayey soils being used to line the ash pond. On this basis, it is our judgement that the fly ash will not impede the flow of water from the ponds. Rather, the clay liner itself will have to be relied upon for reducing seepage losses to acceptable amounts.

The seepage loss rate from the ponds will vary, depending on the level of water in the ponds. For a 1½' thick clay lining, we estimate seepage losses will range from about 20 gallons per acre per day if the water level is at pond bottom elevation to in the range of 340 to 680 gallons per acre per day if the liquid level is 50' above pond bottom elevation. These seepage losses are based on Darcy's relationship for seepage assuming the clay will become saturated and all head losses will occur in the clay lining material. The permeability test results available to date for the clay lining material, if placed above optimum moisture content, indicate an average k-value of 1.1×10^{-8} cm per second, with the test results ranging from 0.5×10^{-8} cm per second to 2.27×10^{-8} cm per second. In general, all clay lining material placed to date has been placed at a moisture content above optimum moisture content. Additional checks of the estimated seepage can be made when the results of additional permeability tests become available.

Very truly yours,

TWIN CITY TESTING AND
ENGINEERING LABORATORY, INC.


Donovan K. Stormoc, P.E.

DKS:ps
Encs.

TWIN CITY TESTING AND ENGINEERING LABORATORY, INC.

645-3601



ENGINEERS AND CHEMISTS

662 Cromwell Avenue - St. Paul, Minn. 55114

REPORT OF: PERMEABILITY TESTS ON FLY ASH MATERIAL



PROJECT: SHERBURNE COUNTY GENERATING PLANT
NEAR BECKER, MINNESOTA

DATE: January 23, 1974

REPORTED TO: Northern States Power Company
414 Nicollet Mall
Minneapolis, Minnesota 55401
Attention: Mr. Pete Johnson

FURNISHED BY:

COPIES TO:

LABORATORY No. 9-5107

SUMMARY

We have conducted laboratory tests to evaluate what effect, if any, hydraulically placed fly ash would have on the seepage losses from the fly ash ponds at this site. Our test results indicate the permeability of the fly ash is much greater than that of the clayey pond lining material. Therefore, the fly ash should have virtually no effect on seepage losses from the ponds. Permeability test data for the clayey lining material indicates seepage losses from the fly ash ponds could vary between a low of 20 gallons per acre per day to a high of as much as 340 to 680 gallons per acre per day, depending on the actual water level in the ponds.

INTRODUCTION

This report pertains to an investigation we have conducted to evaluate seepage losses from the proposed fly ash ponds and to determine the effect of waste fly ash on the seepage from the ponds. The purpose of this report is to present our findings and conclusions.

We have previously conducted permeability tests on undisturbed and remolded samples of the clayey lining soil being used in the pond area. The results of these tests were included in our progress report #4 to you dated December 3, 1973 (Laboratory No. 9-4919). Also, permeability tests were conducted by Soil Exploration Company during an investigation of the clay borrow area. The results of those tests were included in report 18579 to Black and Veatch, dated February 9, 1973. Copies of those previous reports were available to us for this recent work, and the permeability test data sheets from those reports are appended.

We also previously forwarded to you a report concerning this recent seepage investigation. Our report was dated January 15, 1974. In that report, we estimated seepage losses from a pond with a 4' thick clay lining. The clay blanket in the ponds will actually be 1½' thick, with the 4' thickness being used only under the dike embankments. Therefore, this report contains estimated seepage losses which have been revised from our January 15 report.

NSP

NORTHERN STATES POWER COMPANY

MINNEAPOLIS, MINNESOTA 55401

February 8, 1974

Mr George Koonce, Section Chief
Industrial and Other Wastes
Minnesota Pollution Control Agency
1935 West County Road B2
Roseville, Minnesota 55113

SHERBURNE COUNTY GENERATING PLANT E-6881/E-7108
Ash Pond Storage Area
Supplemental Information

As a result of recent discussions in your office concerning the design data of the fly ash storage ponds at the Sherburne plant, we are submitting the following information to supplement plans and specifications filed with your office on July 19, 1973:

Twin City Testing & Engineering Laboratory, Inc. has reviewed the permeability of fly ash sludge and the clay soils used to line the fly ash pond. Attached is a copy of their report, dated January 23, 1974. As you know, the fly ash pond is under construction and is scheduled for completion in 1974. The design includes earthen dikes with a clay core and an 18 inch clay liner for sealing the 68-acre pond. It is anticipated that the pond will be filled to a level of 4 feet as soon as the clay liner has been placed to maintain the integrity of the clay. Anticipated operation of the pond is to maintain an average of 6 to 10 feet of water above the sludge. As sludge is deposited, the water elevation will increase. After the ultimate elevation of the pond is reached (996'msl), the amount of water will be gradually decreased until only fly ash sludge remains. A new pond would then be placed in service. The expected life of the first pond is 10 to 12 years.

Twin City Testing used Darcy's relationship for seepage calculations. Ignoring any effect of fly ash sludge, the 18 inch clay liner has a predicted seepage rate of 20 gallons per acre per day at a minimum water elevation and a seepage rate of 340 to 680 gallons per acre per day at the ultimate water elevation. This is based on a permeability of 0.5×10^{-8} centimeters per second and 2.2×10^{-8} centimeters per second respectively.

NORTHERN STATES POWER COMPANY

Mr George Koonce

-2-

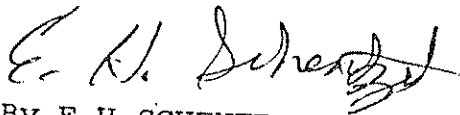
February 8, 1974

Black & Veatch, our consulting engineering firm, calculated seepage rates by a finite element method analysis. These calculations result in a seepage rate of 5 gallons per acre per day at elevation 950', 46 gallons per acre per day at 970' (the average elevation), and 108 gallons per acre per day at 996' (the ultimate elevation). These calculations were based on a permeability of 1×10^{-8} centimeters per second. The average permeability of clay tested to date is 1.1×10^{-8} centimeters per second.

Black & Veatch also investigated seepage rates for various thicknesses of clay. Very little improvement is predicted for a thicker clay lining. For example, a 36" clay liner could reduce the seepage 7% at the average elevation of 970' and 17% at the ultimate elevation of 996'. The approximate cost of doubling the thickness approaches \$400,000. Also, it would be difficult to obtain a large increase in the required quantity of clay.

Hopefully this will provide the information you requested concerning design of this ash storage basin. Feel free to contact us if there are any additional questions on this project.

G V WELK, Director
Regulatory Activities




By E H SCHENTZEL, Administrator
Regulatory Liaison

lg

Attachment

OCT 8 1974



MINNESOTA POLLUTION CONTROL AGENCY
1935 W. County Road #2, Roseville, Minnesota 55113

(612) 296-7383

October 4, 1974

Mr. G. V. Welk, Director
Regulatory Activities
Northern States Power Company
Minneapolis, Minnesota 55401

Re: Disposal System Permit dated July 11, 1972
Sherburne County Generating Plant
Becker Township, Sherburne County

Dear Mr. Welk:

We have reviewed the final plans for coal ash and water storage area, and for cooling tower submitted on July 19, 1973 and October 11, 1973, respectively, in accordance with condition No. 8 of Exhibit A (Water) of Permit dated July 11, 1972.

The plans are satisfactory and are hereby approved subject to conditions given below.

The facilities consist of a bottom ash pond, a fly ash pond, a recycle basin, a holding basin, four wet mechanical draft cooling towers of five cells each, a neutralization basin, pumps, piping and appurtenances.

The bottom ash pond with earthen dike has a total area of approximately 25.5 acres and receives bottom ash sluice water. The fly ash pond with earthen dike has a total area of approximately 60 acres and receives fly ash and scrubber sludge water.

The recycle basin and the holding basin are constructed below normal grade by excavation and have areas of approximately seven acres and four acres, respectively. The recycle basin receives cooling tower blowdown, bottom ash pond effluent, coal storage pile drainage, boiler blowdown, neutralized demineralizer regenerant, and other miscellaneous plant effluents. The holding basin receives fly ash pond effluent and overflow from the recycle basin.

All basins, ponds and coal storage area have an impervious lining and ponds shall be operated to maintain at least three feet of free board.

October 4, 1974

The neutralization basin receives the demineralization system waste water and spent chemicals to control pH prior to release the waste water to the recycle basin.

The facilities are further described in plans and specifications designated "Summary Specifications for Coal, Ash and Water Storage Area Sealing", dated June 20, 1973; drawing No. NF-53266-13; drawing No. NQ-49460-B; drawing No. NX-11500-1, and two letters dated August 30, 1974 from Mr. G. V. Welk.

The company shall submit to the Agency within 90 days of the initial operation of the disposal system and annually thereafter, the results of a study on the effectiveness of the impervious linings. The study shall include a water balance over a period of time and the rate of water lost by percolation.

This approval does not complete the requirement of the condition No. 8 of Exhibit A (Water) of Permit dated July 11, 1972 and plans and specifications not included herein are subject to the Agency approval in accordance with the said condition.

The Agency, its officers, employees and agents shall review and comment upon engineering reports, and construction plans and specifications which provide the basis for this approval solely for the limited purpose of determining whether such report, plans and specifications will enable the facilities subject thereto to reasonably comply with the regulations and criteria of the Agency.

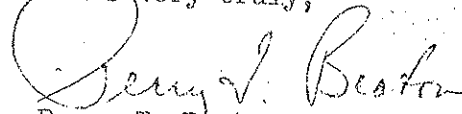
The plans for the project have been approved, with the reservations stated on the attached sheet entitled "Information Relative to Review of Plans and Permit Applications".

The plans and specifications has not been reviewed by the U. S. Environmental Protection Agency and is not approved pursuant to Section 402 of the Federal Water Pollution Control Act Amendments of 1972.

Approval by the Agency will be recommended at its regularly scheduled meeting on October 15, 1974. You will be advised of the Agency's final decision regarding this matter.

Please review the approval carefully and let us know if you have any questions concerning it.

Yours very truly,



Perry T. Beaton, Chief
Facilities Section
Division of Water Quality

Enclosure

cc: Chairman, c/o Auditor or Administrator, Sherburne County Board of
Commissioners, Elk River

MINNESOTA POLLUTION CONTROL AGENCY
Division of Water Quality

INFORMATION RELATIVE TO
REVIEW OF PLANS AND PERMIT APPLICATIONS

October 1972

The review of plans and specifications for sewage, industrial waste or other waste disposal systems and applications for permits for the same is made in accordance with the authority conferred by law (see MS 1971, Section 115.07). Approval of plans and permits is based upon the assumption that the information provided by the applicant is correct and that all necessary legal requirements have been or will be satisfied.

Plans for sewage, industrial waste or other waste disposal systems are examined with regard to the design features which apply to operation and maintenance of the treatment works or sewer system, the degree of treatment to be provided, the effectiveness and reliability of the system or methods employed, and compliance with applicable standards of quality and purity for waters of the state or effluents of disposal systems. The bulletins entitled Recommended Standards for Sewage Works, 1971, revised edition, Tentative Standards for Design of Small Sewage Works, July 1962 and Federal Guidelines for Design, Operation and Maintenance of Waste Water Treatment Facilities, September 1970, and supplements thereto, as well as other memoranda, are used as a guide in examination of the design, operation and maintenance aspects of the proposed system.

Sewer plans are recommended for approval on the basis that the system is to collect only domestic sewage and such industrial or other waste as may have been provided for in the design. Foundation or footing drains to collect ground water and roof drains or other surface water conduits should not be connected to the sanitary sewer system. Adequate field supervision and inspection by a qualified representative of the owner should be provided at all times during construction to assure that the project is constructed in compliance with the approved plans and specifications.

The Agency assumes no responsibility for the integrity of structures or physical features, or for the reliability, durability or efficiency of specific items of proprietary equipment or material. All applicable federal, state and local laws, regulations or ordinances must be followed in the design, location and construction of proposed sewer systems or treatment works.

The Agency reserves the right to withdraw its approval of plans if construction is not undertaken within a reasonable period after issuance of the permit.

WELK FILE
12/3/74 - Sherco Working File

DATE December 3, 1974

E H Schentzel Administrator, Regulatory Liaison

LOCATION Minneapolis ✓

G V WELK *GW*
12-5 Director, Regulatory Activities

LOCATION Minneapolis

SUBJECT SHERCO SLUDGE STORAGE BASIN MONITORING

On November 27, 1974 the following met at the MPCA office to discuss the above subject.

Mike Zagar	Facilities Section	MPCA
Joel Schilling		MPCA
Marvin Horn		MPCA
S Moon Ko		MPCA
Fred Arnold		MPCA
E H Schentzel		NSP
R S McGinnis		NSP
John Noer		NSP

The meeting was to hopefully resolve a request by the agency to evaluate the effectiveness of the impervious liner of the sludge storage basin including a water balance study over a period of time. We had responded negatively to a water balance study by letter dated November 11, 1974. To resolve the problem, Zagar asked for QA studies done during construction of the liner to substantiate original percolation test results provided to the agency. Hopefully these QA results would be indicated on a plot plan of the basin as to where the test results were taken.

Zagar also asked for a plan to be submitted in 2 weeks as to how we might evaluate basin leakage now, before plant operation, with river water in the basin. An early start of pre-operational testing of groundwater, in the vicinity of the sludge pond was also suggested.

The need for a set of plans for the cooling towers for Unit #2 was discussed. It was pointed out that plans for Unit #1 and 2 are identical. Zagar was to check with their legal department to determine if the plans for Unit 1, already in their possession, would meet the need for Unit 2 and if a letter from NSP to this effect would suffice.

E. H. Schentzel
E H Schentzel, Administrator
Regulatory Liaison

kd

Cc: R S McGinnis
John Noer

RECORDS CENTER PERMIT FILE

November 11, 1974

Mr Perry T Benton, Chief
Facilities Section
Division of Water Quality
Minnesota Pollution Control Agency
1935 West County Road B2
Roseville, Minnesota 55113

ENGINEERING VICE PRESIDENTIAL STAFF DEPARTMENT #0327					
	AVD			BWC	
	FCW			TRC	
	EHA			INGG	
	JLB			EAB	
	RSM			P.H.	
	HWS		T	ESS	WSD
	AGG			JAN	
	EIS			EIS	
	GVV		E	LRS	WSD
IA	L.M.L.		W	W.P.P.	
PLEASE HANDLE			FILE		
RETURN TO					

SHERBURNE COUNTY GENERATING PLANT
Disposal System permit Dated July 11, 1972

Thank you for your letter dated October 4, 1974 approving the final plans for the coal, ash and water storage areas and cooling towers, as authorized by the subject disposal system permit. The following clarification and corrections are called to your attention.

- 1) Paragraph 3 page 1, describes the cooling towers for 1 unit only. The plant will include 2 units with 4-five cell cooling towers for each unit (a total of 8-five cell cooling towers).
- 2) Paragraph 5 page 1, last sentence, should also include cooling tower blowdown as being received by the holding basin.
- 3) Paragraph 3 page 2, suggests a study of the effectiveness of the impervious lining. You have suggested that the study should include a water balance over a period of time and the rate of water lost by percolation. We have evaluated the alternative water balance study which you suggested and have concluded a number of unpredictable variables exist which are inherently associated with such a study and tend to affect it's reliability. For example, water will be held within the scrubber sludge (comprising fly ash, calcium sulfate and limestone). The inherent errors of measuring and predicting this quantity of water is greater than the predicted rate of percolation.

Mr. G. V. Ash, Director - Regulatory Activities

DATE FILED	FILE NO.	CITY	PROJECT NO.
1-6-75	92F240
PROJECT	OR	TECHNICAL	...
...

Handwritten notes:
 1-6-75
 P.V. Collins
 Sherco

SHERBURNE COUNTY GENERATING PLANT

1-0111

Report on Quality Control Program for Ash Ponds and Water Basins Construction

1/17/75

The quality control program consisted of a quality control program for the construction of the bottom ash and scrubber... This program was completed with them on December 2, 1974.

In order to evaluate the quality control program we would like to identify the... The laboratory and field testing program was done by Twin City Testing and Engineering... The design engineering work was done by... The contractor and the engineers were under the supervision of the... Plant Engineering and Construction Department.

G. A. Demers' role in the quality control program consisted of an hour by hour, load by load inspection of materials hauled to the site to verify that the materials were as specified, that they were going in the right place, that they were at a workable moisture content, that they were placed in the specified layer thickness, and that they received the proper compactive effort with the right equipment and correct number of passes. Their efforts were also carried out in the clay pit where materials were classified, stockpiled, dried, and loaded out. By carrying out their quality control efforts they were able to reduce their costs by effectively using their equipment and minimizing test failures which require reworking of materials. The reworking of materials will be described later. The result of their quality control program is a uniform predictable soil embankment.

Twin City Testing and Engineering's role in the quality control program was to provide the field testing program, to provide a laboratory for soil tests, and to provide soil engineering advise and expertise. In carrying out their assignment they provided us with a record of the field testing program, laboratory testing, and the engineering decisions which were made. The work done by Twin City was under the direction of a Registered Professional Engineer and was supervised in the field by an engineer. A field laboratory was set up and staffed to provide

the day-to-day testing and site inspection work required by the work load. The field laboratory classified the soils with the aid of gradation tests, Atterberg limits, and other tests. They also ran soil density and moisture tests to evaluate the compactive effort on the soil. In addition to the field testing described, Twin City used their laboratory facilities in St. Paul to evaluate soil strength properties and permeability for various soil densities and moisture conditions. Based on their laboratory work, they were able to provide engineering advise on the quality of the work and evaluate whether we were meeting the design parameters.

Black and Veatch's role was that of design engineer and consultant. In their capacity they produced the design, and served as a consultant during the construction work. As a consultant during construction, they were able to evaluate the contractor work and were able to use the data from Twin City to assure conformance with their design parameters.

NSI Plant Engineering and Construction's role was that of owner and supervisor of the work. Our effort was to monitor the work of our engineering consultants and to supervise our contractor to assure ourselves that the work was being properly executed with the project schedule.

During the course of the work Twin City issued 13 field testing reports and two technical laboratory reports on the work. The 13 test reports covered 2,050 moisture-density tests and 123 other tests which were run to control the soil compaction and evaluate the soils. Of 2,050 moisture-density tests, 193 showed the compactive efforts by the contractor were inadequate. In those cases the soil in that layer and area was removed, recompact, and retested for acceptance.

Twin City also ran laboratory tests to evaluate the strength of the soil as a function of density and moisture. This program was carried out to evaluate the effect of the moisture content on the cohesive strength for field attainable densities. The result of these tests were evaluated by Black and Veatch to determine acceptable field moisture and density requirements. On the basis of these tests a minimum density of 90 percent of maximum based on ASTM D:1557 at 0-6 percent moisture above optimum was judged to give strengths of at least 1,000 psf which was the basic design parameter for the strength of the core material.

Twin City also ran a laboratory program to evaluate the consolidation, shrinkage, and permeability of the clay at a high moisture contents and specified density. This program was initiated to evaluate the effects of placing the fill at 90 percent of maximum density with moisture at seven percent above optimum. The results of this testing showed that the permeability would be 10^{-8} to 10^{-9} cm/sec under these conditions and that settlements would be about 2-4 inches. Both of these values are consistent with the project design parameters.

In the design-construction process, 19 permeability tests were performed on the impervious material soils by Twin City Testing in their laboratory in St. Paul. These tests showed that permeabilities of 10^{-8} to 10^{-9} cm/sec are expected when the project soils were compacted to at least 90 percent of maximum density with moisture contents of 0-6 percent above optimum. This permeability is better than the project design basis.

Mr. G. V. Walk

-3-

December 20, 1974

We feel the above gives a summary of our quality control effort, but since the work described above is the accumulation of tests and reports over a period of two years, and since the test reports are so voluminous, we have asked Twin City Testing to prepare a summary report which would be their final report. This report would give an overview of their work and organize the numerous tests into a logical frame for review. This report should be available by February 1, 1975.

If you have any questions, please contact me. By copy of this letter we are asking for comments and/or corrections.

Very truly yours,



P. A. Hanson, P. E.
Supervising Engineer - Civil

PAJ:rad

cc: J.A. Smith

J.R. Wykowski

A second approach would be to relax the precision of the stage measurement and measure the best we can with an ordinary steel ruler. The precision of this technique would be about $\pm .1$ " which corresponds to 10 gpm of seepage. We would then argue that we have made our measurements consistent with normal field practice. One other factor which affects the results is the amount of head due to the snow load. Assuming 40 inches of snowfall during the test duration we could end up with about four inches of pressure head due to snow. This certainly is a large number compared to the projected stage changes due to seepage which further augments measuring the stages to $\pm .1$ ". The accuracy of the snow cover measurement is at best questionable. Perhaps it could be $\pm .5$ " water. In any event, an accurate measurement of the snow cover is also very important to evaluate the seepage. Hopefully we will not have any gross leaks.

Suggested Techniques

To measure the stage, a stilling well protected from the wind should be set up. This could be done adjacent to the sheet pile wall at each pond's discharge structure. Then a datum should be established from which the stage measurements can be taken. To make the measurements a thin steel tape or ruler should be used to minimize the effect of surface tension. The measurements should be taken every other week.

On the same day the stage measurements are made, the moisture content of the snow on the ice must also be measured. The snow measurement should determine the average snow cover on the ice in inches of water. To physically make the measurement, a sampler must be made from which we can remove all of the snow. We can then melt the snow, and measure the volume and compute the water head. The number of samples and their location will have to be made in the field using judgment.

To get the best data picture we should make our first measurements as soon as possible, since a longer period should give larger changes.

If you have any questions, please contact me.

Yours very truly,

Pete

P. A. Johnson, P.E.
Supervising Engineer - Civil

PAJ/rmd

JAN 17 1975

MINNESOTA POLLUTION CONTROL AGENCY

1935 W. County Road B2, / Roseville, Minnesota 55113

(612) 296- 7373

January 15, 1975

Mr. Gary V. Welk, Director
Regulatory Activities
Northern States Power Company
Mimeapolis, Minnesota 55401

Re: Sherburne County Generating Plant

Dear Mr. Welk:

This will respond to your letter dated November 11, 1974 and will confirm our meeting of November 27, 1974 regarding the approval of the plans and specifications of the above referenced project. The following refers to items listed in your letter.

- 1) Plans and specifications for Unit No. 2 cooling tower should be submitted but if they are identical to those of Unit No. 1, a confirmation letter may be submitted instead.
- 2) The last sentence of the paragraph should read as "The holding basin receives flyash pond effluent, cooling tower blowdown, and overflow from the recycle basin".
- 3) At the time of the meeting, technical difficulties of the water balance study were discussed. As an alternative development effort, the company agreed to:
 - a) Submit to the Agency the test results of the pond seal by an independent soil engineering firm along with the layout of samples, the method of sampling, and number of samples.
 - b) Check the possibility of performing an actual plant-scale seepage study of the ponds over a period of time before the commencement of plant operation.
 - c) Have a follow-up meeting with the Agency to discuss and finalize items a) and b) above.
- 4) Upon submission of plans and specifications for Unit No. 2 cooling tower, the company will be considered to be in compliance with

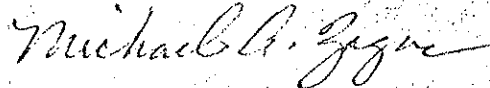
January 16, 1975

condition No. 8 of the permit dated July 11, 1972. However, any additional or future construction within the scope of testimony presented at the public hearing which was held commencing on April 25, 1972 and concluding on May 1, 1972, will require submission of plans and specifications for Agency approval, pursuant to condition No. 8.

- 5) We recognize that you have taken steps toward obtaining a NPDES permit for this facility. However, the approval granted by our letter of October 4, 1974 was under the provisions of Minnesota Statutes, Chapters 115 and 116, and is not to be construed as an approval under the National Pollutant Discharge Elimination System permit program, which is separate and distinct. We understand your application for the NPDES permit is under processing and questions on the status of the permit application should be directed to Mr. Robert A. Kaiser of the Permit Section.

Your cooperation on this matter is appreciated and should you have any questions please contact Mr. S. Moon Ko at 296-7383.

Very truly yours,



Michael A. Zagar, P.E.
Facilities Section
Division of Water Quality

COPIY - PLANT ENRG & CONST	
Project	File No. 97F240
Page 24	1975
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Comm/Info	
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Mr. G. V. Welk, Director -
Regulatory Activities

SHERBURNE COUNTY GENERATING PLANT E-6881
Permits - MPCA - Solid Waste Disposal
Seepage Measurements - Ash Ponds
97F240

During the past winter, field measurements were made to determine the rate of seepage from the ash ponds at the Sherco Plant. Using these field measurements, the in situ permeability of the clay material in the ponds was calculated.

A water budget approach was used to determine the seepage from the ponds. To use the water budget, the stage of the ponds and snow cover on the ponds were measured on a weekly basis, and the seepage was then computed. The surface inflow and evaporation from the ponds was assumed to be negligible, since the measuring period was during the winter. The surface outflow was zero. The resulting average seepage rates were:

Bottom ash pond	.049 "/da
Fly ash pond	.015 "/da

Using the measured seepage rates, the in-place permeability of the clay was calculated using Darcy's Law. The resulting permeability coefficients were:

Bottom ash pond	2.5×10^{-7} cm/sec
Fly ash pond	0.7×10^{-7} cm/sec

In July, 1973, we submitted plans and specifications to the MPCA for approval in accordance with conditions of our discharge permit. The specifications submitted to the MPCA described the "earth blanket material" to have a permeability of 10^{-7} cm/sec. Laboratory tests made during the construction gave permeabilities in the 10^{-8} to 10^{-9} cm/sec range. Thus the field measured permeability is higher than the laboratory measured permeability, and the field measured permeability meets the MPCA specifications.

The difference between the laboratory and the field measured permeability could be the result of one or a combination of the following factors:

1. Inherent errors in the field measurement of seepage
2. Design oversights which cause leaks
3. Construction flaws which cause leaks.

Mr. G. V. Welk
June 24, 1975
Page 2

We are confident that the construction was in compliance with the drawings, specifications, and design criteria. Therefore we can rule out construction flaws as a difference cause. We are investigating for design oversights giving emphasis to design details at places where we have earth blanket penetrations. We are also investigating the inherent errors in the field measurements made to determine seepage. We feel that this may explain the difference in the laboratory and field measured permeability.

In summary, based on our testing program, we have verified that (1) we do not have substantial leaks, and (2) the work meets the MPCA specification. We are in the process of testing the permeability of the scrubber sludge and should be able to share the results of that work in the near future. It is our judgment that the fines in the sludge differ from the fines in fly ash and that they will decrease the permeability the earth blankets.

If you have any questions, please do not hesitate to call.

Very truly yours,



P. A. Johnson, P. E.
Supervising Civil Engineer

PAJ/rmd

cc: J. A. Smith
J. R. Zylkowski

NORTHERN STATES POWER COMPANY

Mr. Louis J. Breimhurst
July 18, 1975
Page 2

Plans and specifications for the ash ponds (submitted to the Agency in July, 1973, in accordance with permit conditions) described the earth blanket material to have a permeability of 10^{-7} cm/sec. Laboratory tests made during construction gave permeabilities in the 10^{-8} to 10^{-9} cm/sec range. Thus, the field-measured permeability is higher than the laboratory-measured permeability and the field-measured permeability meets MPCA specifications.

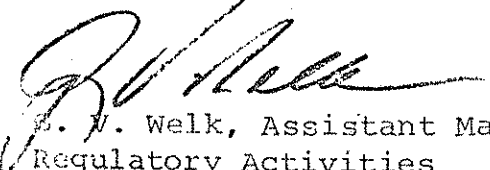
The difference between the laboratory and the field-measured permeability could be the result of one, or a combination, of the following factors:

1. Inherent errors in the field-measurement of seepage.
2. Design oversights which cause leaks.
3. Construction flaws which cause leaks.

A rigid quality assurance program has been in effect since the early beginning of construction activity; thus, we are confident that the construction was in compliance with the drawings, specifications and design criteria. Therefore, we can rule out construction flaws as a difference cause. We are investigating for design oversights giving emphasis to design details at places where we have earth blanket penetrations. We are also investigating the inherent errors in the field measurements made to determine seepage. We feel that this may explain the difference in the laboratory and field-measured permeability.

In summary, based on our testing program, we have verified that 1) we do not have substantial leaks, and 2) the work meets the MPCA specification. We are in the process of testing the permeability of the scrubber sludge and should be able to share the results of that work in the near future. It is our judgment that the fines in the sludge differ from the fines in fly ash and that they will decrease the permeability of the earth blankets.

If you have any questions, please contact this office.


E. N. Welk, Assistant Manager
Regulatory Activities

(File Copy)

DATE October 16, 1975

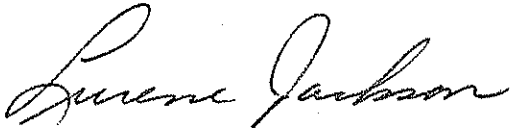
FROM E H Schentzel Assistant Administrator
Regulatory Liaison
TO P A JOHNSON Supervising Civil Engineer
LOCATION Minneapolis
LOCATION Minneapolis

SUBJECT SHERBURNE COUNTY GENERATING PLANT E-6881
MPCA Seepage Measurements - Ash Ponds

97F240

Attached is a copy of the Minnesota Pollution Control Agency letter dated October 2, 1975, acknowledging acceptance of the results of water balance tests of the seepage rates from the bottom ash and fly ash ponds, for the subject generating plant, submitted to the Agency July 18, 1975.

Please note in the last paragraph of the referenced July 18 letter we advised the Agency that we were testing the permeability of the sludge. These test results will need to be provided to the Agency when they are available.

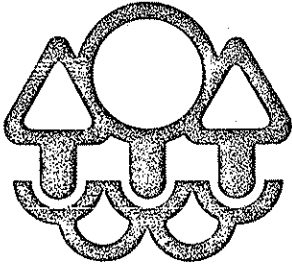


Lurene Jackson
Staff Assistant

kd

Attachment

OCT 9 1975



Minnesota Pollution Control Agency

October 2, 1975

Mr. G. V. Welk
Assistant Manager
Regulatory Activities
Northern States Power Company
414 Nicollet Mall
Minneapolis, Minnesota 55401

Re: Sherburne County Generating Plant
Seepage Measurements - Ash Ponds

Dear Mr. Welk:

This will acknowledge receipt of your letter of July 18, 1975 which included the results of water balance tests of the seepage rates from the bottom ash and fly ash ponds. The letter is accepted in fulfillment of the request of the Agency in its letter of October 4, 1974.

We look forward to receiving the results of the permeability tests on the scrubber sludge when these are available. If you have any questions, please contact us.

Yours very truly,

For

Perry T. Beaton, Chief
Facilities Section
Division of Water Quality

November 4, 1975

Mr. P. A. Johnson

Mr. E. H. Schentzel, Assistant Administration
Regulatory Liaison

SHERBURNE COUNTY GENERATING PLANT E-6881
Permeability Tests on Scrubber Sludge
DIN SLPH97F240

In their letter of October 2, 1975, the PCA requested test data on scrubber sludge permeability. This was the result of NSP informing the PCA that such tests were in progress when we were asked to estimate pond seepage rates.

The permeability tests using Black Dog scrubber sludge have been completed. Using the constant head test procedure, the coefficient of permeability was 3.1×10^{-5} centimeters per second for sample # 1 and 4.8×10^{-5} centimeters per second for sample # 2. The samples were taken at zero to 6" depth and 6" to 1' depth respectively. The particle size was about 15% sand, 75% silt, and 10% clay.

Attached is a copy of the test result.

PA Johnson

P. A. Johnson, P. E.
Supervising Civil Engineer

PAJ/rmd
Enclosure

cc: J. R. Zylkowski
J. A. Smith

FILE COPY - PLANT ENGRG & CONST									
Date	Project								
E No	File No			97F240					
CJT									
FOSSIL	RAH	MS							
NUCLEAR	BSL								
QA	WVJ								
TECH SERV	FHE								
GEN SERV	RFI	RFI	RFI	PIS					
	RFI	RFI	RFI	RFI					
Pls Handle									
Comments									

PERMEABILITY TESTING

PROJECT: NORTHERN STATES POWER CO BLACK DOG PLANT
FLY ASH LAGOON

REPORTED TO: Northern States Power Co

<u>SAMPLE NO:</u>	1	2
<u>UNIFIED SOIL CLASSIFICATION:</u>	Fly Ash Sludge	Fly Ash Sludge
<u>MOISTURE-DENSITY RELATION:</u> (ASTM:D698-70)		
Maximum Dry Density (pcf)	70.9	70.9
Optimum Moisture Content (%)	46.8	46.8

PERMEABILITY TEST -

<u>TYPE TEST:</u>	Constant Head	Constant Head
<u>TYPE SPECIMEN:</u>	Undisturbed	Undisturbed

<u>SAMPLE HEIGHT:</u> (in.)	4	4
<u>SAMPLE DIAMETER:</u> (in.)	2.85	2.85
<u>CONFINING PRESSURE:</u> (psi-effective)	2	2

<u>HEAD DIFFERENTIAL:</u> (H, in ft)	5	5
<u>COEFFICIENT OF PERMEABILITY:</u> K @ 20°C (cm/sec)	3.1×10^{-5}	4.8×10^{-5}

97F520

DATE April 5, 1974

TO Mr M L Anderson Manager, Real Estate Activities
MR C J TICE Manager, Plant Engineering and Construction
Attn: J A Smith

LOCATION Minneapolis

SUBJECT SHERBURNE COUNTY CLAY MINING
Conditional Use Permit
Sherburne County, Minnesota

FILE COPY - PLANT ENGRG & CONST			
LOCATION	Minneapolis		
E No	File No		
CJT			
FOSSIL	IRAH		
NUCLEAR	RJJ		
QA	WVJ		
TECH SERV	PHF		
GEN SERV	RFR	REH	PJS
	RFJ	PIA	KKA
Pls Handle		Return To	
Comments			

Northern States Power Company's application for a conditional use permit to excavate clay from a tract of land in Becker Township was approved by the Sherburne County Board of Commissioners on April 4, 1974.

The permit application had previously been recommended for approval by the Becker Township Board on March 19, 1974, and the Sherburne County Planning Commission on March 28, 1974.

This completes the permit activities on this project in Sherburne County.

C GARY ANDERSON
Staff Assistant

lfa

Cc: R F Statz
J R Zylkowski

NSP

NORTHERN STATES POWER COMPANY

MINNEAPOLIS, MINNESOTA 55401

March 7, 1974

51PH
97F520

Mr Harvey A Alford
Sherburne County Zoning Administrator
Sherburne County Courthouse
Elk River, Minnesota 55330

Northern States Power Company herein makes application for a Conditional Use Permit to excavate on a tract of land legally described as:

East $\frac{1}{2}$ of the Southeast $\frac{1}{4}$ of Section 20, Range 28 West, Township 34 North, excepting therefrom the Southeast $\frac{1}{4}$ of the Southeast $\frac{1}{4}$ of the Southeast $\frac{1}{4}$, of Sherburne County, State of Minnesota.

The purpose of the excavation is to remove the clay and use it for sealing the coal, ash and water storage basins at the new Sherburne County Generating Plant. On January 26, 1973, we had received a Conditional Use Permit from Sherburne County for excavation of clay on the 80 acres immediately west of the above described property, however, that clay source has proved to be insufficient in quantity. We intend to complete the clay excavation from that area within a couple of months and will then regrade and seed to prevent erosion of the land.

Our present schedule calls for excavation to begin in April of 1974, and that hauling and restoration of the land will be completed by October of 1975. The amount of clay expected to be excavated from this property is 600,000 cubic yards.

The present contour of the land indicates the lowest point is in the North-Northwest area. Upon completion of the excavation, the finished area will drain in the same direction as it does at the present time.

FILE COPY - PLANT ENGRG & CONST				
Date	Project			
E No	File No			
CJT				
FOSSIL	RAH	JA	37AD	
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GEN SERV	RFR	PLH	PJS	
	RTJ	PI	KKA	
Pls Handle		Return To		
Comments				

NORTHERN STATES POWER COMPANY

Mr Harvey A Alfords

-2-

March 7, 1974

Access to the property will be across the 80-acre site that we are now excavating. The route to the Sherburne County Generating Plant will be the same as is presently being used by the clay hauling contractor.

We request a Conditional Use Permit be issued to Northern States Power Company for the above described excavation.



Merle L. Anderson, Manager
Real Estate Activities

CGA/lg

June 22, 1973

J. V. Sullivan, Construction Superintendent

C. J. Tice, General Manager

Plant Engineering & Construction

SHERBURNE COUNTY GENERATING PLANT

Haul Road for Clay Source for Coal Storage & Asn. Pond Construction

5377-D-4C DIN 97F520

During discussions with the Becker Town Board and property owners prior to receiving the Conditional Use Permit to excavate clay, NSP representatives agreed that there was a likely dust problem in hauling clay on the 1 1/2 miles of county road 67. NSP agreed that the road would be surfaced to prevent the dust. In resolving the problem, NSP and the Sherburne County Highway Engineer verbally agreed that the 1 1/2 miles of county road 67 would be regraded and blacktop paved by the county and that NSP Co. would then reimburse the county for paving 1 1/2 miles of county road 67 at an estimated cost of \$20,000.

The paving agreement was verbal but is considered a condition for receiving the Conditional Use Permit to excavate clay.

Mr. Matchinsky, the Sherburne County Highway Engineer, then informed NSP that he could not be reimbursed the estimated \$20,000 by NSP for paving the 1 1/2 miles of county road 67. He stated that the County Attorney would not permit such procedure.

In a meeting at Becker, Minnesota on May 16, 1973 attended by Messrs. Matchinsky; Overland of Milnar Carling Associates; Horgaarden, King and Anderson of NSP agreed that NSP would specify in the Coal & Ash Storage Area Specification 5377-D-4C that the contractor shall pave a 24 foot wide surface with blacktop and build it to the satisfaction of the county authorities. This has been done in Addendum #1 to the Specification.

It is estimated that paving 1 1/2 miles of 24'x3" thick bituminous surface will cost approximately \$45,000. (The county estimate was about \$24,000.)

Copies of pertinent correspondence are attached.

J. V. Sullivan
Construction Superintendent

JVS/kw

Attachments

FILE COPY			
DATE	INITIALS	FILE	REMARKS
		ARC	
		GHH	
		LSN	
		LEB	
		WJM	
		PYC	
		JRE	
		WEL	
		CIS	
		MTO	
		REH	

DATE February 5, 1973

FROM Mr M L Anderson Manager, Real Estate Activities
 TO MR C J TICE Manager, Plant Engineering and Construction
 Attn: P A Johnson

LOCATION Minneapolis

LOCATION Minneapolis

SUBJECT SHERBURNE COUNTY CLAY MINING
 Conditional Use Permit
 Sherburne County, Minnesota

Northern States Power Company's application for a Conditional Use Permit to excavate clay from a tract of land in Becker Township was approved by the Sherburne County Board of Commissioners on January 26, 1973. A copy of the permit is attached for your file.

The Conditional Use Permit application had been recommended for approval by the Sherburne County Planning Commission and the Becker Township Board in prior meetings.

This completes the necessary permit activities on this project in Sherburne County.

C. G. Anderson

C. G. ANDERSON
 Staff Assistant

lfa

Attachment

Cc: L J Crain
 G V Welk

FILE COPY			
PLANT ENGINEERING & CONSTRUCTION DEPT.			
DATE: 2/5/73			
FILE	DATE	BY	REMARKS
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sent Notice Jan 31, 73

To Edward King for N.S.P.

Your application for a permit to excavate for removal of

Erect (), Repair (), Extend (), Remove (), Move in (), Demolish ()

~~a structure~~ located at 20 1/2 of SE 1/4 Sec. 20 Twp. 34 Rng. 28

has been approved. Jan 18, 1973 Planning Commission
Jan 26 " " Court Approval

Permit will be issued upon receipt of none dollars, building permit fee,

State Surcharge none Total Fee none.

Please make check or money order payable to Sherburne County Treasurer and mail to

Harvey L. Alfords

HARVEY L. ALFORDS
SHERBURNE CO. ZONING ADM.
COUNTY ADMINISTRATION BLDG.
ELK RIVER, MINN. 55330

Coal Pit Operation Approved Jan 26, 73
APPLICATION FOR BUILDING PERMIT IN SHERBURNE COUNTY

Sherburne County Planning Advisory Commission
County Auditor's Office, Elk River, Minn.

PERMIT FOR USE (); FOR OCCUPANCY (); TEMPORARY PERMIT (.

Application No. _____ Date Oct. 18, 1972

APPLICATION is hereby made to: Use (); Erect (); Repair (); Move In ();
Extend (); Remove (); Demolish (); Occupy (); a structure located at Becker Twp.
W 1/2 of SE 1/4 Sec. 20, Twp. 34 Range 28

at a cost of \$ _____ for the following use: Residence (); Commercial () or
other use () with accessory building ().

The description of the use for this property, for which this application is submitted is
as follows request to excavate for removal of clay.

A plot plan is attached (); is sketched on the back of this application (); and
floor plans are (); are not (); included.

The main structure will be as follows:

Construction _____ Front yard depth (in feet) _____
Height (stories & feet) _____ Side yard depth (in feet) _____
Number of family units _____ Rear yard depth (in feet) _____
Dimensions of lot 80 acres Depth means distance of structure from _____
Corner () or interior () lot.

The accessory buildings will be as follows:

Description _____ Distance from rear lot line _____
Height _____ Size _____ Distance from side yard line _____

I hereby certify that I am the owner or authorized agent of the owner of the above property
and that all construction will conform to existing state laws and local ordinances.

D. Ward King - N.S.P.

D. Ward King Signature N.S.P. St. Cloud Address 252-1450 Phone Number

PERMIT FOR USE: Approved (); Denied (); Not in conformity with the following pro-
visions of the Zoning Ordinance: _____ Because _____

DATED: Jan 26, 1973 _____ Enforcing Officer
Harvey J. Allford

INSPECTION: Approved (); Disapproved (); Not in _____ following provisions
of the Zoning Ordinance _____
BECAUSE _____
DATED _____
Enforcing Officer _____

PERMIT FOR OCCUPANCY: Approved (); Denied (); Not in conformity with the following
provision(s) of the Zoning Ordinance: _____
because _____

DATED _____
Enforcing Officer _____

TEMPORARY PERMIT: Approved (); Denied (); Not in conformity with the following
provision(s) of the Zoning Ordinance: _____
because _____

DATED _____
Enforcing Officer _____

REMARKS: _____

NSP

NORTHERN STATES POWER COMPANY

MINNEAPOLIS, MINNESOTA 55401

May 15, 1973

Mr John Nord, Chairman
Sherburne County Board of Commissioners
Elk River, Minnesota

5-18-73
Per Gary Anderson

Dear Sir:

This will confirm the understanding that Northern States Power Company will honor a billing from Sherburne County for the costs of blacktopping 1½ miles of County Road No. 67 which is located within Becker Township, Sherburne County, as indicated on the attached map.

In a previous conversation with Mr Russ Matchinsky, County Engineer, and Mr Lyle Smith, member of the Sherburne County Board of Commissioners, NSP had agreed to the blacktopping costs, and Sherburne County would absorb the grading, fill, and other work necessary to prepare the above described road for blacktopping.

We now understand that bids will soon be let by the County for the blacktopping of certain county roads, and the above described road is included in the bid letting.

Upon completion of the blacktopping of this road, please submit a statement to this office which describes the bid price and the total cost of this project.



M L ANDERSON, Manager
Real Estate Activities

CGA/pas

MAY 16 1973

Att.

Bcc: L J Crain
C J Tice

FILE COPY			
PLANT ENGINEERING & CONSTRUCTION DEPT.			
DATE	FILE		
GJT	RGL		
RJJ	JVS		
WVJ			
RAH	JMS		
RLH	TFG		
RIG	MJR		
MNR	PJS		
JEK	KRH		
GY	DTG		
RIF	GLI		
AMK	JJS		
JMN	JAN		
AEI	VJ		

PLS HANDLE RETURN TO 4511

PAS

Discussion than centered on an alternate route for hauling that would bypass Becker entirely. Mitchinsky indicated this was the only feasible route to the Plant site. He didn't feel any of the other roads would be able to handle this type of traffic, beside they are mostly gravel too, therefore, a dust problem would naturally occur.

The County has agreed to prepare a road base for the $1\frac{1}{2}$ miles on County Road 67 and the Engineer for Milnar Carling indicated they would do the same for those sections of 4 and 23 that are within the Village of Beckers corporate limits. This would make these areas feasible for travel. NSP

Our conclusion was that NSP, in its specifications to interested bidders on this project, state that, "the Contractor is required to put a bituminous mix on the roads in question for dust control purposes and to maintain the roads to the satisfaction of the governmental units involved for the length of time that hauling is required, and that upon completion of hauling, a bituminous surface be installed on the portion of roads which the County will so indicate in a letter to the Contractor".

We feel this will keep NSP out of the road building business and also leave the County with control of their roads and vehicular traffic over these roads.

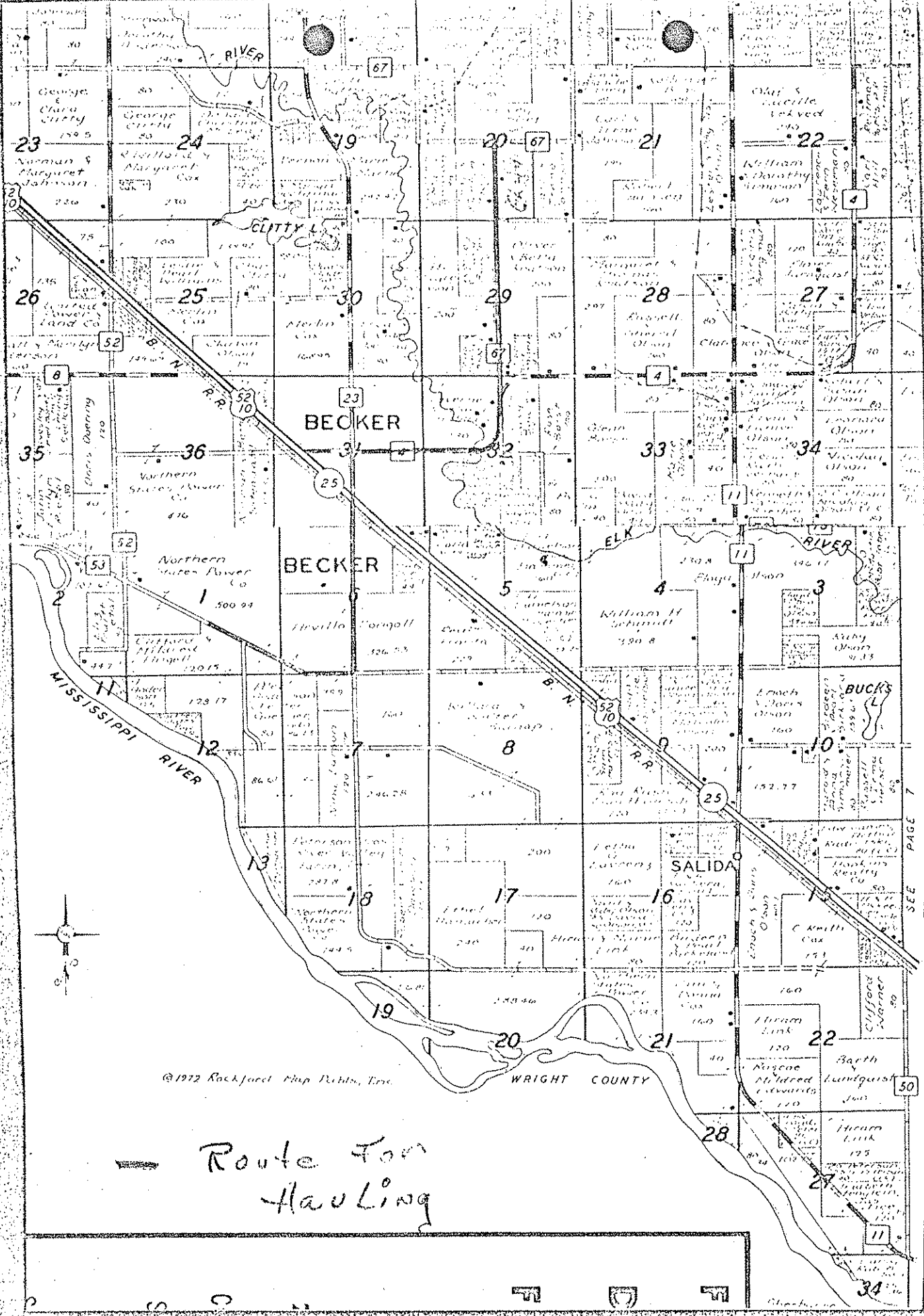
Clay Anderson

CCA/pas

May 17, 1973

Att.

Cc: E J Crain
C J Tice ✓



©1972 Rockwell Map Repts, Inc.

WRIGHT COUNTY

Route For Hauling

PAGE 7
SEE PAGE 7

sent notice Jan 31, 73

To D Ward King for N.S.P.

Your application for a permit to excavate for removal of clay

Erect (), Repair (), Extend (), Remove (), Move in (), Demolish ()

~~a structure~~ located at 20 1/2 of SE 1/4 Sec. 20 Twp. 34 Rng. 28

has been approved. Jan 18, 1973 Planning Commission
Jan 26, " " Court Board

Permit will be issued upon receipt of none dollars, building permit fee,

State Surcharge none Total Fee none.

Please make check or money order payable to Sherburne County Treasurer and mail to

Harvey L. Alfords

HARVEY L. ALFORDS
SHERBURNE CO. ZONING ADM.
COUNTY ADMINISTRATION BLDG.
ELK RIVER, MINN. 55330

Level Pit Operation // approved Jan 26, 73

APPLICATION FOR BUILDING PERMIT IN SHERBURNE COUNTY

Sherburne County Planning Advisory Commission
County Auditor's Office, Elk River, Minn.

PERMIT FOR USE (✓); FOR OCCUPANCY (); TEMPORARY PERMIT ().

Application No. _____ Date Oct. 18, 1972

APPLICATION is hereby made to: Use (); Erect (); Repair (); Move In ();
Extend (); Remove (✓); Demolish (); Occupy (); a structure located at Becker Twp.
W 1/2 of SE 1/4 Sec. 20, Twp. 34 Range 28,
at a cost of \$ _____ for the following use: Residence (); Commercial () or
other use () with accessory building ().

The description of the use for this property, for which this application is submitted is
as follows request to excavate for removal of clay.

A plot plan is attached (); is sketched on the back of this application (); and
floor plans are (); are not (); included.

The main structure will be as follows:

Construction _____ Front yard depth (in feet) _____
Height (stories & feet) _____ Side yard depth (in feet) _____
Number of family units _____ Rear yard depth (in feet) _____
Dimensions of lot 80 acres Depth means distance of structure from
Corner () or interior () lot.

The accessory buildings will be as follows:

Description _____ Distance from rear lot line _____
Height _____ Size _____ Distance from side yard line _____

I hereby certify that I am the owner or authorized agent of the owner of the above property
and that all construction will conform to existing state laws and local ordinances.

D. Ward King - N.S.P.

D. Ward King Signature N.S.P. St Cloud Address 252-1450 Phone Number

PERMIT FOR USE: Approved (✓); Denied (); Not in conformity with the following pro-
visions of the Zoning Ordinance: _____ Because _____

DATED: Jan 26, 1973 _____ Enforcing Officer

HARVEY L. CALFORD
SHERBURNE/CO. ZONING ADM.
COUNTY ADMINISTRATION BLDG.
ELK RIVER, MINN. 55330

INSPECTION: Approved (); Disapproved (); Not in conformity with the following provisions
of the Zoning Ordinance _____

BECAUSE _____
DATED _____ Enforcing Officer

PERMIT FOR OCCUPANCY: Approved (); Denied (); Not in conformity with the following
provision(s) of the Zoning Ordinance: _____

Because _____
DATED _____ Enforcing Officer

TEMPORARY PERMIT: Approved (); Denied (); Not in conformity with the following
provision(s) of the Zoning Ordinance: _____

Because _____
DATED _____ Enforcing Officer

REMARKS:

COPY

FILE COPY			
PLANT ENGINEERING & CONSTRUCTION DEPT.			
DATE	FILE		
CJT	AGE		AL
RJJ	JCS		TRD
WVJ			WSE
RAH	JCS		CLS
RLH	SHF		MR
RFS	SHR		7
WNB	JCS		7
JEK	JOB		SH
GY	DTB		DEL
JHF	NEL		CJR
AMR	JCS		MD
JMN	JAP		///
AEL	VJ		REH
PLS HANDLE		RETURN TO	
		POSTBOX	

MEMORANDUM

SHERBURNE COUNTY CLAY MINING
 Conditional Use Permit
 Sherburne County, Minnesota

JAN 23 1973

On Monday night, January 22, 1973, D Ward King and I met with the Becker Township Board and property owners concerned with our Conditional Use Permit Application, which is to excavate clay on the Hansen property, we have an option to purchase.

Upon conclusion of our presentation and answers to various questions from the Board and property owners, the Township passed a resolution favoring our application. This resolution will be forwarded to the Sherburne County Board of Commissioners.

Ward and I had previously met with the Sherburne County Planning Commission and they had recommended approval of our application, subject to concurrence by the Township; and on January 18, 1973, the Sherburne County Board of Commissioners had also recommended the Conditional Use Permit Application be granted, providing the Township concurred.

This completes all permit activity on this project, therefore, the option on the property may be exercised.



C G ANDERSON
 Staff Assistant

pas

January 23, 1973

- Cc: M L Anderson
 L J Grain
 C J Tice ✓
 G V Welk

BLACK & VEATCH
CONSULTING ENGINEERS

AREA CODE 816
TEL. 361-7000

1500 MEADOW LAKE PARKWAY
MAILING ADDRESS: P.O. BOX NO. 8405
KANSAS CITY, MISSOURI 64114

AIR MAIL

Northern States Power Company
Sherburne County Generating Plant
Unit No. 1 (E-6881)
Coal and Ash Storage Area Construction

B&V Project 5377
B&V File D-4C.2
July 31, 1974

Northern States Power Company
414 Nicollet Mall
Minneapolis, Minnesota 55401

87516
117100

c/o sent to JAL
8-5-74

Attention: Mr. J. R. Zylkowski

Gentlemen:

During a recent meeting at the site, P. A. Johnson and G. Y. Gunn reviewed the various field test data regarding density and moisture content of the fly and bottom ash pond embankments. It was apparent that the field densities were within the specified requirements; however, they were lower than the densities used in our previous analysis of the embankments.

We have re-analyzed the most critical embankment which is the east embankment. The most critical design conditions for this embankment occur when the fly ash pond is full of water and when construction of Phase II Ash Ponds is in progress. This condition may never occur.

The results of the recent analysis, using an in-place density of 120 pounds per cubic feet instead of 136 pounds per cubic feet, result in a reduction in safety factor of the embankment for the condition described above. We consider the safety factor adequate and see no need to re-analyze the remainder of the embankments.

Very truly yours,

BLACK & VEATCH

J. R. Belden

AUG 1 1974

J. R. Belden
Project Manager

JRB:nmq

cc: (2) Mr. J. R. Zylkowski

FILE COPY - PLANT ENGRG & CONST	
Project	File No
CJT	
FOSSIL	
INDUSTRIAL	
QA	
TECH	
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PLANT	
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PERMITS	
INSURANCE	
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OPER	
TRAINING	
SAFETY	
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ADMIN	
RECORDS	
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CHANGE ORDER

FORM 0334-3 (9-72)

JOB Sherburne County Generating Plant

DATE July 8, 1975

ORDER REF. C-87516

CHANGE ORDER NO. 10

W.O. NO. SLPH14MOOO ACCT. _____

LOCATION NO. _____

TO J.A. Danens & Son, Inc.

7175 Cahill Road

Minneapolis, MN 55435

In accordance with the terms and conditions of our contract dated July 26, 1973

we hereby authorize you to make the change in the work described below:

This change shall be made for the sum of \$ \$19,349.90

as per your proposal dated June 16, 1975

This change shall be billed at cost plus the percentage named in the contract.

This change shall be made for a credit of \$ _____

as per your proposal dated _____

FILE COPY - PLANT ENGRG & CONST	
Date _____	Project _____
F No _____	File No _____
CJT	
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NUCLEAR	
QA	
TECH SERV	
GEN SERV	
Pls Handle Comments	Return to <u>file</u>

Description of Change:

Furnish necessary labor, material and equipment to perform chemical injection grouting to seal the sheet piling interlocks in the recycle and holding pond areas as per your attached proposal dated June 16, 1975.

Please invoice as a separate item from the contract.

ACCEPTED FOR THE CONTRACTOR

BY D. J. Bruner

DATE 7/15/75

NORTHERN STATES POWER COMPANY

BY [Signature]

rr

cc: P E & C File
Plant Accounting
Cost/Sched. Section
Purchasing

J. A. DANENS & SON, Inc.

September 29, 1973

Page 2

Mr. James Sullivan

Norm Henning did not wish to make any comment until he has made an inspection of the borrow pit and observed the actual placing of the clay.

He will be at the job site 10:00 A.M. Wednesday, October 3, 1973 to study the problems with the clay. We would appreciate very much if you could also arrange to be on the job at this time so we could discuss this matter and hopefully come up with a solution.

Yours very truly,

J. A. DANENS & SON, INC.



C. J. Danens

CJD:m

BLACK & VEATCH
CONSULTING ENGINEERS

AREA CODE 816
TEL. 361-7000

1500 MEADOW LAKE PARKWAY
MAILING ADDRESS: P.O. BOX NO. 8405
KANSAS CITY, MISSOURI 64114

1529

Northern States Power Company
Sherburne County Generating Plant
Units No. 1 & 2 (E-6881 & E-7108)
Sealing of Coal, Ash and Water Storage Areas
PH11A600, PH12K700, PH12M300, PH14M000
ee ee ee

AUG 22 1972

August 18, 1972
B&V Project 5377/5619
B&V File D-4C.2

Mr. C. J. Tice, Manager
Plant Engineering and Construction
Northern States Power Company
414 Nicollet Mall
Minneapolis, Minnesota 55401

Attention: Mr. J. E. Kettner, Project Sponsor

Gentlemen:

FILE COPY			
PLANT ENGINEERING & CONSTRUCTION DEPT.			
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WVJ		LGS	
RAH	JMS	LCB	
RLH	FHF	WJM	
RFR	NJR		
MINB	PJS	PDC	
JEK	JCB	IMR	
GY	PTG	DEL	
RHF	NLU	CJR	
AMK	JFS	MTL	
JMN	JAN		
AEJ	VJ	REH	
PLS HANDLE		RETURN TO DESTROY	

1-100

A decision was made to use clay for sealing coal, ash, and water storage areas in the meeting held in Minneapolis on August 10, 1972. This decision was based on satisfactory findings of the following reports and memorandums:

Supporting Analysis II-K, Seepage Control For Ground Water Pollution Abatement

Clay Source Investigations, Phases I and II

B&V Intraoffice Memorandum dated July 20, 1972

A summary of recommendations regarding the use of clay follows:

Quantity of Clay Required

Recommended Clay Source

Schedule

Phase III - Soil Investigations for Design

Topographic Mapping

1. QUANTITY OF CLAY REQUIRED. The estimated amount of clay required for sealing purposes for Units No. 1 and No. 2 performed under Project Numbers 5377 and 5619 is 560,000 cubic yards. An additional 440,000 cubic yards of clay will be required at a later date to extend the bottom ash and fly ash and scrubber sludge storage areas for their service life. The selected clay source area would be required to provide at least 1,000,000 cubic yards of high quality clay.

2. RECOMMENDED CLAY SOURCE. It is recommended that the 80 acre tract of land owned by Mrs. Anna B. Hansen be purchased. The Hansen tract is located about 2 miles northeast of Becker and about 5.3 miles from the SHERCO site. The Hansen tract is legally described as the west 1/2 of the southeast 1/4 of Section 20, Range 28W, Township 34N of Sherburne County, state of Minnesota.

The 80 acre tract of land owned by Mrs. Anna B. Hansen offers the following advantages for use as the clay source:

- a. Eighty acres is a reasonable size tract to obtain the quantity of clay required.
- b. The tract contains sufficient clay for Units No. 1 and No. 2 sealing purposes.
- c. The clay is of sufficient quality for the intended use.
- d. The site affords dry excavating and good drainage conditions.
- e. The borrow area has a very small amount of woods to be cleared and grubbed.
- f. The tract is located on top of a hill offering reasonable grading potential.
- g. This plot offers the shortest haul distance to the site of about 5.3 miles.
- h. Only about 1 foot of topsoil overburden will have to be stockpiled to reach good quality clay.

A field reconnaissance inspection of the Hansen property verified the physical acceptability of the site. A bridge located about 3/4 miles east of Becker which would be used for clay haulage to the site was inspected and determined to be adequate for truck traffic hauling clay.

3. SCHEDULE. The first need for any appreciable quantity of clay would be for the 5377 D-4C Coal and Ash Storage Area Construction contract. The small amount of clay required in other contracts such as for sealing the fuel oil storage areas may be obtained by each involved contractor.

It has been determined that the initial development, excavating and hauling of clay from the Hansen tract should be included in Contract 5377 D-4C.

The bid date for Contract 5377 D-4C should be moved up to June 30, 1973 to allow adequate overlap with substructure contracts. The following schedule interfaces are proposed to allow effective prosecution of the work:

Acquisition of the 80 acre Hansen tract	November 14, 1972
Begin topographic mapping of Hansen tract	November 14, 1972

Mr. C. J. Tice, Manager
Northern States Power Company

3

August 18, 1972
Project 5377/5619

Begin soil investigations for design purposes	January 3, 1973
Begin preparation of construction drawings for Hansen tract	March 1, 1973
NSP review issue of Contract 5377 D-4C Package	May 24, 1973
Bid issue of Contract 5377 D-4C Package	June 29, 1973

4. TOPOGRAPHIC MAPPING. The required topographic mapping for the Hansen tract may be performed using either aerial or ground survey methods.

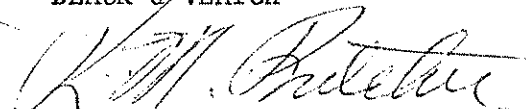
One NF size drawing delineated at a scale: 1" = 100' with a contour interval of one foot would be suitable. The drawings should be prepared with vertical control based on mean sea level, 1929 adjustment and horizontal control based on the Minnesota State Grid, south zone. Property corners should be located and referenced to appropriate section corners.

Upon receipt of this drawing, B&V will indicate the location of proposed soil borings.

5. PHASE III - SOIL INVESTIGATIONS FOR DESIGN. The additional soil borings and laboratory testing required for design would be performed by Twin City Testing and Engineering Laboratory, Inc. as an extension to the present Purchase Order SHERCO-1558. The scope of this work will be defined in accordance with the above proposed schedule.

Very truly yours,

BLACK & VEATCH



R. M. Butcher, Project Manager

RMB:mvw

cc: Mr. C. J. Tice ✓
Att: Mr. J. E. Kettner

BLACK & VEATCH
CONSULTING ENGINEERS

AREA CODE 816
TEL. 361-7000

1528

1500 MEADOW LAKE PARKWAY
MAILING ADDRESS: P.O. BOX NO. 8405
KANSAS CITY, MISSOURI 64114

AIR MAIL

Northern States Power Company
Sherburne County Generating Plant
Unit No. 1 (E-6881)
Coal and Ash Storage Area Construction

B&V Project 5377
B&V File D-4C.2
July 31, 1974

Northern States Power Company
414 Nicollet Mall
Minneapolis, Minnesota 55401

E 82516
11A100

c/o sent to JAS
8.5.74.

Attention: Mr. J. R. Zylkowski

Gentlemen:

During a recent meeting at the site, P. A. Johnson and G. Y. Gunn reviewed the various field test data regarding density and moisture content of the fly and bottom ash pond embankments. It was apparent that the field densities were within the specified requirements; however, they were lower than the densities used in our previous analysis of the embankments.

We have re-analyzed the most critical embankment which is the east embankment. The most critical design conditions for this embankment occur when the fly ash pond is full of water and when construction of Phase II Ash Ponds is in progress. This condition may never occur.

The results of the recent analysis, using an in-place density of 120 pounds per cubic feet instead of 136 pounds per cubic feet, result in a reduction in safety factor of the embankment for the condition described above. We consider the safety factor adequate and see no need to re-analyze the remainder of the embankments.

Very truly yours,

BLACK & VEATCH

J. R. Belden

AUG 1 1974

J. R. Belden
Project Manager

JRB:nmq

cc: (2) Mr. J. R. Zylkowski

FILE COPY - PLANT ENGRG & CONST	
Project	File No
CJT	
FOUR	
GA	
GEN	
REN	
PJS	
KRA	
Please Hand In _____ Return To _____	
Comments _____	

BLACK & VEATCH
CONSULTING ENGINEERS

ARIA CODE B16
TEL 361-7000

J.R. Zylowski

1500 MEADOW LAKE PARKWAY
MAILING ADDRESS P.O. BOX NO. 8405
KANSAS CITY, MISSOURI 64114

AIR MAIL

JUL 31 1974

Northern States Power Company
Sherburne County Generating Plant
Unit No. 1 (E-6881)
Coal and Ash Storage Area Construction

HA 100
CF# 87316

B&V Project 5377
B&V File D-4C.2
July 30, 1974

1528

FILE COPY - PLANT ENGRG & CONST		Date	Project
E No	File No		
CJT			
FOSSIL	RAB		
NUCLEAR	FJJ		
GA	WVJ		
TECH SERV			
GEN SERV			
		REN	PJS
		FIG	KRA
Pls Handle		Return To	
Comments			

Northern States Power Company
Sherburne County Generating Plant
P. O. Box 68
Becker, Minnesota 55308

Attention: Mr. J. A. Smith

Gentlemen:

We were requested to again review the moisture-density criterion set forth in the Specification 5377 D-4C for construction of the ash pond embankment fill by your personnel during a conference on July 9, 1974. The specifications require the embankment fill to be constructed of SM, SP, or SW material compacted to 95 percent of maximum density at optimum moisture content and at a moisture content within plus or minus 2 percent of optimum.

Our telephone memorandum of October 13, 1973 modified the moisture requirements of the granular embankment material. The required moisture content was established as a range from 5 percent below optimum moisture to 2 percent above optimum.

A review of all field control test data indicates that the specified compaction of the granular embankment has been achieved. However, in many instances the moisture content was less than specified in the original specification, and also less than the moisture content given in our telephone memorandum of October 13, 1973.

In general, the field moisture density tests indicate field moisture content of 3.1 percent or greater. A small number of tests indicate a field moisture content of 2 to 3 percent. In all cases the specified compaction was obtained.

The optimum moisture content of the granular material used in the embankments generally ranges from 9.6 percent to 13.0 percent. One type of granular material encountered which has gravel in it has an optimum moisture content of 6.7 percent.

C
O
P
Y

Northern States Power Company
Att'n: Mr. J. A. Smith

-2-

B&V Project 5377
July 30, 1974

Therefore, the required minimum moisture content as set forth in our telephone memorandum would be 4.6 percent to 8.0 percent for the majority of the granular materials found on-site.

The specified compaction is being achieved at moisture content less than specified. Thus we believe that field moisture requirements can be modified as follows for the granular embankment fills.

1. Minimum moisture content of 3 percent with a preferred moisture content of 4 percent.
2. Density requirements are to remain at 95 percent of optimum density as a minimum.
3. Compactive effort to remain essentially unchanged.
4. The material which was placed at moisture content of 2 to 3 percent does not need to be removed since it would be impractical at this time. Also the amount of material placed with the low moisture content is apparently small as indicated by field test data. Moisture content for all future work should be as given in Paragraph 1 above.

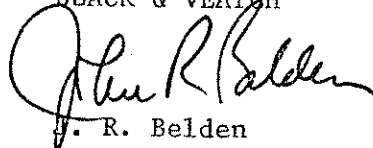
We have received the "Report on Additional Strength Tests of Impervious Clay Sand, Coal and Ash Storage Areas" prepared by Twin City Testing and Engineering Laboratory, Inc. at your request. The report concludes that compaction of the impervious clayey material to a minimum density of 90 percent of optimum density at moisture content ranging from 0 to 6 percent above optimum will produce a material having a minimum cohesive strength of 1000 pounds per square foot, which will meet the design requirements. Therefore, the moisture density requirements for the impervious clay cores and embankments may be modified as given in the above paragraph.

It should be recognized that modification of the moisture-density relationships as outlined in this letter results in a benefit to the Contractor since less equipment and effort are required for the criteria set forth in the bid documents.

This letter establishes the moisture-density relationships which we recommended be followed for the remainder of the project. If you have any questions in this regard please let us know.

Very truly yours,

BLACK & VEATCH


J. R. Belden

JRB:mpb
3cc: Mr. J. R. Zylkowski

BLACK & VEATCH
CONSULTING ENGINEERS

AREA CODE 816
TEL 361-7000

1500 MEADOW LAKE PARKWAY
MAILING ADDRESS: P.O. BOX NO. 8495
KANSAS CITY, MISSOURI 64114

AIR MAIL

MAY 15 1974

Northern States Power Company
Sherburne County Generating Plant
Unit No. 1 (E-6881)
Coal and Ash Storage Area Construction
PH12M100

B&V Project 5377

FILE COPY - PLANT ENGRG & CONST
Project B&V File D-4C.2

Date _____ Project _____
E No _____ File No May 14, 1974

CJT									
FOSSIL	RAH								
NUCLEAR	RJJ								
QA	WVJ								
TECH SERV	PHK								
GEN SERV	RET	REN	PM	PIS	AKA				

Pls Handle _____ Return to _____
Comments _____

1528
PAT CE

Northern States Power Company
P. O. Box 68
Becker, Minnesota 55308

Attention: Mr. J. A. Smith

Gentlemen:

We have reviewed the moisture-density requirements for the clay material (type CL) used in the core and impervious blanket for the fly ash and bottom ash ponds, as you requested during our meeting of May 2, 1974 at the plant site.

Specification 5377 D-4C, as modified by Addendum No. 1, requires the clay core and impervious earth blanket to be compacted to 93 percent of maximum density at optimum moisture content. The specification further states that during compaction of the clay core and the impervious earth blanket, the moisture content shall be within a range of 0 to 3 percent above optimum.

During the month of October 1973, NSP advised that the material for the clay core had a very high moisture content as had been indicated by the previous tests and requested a review of the criteria for compacting this material in order that construction might continue into the fall. At that time B&V advised that there were two alternative solutions.

1. The type CL material for the clay core could be compacted to 88 percent of maximum density with a moisture content of 0 to 6 percent above optimum. Compaction at 88 percent of maximum density would have the following undesirable characteristics:
 - a. Increased long-term settlement of the ash pond dikes of 3 to 6 inches.
 - b. Compaction at 88 percent of maximum density at the location of the 36-inch discharge pipes beneath the dikes would be unacceptable.
 - c. The elevation of the fly ash pond and bottom ash pond dikes and all interior portions including the clay core should be raised 6 inches above the elevation shown on the drawings, and the top width of the dikes and the slopes of the dikes retained as shown on the drawings.

Northern States Power Company
Mr. J. A. Smith

-2-

B&V Project 5377
May 14, 1974

2. Construction of the clay core for the ash pond dikes could be stopped for the construction season, then begun in late spring of 1974 when the weather would allow the type CL material to be dried by discing and working such that the material could be placed at the specified 93 percent of maximum density and within 0 to 3 percent of optimum moisture.

The contractor continued construction as outlined under Item 1.

The selection of the compaction values of 88 percent of maximum density and moisture contents of 0 to 6 percent above optimum were based upon estimates that the cohesive strength of type CL material compacted at 88 percent of maximum density and 0 to 6 percent above optimum moisture content was 2,000 psf. The required design cohesive strength is 1,000 lbs. per square foot.

Report No. 4, entitled "INSPECTION AND TESTING DURING EARTH WORK OPERATIONS COAL AND ASH STORAGE" dated December 3, 1973 indicates cohesive strengths of approximately 760 lbs. per square foot. Test results for the coefficient of permeability indicate values ranging from 2.27×10^{-10} to 5.5×10^{-9} centimeters per second at 20° centigrade.

In view of the low cohesive strengths obtained at 88 percent of maximum density, we believe it advisable to compact the clay core and impervious earth blanket material as originally specified. The specified requirements are 93 percent of maximum density with a moisture content of 0 to 3 percent above optimum.

It will not be necessary to re-compact any material already in place. The permeability tests given in Report No. 4 indicate permeabilities greater than 1×10^{-8} centimeters per second, which will be satisfactory.

If you have any further questions regarding the compaction criteria, please advise.

Very truly yours,

BLACK & VEATCH


J. R. Belden
Project Manager

JRB:nmq

cc: (3) Mr. J. R. Zylkowski ✓

INTERNAL CORRESPONDENCE

FORM 17-3467

T. A. Johnson
DATE September 25, 1975

FROM Mr. P. A. Johnson

LOCATION

1 Mr. J. A. Smith, Project Manager

LOCATION

SUBJECT SHERBURNE COUNTY GENERATING PLANT E-6881
NCN-10-C87516 DIN 984820, 12K720, 12M300

This memorandum is to respond to NCN 10-C87516, which reported a discrepancy in the construction of work under Specification 5377 D-4C Coal and Ash Storage Area Construction as follows:

Of the 2201 soils tests reported as of November 15, 1974, 162 have reported moisture contents not as required by specification.

The NCN lists in a 12 page tabulation the tests having the discrepancies. The objectives of this memorandum are:

1. To review the contract specifications
2. To review the design criteria
3. To summarize the construction problems and specification changes
4. To evaluate the acceptability of the tests.

Contract Specifications

The contract specifications call for classification of clay material for various lining purposes. The classifications were:

Clay Core	CL
Impervious Earth Blanket	
Type 1	CL
Type 2	CL, SC
Type 3	SC
Type 4	SC, SC-SM, CL-SC

The designated use of the classified materials is described in the specifications and drawings.

Once classified, the materials were to be compacted to 93 percent of maximum density with a moisture content at 0-3 percent above optimum.

Design Criteria

The embankment and liner design was made using assumed soil properties that were estimated by Twin City Testing. The design method, loading conditions, and assumed

soil properties are documented in B&V Supporting Analysis 11-M. This analysis was reviewed by NSP Engineering. It was also given a second level review by Dames and Moore. The above reviews approved the design, and suggested some changes, and additional laboratory testing.

The clay soil properties used in the design were:

Cohesive Strength	500 psf
Density	124 pcf
Friction Angle	0 degrees
Permeability	10^{-7} cm/sec

Prior to construction, laboratory tests were run on the borrow pit materials and the above properties were judged as conservative. Construction specification D-4C was written based on the above engineering.

Construction Problems and Specification Changes

Construction under the D-4C package began in July 1973. The specification called for completion by November 1974. During the fall of 1973, the contractor began to have trouble meeting the clay compaction specifications. The materials in the pit were wet and his drying methods were inadequate. The pit materials also were not as homogeneous as expected. We also realized at this time that we probably would not have enough materials for the job and that we would have similar wet conditions and compaction problems in the spring of 1974.

To keep the job going, we decided to relax the compaction requirements for work done during the fall. This was done on the basis of strength and consolidation tests reported in a B&V telephone memo dated October 10, 1973. Later the tests were documented in Twin City Testing Report No. 4. The relaxed specification of October 4, 1974, called for clay compaction to 88 percent density at 0-6 percent moisture above optimum. To compensate for the projected increased consolidation (due to less compaction), the contractor agreed to raise all embankments by six inches. The work continued on this basis until freeze up.

Work started in the spring of 1974 in late April with the first clay coming to the job in mid-May. The job specification for clay compaction was 88 percent density at 0-6 percent over optimum. Since some question existed about the extension of the relaxed specification into 1974, we asked B&V to review and clarify the matter. In their letter of May 14, 1974, they advised us to return to the contract specification. We did this and it proved unworkable by the end of May. Because of the problem, we held a meeting to discuss alternative actions. At the meeting we concluded:

1. The contractor should increase his drying efforts
2. We should do additional testing to evaluate the compaction requirements.

As a result of our testing, B&V modified the specification on July 30, 1974 to 90 percent density at 0-6 percent moisture above optimum. The job was completed on

this basis. The six percent moisture requirement proved to be a field attainable moisture.

As the work proceeded, some samples were accepted where the density was met at moisture in the six to seven percent range. These were accepted on the basis of field judgment. Another meeting was held to review the above decisions. It was concluded that testing could provide differences up to .5 percent in moisture, so we would accept 6.5 percent moisture provided the density was met and most importantly provided the layer was stable so the next layer could be compacted. At 6.5-7 percent we decided to reject the materials, except we would accept an occasional 6.5-7 percent test. The NCN concerns the above approvals.

Evaluation

To evaluate the engineering acceptability of the approvals, I have compared the design basis soil properties with the field obtained soil properties. I also have made some stability calculations to verify the safety factors.

The results of the parameter comparisons are as follows:

<u>Soil Property</u>	<u>Design Basis</u>	<u>Laboratory Test</u>
Density	124 pcf	110 pcf
Cohesion	500 psf	1,000 psf
Friction	0 degrees	0 degrees
Permeability	10^{-7} cm/sec	10^{-7} cm/sec

For information a graph showing soil strength as a function of density is attached. The molding moisture is also noted for individual tests.

Reviewing the above comparison, the reduced density of the clay will produce an increase in the factor of safety (stability), so reduced density is acceptable. (B&V considered the reduction of density in the embankment from 136 pcf to 120 pcf and approved the factor of safety in their letter of July 31, 1974. My consideration concerns only the core soil.) The cohesive strength is higher than the design basis, so it would also increase the factor of safety. Finally, the permeability is equal to the design requirement, so it too is okay. Thus on the basis of this comparison, the field construction is compatible with the design.

To verify the safety of the embankments, stability calculations were made using the soil properties obtained in our laboratory testing program. Based on the "sliding wedge" method of analysis, the minimum factor of safety is about 1.6. This would be considered marginal, so the embankment was analyzed using a modified "Swedish Circle Method." Based on this analysis, the minimum factor of safety is 2.3 which is conservative. Thus, the construction is compatible with the design.

Mr. J. A. Smith
September 25, 1975
Page 4

It is my opinion that the constructed dams have adequate safety factors, and that the field construction is in compliance with the design criteria. I therefore recommend that the 162 tests identified in the NCN be accepted.

PA Johnson PE

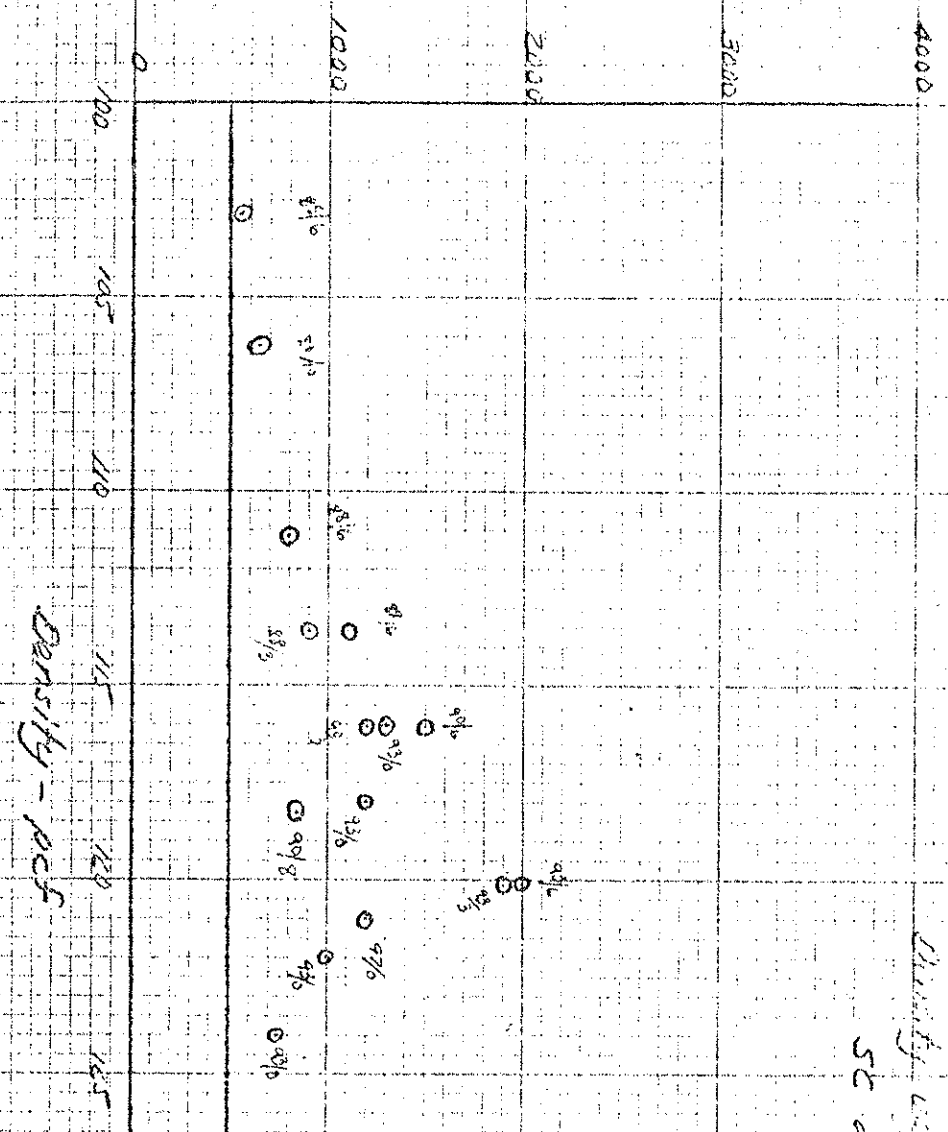
P. A. Johnson, P. E.
Supervising Civil Engineer

PAJ/rmd

cc: J. R. Zylkowski

J. C. Meier

Shear Strength - psf



Density - pcf

500 psf (Design Basis)

Note: 2 1/2% = % density / 10 moisture above opt.

Stearns County Gen. Plant E 6881
 ST and CL Sails
 Density vs. Shear Strength Test Results For

PAD 7-31-75

FORM 0330-37

NONCONFORMITY NOTICE

Project <u>Sherburne County Generating Plant</u>	E. <u>6881</u>	DIN. No. <u>SLPH97D040</u>
System <u>Coal and Ash Storage Areas</u>	Part <u>N/A</u>	
Spec. <u>5377 - D-4C</u>	Dwg. No. <u>49064 to 49107</u>	
Bldg. <u>N/A</u>	Elev. <u>See attached summary sheets</u>	
Supplier <u>RSP</u>	P. O. <u>C-87516</u>	
Contractor <u>J. A. Danens and Sons, Inc.</u>	Originator <u>W.F. Mahoney</u>	Date <u>6/2/75</u>

Discrepancy

The 2201 soils tests reported as of November 15, 1974, were reviewed; and 14 densities were found to be less than the specified value. The 14 tests are tabulated on the attached 2 summary sheets and 2 sketches.

Disposition

Recommend acceptance of tested areas "as reported" based on the following:

1. Failing tests are mostly in single lifts and are not cumulative; therefore, it is felt there are only small interrupted lenses of low density embankments.
2. Few compaction values vary as much as 3.8% below required minimum density.
3. Because of elevation, it is not feasible to rework those areas with low test values.

Cause

Corrective Action

Q. A. Concurrence

Construction Concurrence

David V. Collins Date 7-7-75

W.F. Mahoney Date 7-7-75

TRB Instructions

The TRB accepts this nonconformance based on review of reported data, and agrees with the disposition stated above.

TRB Approval Engr. *J.R. Zylinski* 7/11/75 QA *W.F. Mahoney* 7-18-75 Const. *R.A. Smith* 7-18-75

Final Buy Off (Site)

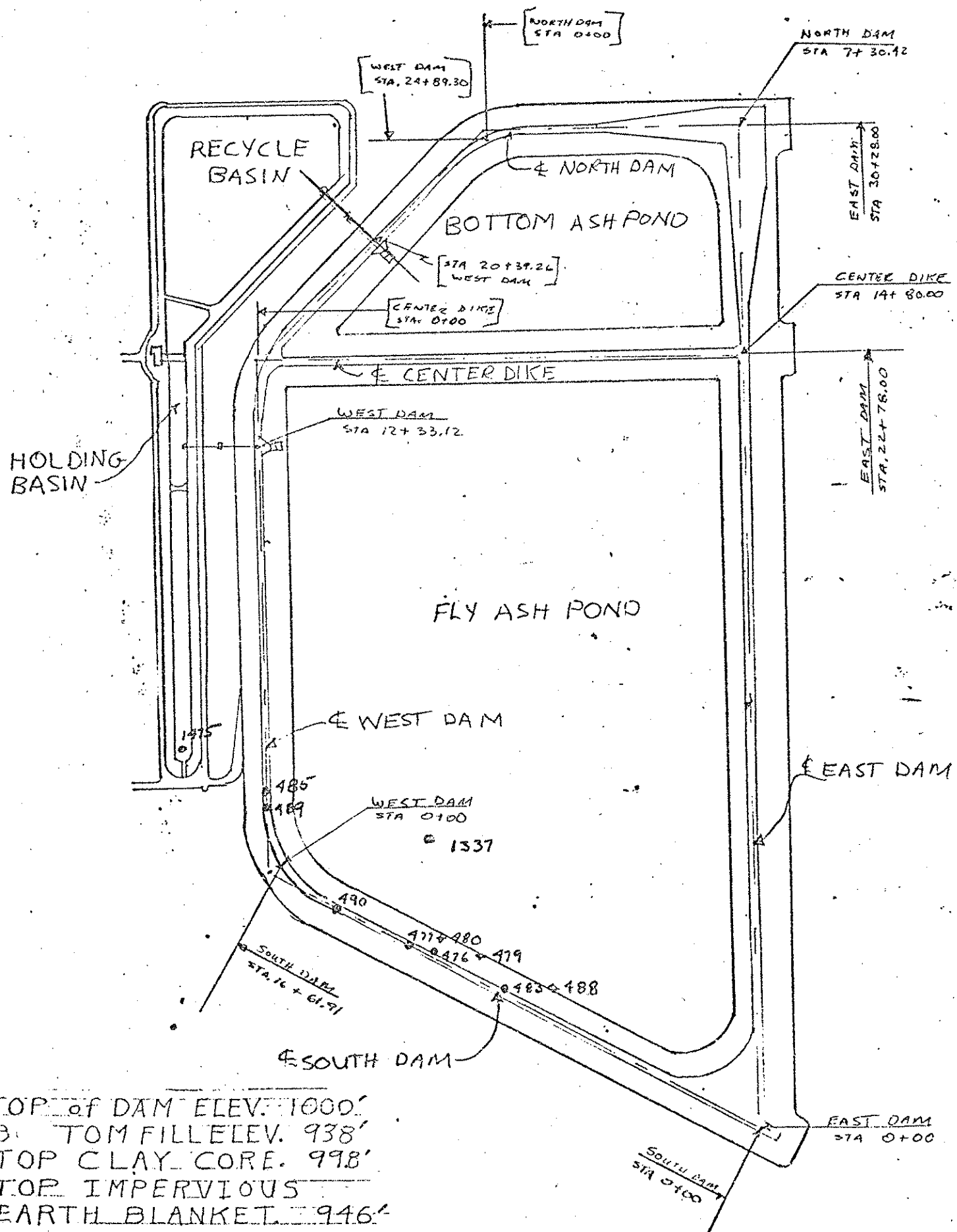
QA Acceptance *David V. Collins* 7/14/75 Const. Acceptance *W.F. Mahoney*

SUMMARY OF FAILING DENSITY T. BY PERCENT OF COMPACTION


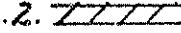
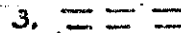
TEST NUMBER	T.C.T. REPORT NUMBER	COMPACTION RESULTS		SOIL TYPE	LOCATION	ELEVATION	DATE TAKEN	RETEST NUMBER
		ACTUAL	REQUIRED					
374	9	92	95	Sand	Coal yard, grid F $\frac{1}{2}$ -2 $\frac{1}{2}$	966.5'	12/5/73	375
375	9	93	95	Sand	Coal yard, grid F $\frac{1}{2}$ -2 $\frac{1}{2}$	966.5'	12/5/73	459
459	11	93	95	Sand	Coal yard, grid F $\frac{1}{2}$ -2 $\frac{1}{2}$	966.5'	5/15/74	479
476	11	91	93	Clayey sand	Fly ash pond, 75' NE of S dam, Sta 11+50	945'	5/20/74	480
477	11	90	93	Clayey sand	Fly ash pond, S dam, Sta. 12+00	950'	5/20/74	-
479	11	91	93	Clayey sand	Fly ash pond, 75' NE of S dam, Sta 11+50	945'	5/20/74	-
480	11	90	93	Clayey sand	Fly ash pond, S dam, Sta 12+00	950'	5/20/74	-
483	11	90	93	Clayey sand	Fly ash pond, 65' NE of S dam, Sta 10+00	943'	5/20/74	-
485	11	91	93	Clayey sand	Fly ash pond, W dam, Sta 2+50	965'	5/20/74	489
488	11	91.5	93	Clayey sand	Fly ash pond, 15' NE of S dam, Sta 10+00	944'	5/21/74	-
489	11	91.5	93	Clayey sand	Fly ash pond, W dam, Sta. 2+50	965'	5/21/74	-
490	11	91.5	93	Clayey sand	Fly ash pond, S dam, Sta 14+75	962'	5/21/74	-
1337	14	88	90	Clayey sand	Fly ash pond, grid 863950N-2028250E	945'	8/26/74	-

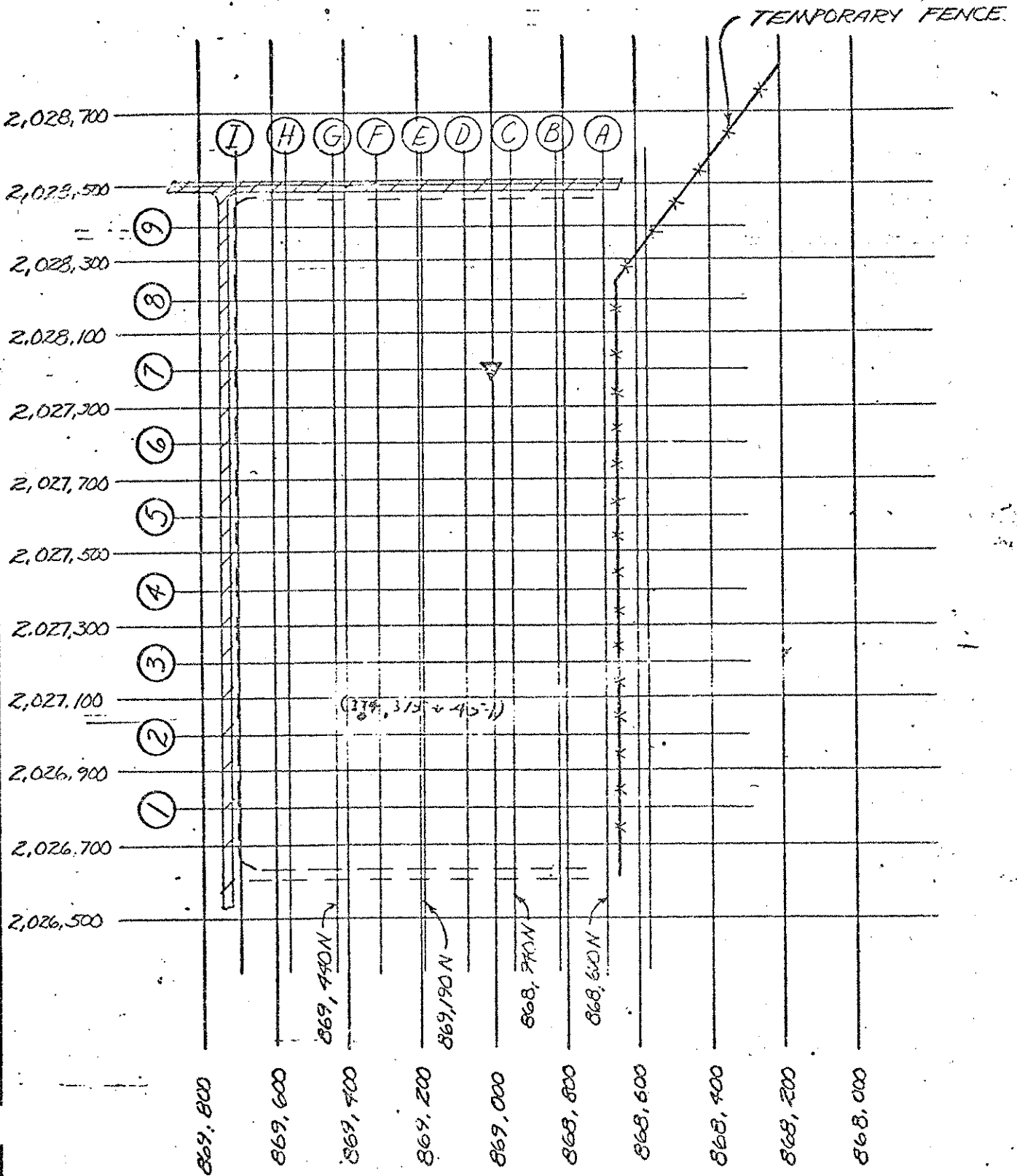
SUMMARY OF FAILING DENSITY LIMIT BY PERCENT OF COMPACTION

TEST NUMBER	T.C.T. REPORT NUMBER.	COMPACTION RESULTS		SOIL TYPE	LOCATION	ELEVATION	DATE TAKEN	RETEST NUMBER
		ACTUAL	REQUIRED					
1475	15	88	95	Sand	Holding basin, grid 864300N-2027205E	945	10/6/74	



• Red dot - low compaction in clay core or impervious blanket.

- NOTE:
1.  INDICATES MONUMENT (ELEV. 968.99)
 2.  " COAL YARD ROAD
 3.  " DITCH



• PURPLE DOT FOR LOW COMPACTION IN IMPERVIOUS BLANKET.

BLACK & VEATCH
CONSULTING ENGINEERS

AREA CODE 816
TEL. 361-7000

1500 MEADOW LAKE PARKWAY
MAILING ADDRESS: P.O. BOX NO. 8405
KANSAS CITY, MISSOURI 64114

1558

Northern States Power Company
Sherburne County Generating Plant
Units No. 1 & 2 (E-6881 & E-7108)
Ground Water Seepage Control
PH11A600 PH12K700 PH12M300 PH14M000

December 29, 1971
B&V Project 5377/5619
B&V File S-34:Z

Mr. C. J. Tice, Manager
Plant Engineering and Construction
Northern States Power Company
414 Nicollet Mall
Minneapolis, Minnesota 55401

Attention: Mr. J. E. Kettner, Project Sponsor

Gentlemen:

We are proceeding with an investigation to determine the availability and cost of clay within a feasible hauling distance of the site in accordance with Memorandum No. 205 dated December 22, 1971.

Phase I of the investigation is essentially complete. A literature search of the following sources of information is essentially complete:

USDA Soil Surveys for Wright and Sherburne Counties
Geological Survey (Federal and State)
State Highway Department
Water Well Reports

Phase II of the investigation, which includes contact with the following local sources, has been initiated:

USDA local offices
State Highway Department
Sherburne County Highway Department
Wright County Highway Department
University of Minnesota
Local well drilling firms
Local soil consulting firms
Heavy construction contractors
Clay product manufacturing firms

Mr. C. J. Tice
Attention: Mr. J. E. Kettner

2

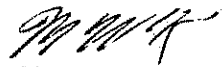
December 29, 1971

Please advise if you have any suggestions or comments. As a part of this Phase II we plan to have personnel in the area in the very near future.

We expect to submit a preliminary report covering Phase I and II of the subject investigation in early February 1972.

Very truly yours,

BLACK & VEATCH



M. W. Kaufman

MWK:lkj

cc: Mr. C. J. Tice ✓
Attention: Mr. J. E. Kettner