# 2314 - Silver Lake Dam Improvements

## Application Details

**Funding Opportunity:** 1307-Outdoor Heritage Fund March 2020 - Round 16

**Funding Opportunity Due Date:** Mar 16, 2020 3:00 PM

**Program Area:** Outdoor Heritage Fund

**Status:** Under Review

**Stage:** Final Application

**Initial Submit Date:** Mar 13, 2020 2:27 PM

**Initially Submitted By:** Benjamin Kugler

**Last Submit Date:** Mar 16, 2020 8:27 AM

**Last Submitted By:** Benjamin Kugler

## Contact Information

### Primary Contact Information

**Active User*:** Yes

**Type:** External User

**Name*:** Mr. Benjamin P Kugler
Salutation / First Name / Middle Name / Last Name

**Title:** Project Engineer

**Email*:** benjamin.kugler@mooreengineeringinc.com

**Address*:** 444 Sheyenne Street
Suite 301

West Fargo North Dakota
City State/Province

58078
Postal Code/Zip

**Phone*:** (701) 551-1073 Ext.
Phone
###-###-####

**Fax:** (701) 282-4530
###-###-####

### Organization Information

**Status*:** Approved

**Name*:** Sargent County Water Resource District

**Organization Type*:** County Government

**Tax Id:**

**Organization Website:** http://www.sargentnd.com/dept_water.php

**Address*:** 355 Main St S Ste 1

Forman North Dakota
City State/Province

58032
Postal Code/Zip

**Phone*:** 701-724-6241 Ext.
###-###-####

**Fax:** ###-###-####

REVISED BUDGET

Budget

***Objective of Grant***

- Objective of Grant

The objective of the grant is to perform remedial work to the embankment of the Silver Lake dam in order to conserve the existing recreational and natural resources. The project is a joint effort between the Sargent County WRD and the Sargent County Park District (the "Project Sponsors")

***Summary***

- Grant Request$41,577.00

Matching Funds$231,423.00

Total Project Costs$273,000.00

**You must have at least 25% match**

Percentage of Match84.77%

***Project Expenses***

| Project Expense Description | OHF Request | Match Share (Cash) | Match Share (In-Kind) | Match Share (Indirect) | Other Project Sponsor's Share | Total Each Project Expense |
|---|---|---|---|---|---|---|
| Total Construction | $40,255.95 | $36,422.05 | $0.00 | $0.00 | $115,017.00 | $191,695.00 |
| Engineering - Design | $440.35 | $7,159.65 | $0.00 | $0.00 | $11,400.00 | $19,000.00 |
| Engineering - Construction | $440.35 | $7,159.65 | $0.00 | $0.00 | $11,400.00 | $19,000.00 |
| Engineering - Geotech | $440.35 | $3,559.65 | $0.00 | $0.00 | $6,000.00 | $10,000.00 |
| Contingencies | $0.00 | $7,522.00 | $0.00 | $0.00 | $11,283.00 | $18,805.00 |
| Permitting | $0.00 | $3,000.00 | $0.00 | $0.00 | $4,500.00 | $7,500.00 |
| Cultural Clearance - Class III | $0.00 | $1,400.00 | $0.00 | $0.00 | $2,100.00 | $3,500.00 |
| Legal Fees | $0.00 | $2,000.00 | $0.00 | $0.00 | $0.00 | $2,000.00 |
| Administrative Fees | $0.00 | $500.00 | $0.00 | $0.00 | $0.00 | $500.00 |

| Project Expense Description | OHF Request | Match Share (Cash) | Match Share (In-Kind) | Match Share (Indirect) | Other Project Sponsor's Share | Total Each Project Expense |
|---|---|---|---|---|---|---|
| Right-of-way - Land Acquisition | $0.00 | $1,000.00 | $0.00 | $0.00 | $0.00 | $1,000.00 |
| | $41,577.00 | $69,723.00 | $0.00 | $0.00 | $161,700.00 | $273,000.00 |

### *Budget Narrative*

- Budget Narrative

Preliminary engineering feasibility study was supported by $99,500 in funding from the Project Sponsors (Sargent County WRD, Sargent County Park District). The NDSWC has approved cost share for 60% of project expenses

### *Bid Attachments*

| Description | File Name | Type | Size | Upload Date |
|---|---|---|---|---|
| Letter from Sargent County WRD | 16-10 letter.pdf | pdf | 409 KB | 05/20/2020 08:44 AM |
| Revised Opinion of Probable cost with 60% NDSWC funding, $41,577 OHF funding, 25% Local Funding | 20438 - Engineer Opinion of Probable Cost_20200520.pdf | pdf | 79 KB | 05/21/2020 10:15 AM |

### *Match Funding*

| Match Amount | Funding Source | Match Type |
|---|---|---|
| $161,700.00 | North Dakota State Water Commission | Cash |
| $69,723.00 | Sargent County Water Resource District / Sargent County Park District | Cash |
| $231,423.00 | | |

### *In-Kind*

- In-Kind Total$0.00

**Comments:**

PRIOR BUDGET

# Budget

### *Objective of Grant*

**Objective of Grant:**

The objective of the grant is to perform remedial work to the embankment of the Silver Lake dam in order to conserve the existing recreational and natural resources. The project is a joint effort between the Sargent County WRD and the Sargent County Park District (the "Project Sponsors")

### *Summary*

**Grant Request:** $95,550.00

**Matching Funds:** $177,450.00

**Total Project Costs:** $273,000.00

**You must have at least 25% match**

**Percentage of Match:** 65.0%

### *Project Expenses*

| Project Expense Description | OHF Request | Match Share (Cash) | Match Share (In-Kind) | Match Share (Indirect) | Other Project Sponsor's Share | Total Each Project Expense |
|---|---|---|---|---|---|---|
| | **$95,550.00** | **$69,650.00** | **$0.00** | **$0.00** | **$107,800.00** | **$273,000.00** |

| Project Expense Description | OHF Request | Match Share (Cash) | Match Share (In-Kind) | Match Share (Indirect) | Other Project Sponsor's Share | Total Each Project Expense |
|---|---|---|---|---|---|---|
| Total Construction | $67,093.25 | $47,923.75 | $0.00 | $0.00 | $76,678.00 | $191,695.00 |
| Engineering - Design | $6,650.00 | $4,750.00 | $0.00 | $0.00 | $7,600.00 | $19,000.00 |
| Engineering - Construction | $6,650.00 | $4,750.00 | $0.00 | $0.00 | $7,600.00 | $19,000.00 |
| Engineering - Geotech | $3,500.00 | $2,500.00 | $0.00 | $0.00 | $4,000.00 | $10,000.00 |
| Contingencies | $6,581.75 | $4,701.25 | $0.00 | $0.00 | $7,522.00 | $18,805.00 |
| Permitting | $2,625.00 | $1,875.00 | $0.00 | $0.00 | $3,000.00 | $7,500.00 |
| Cultural Clearance - Class III | $1,225.00 | $875.00 | $0.00 | $0.00 | $1,400.00 | $3,500.00 |
| Legal Fees | $700.00 | $1,300.00 | $0.00 | $0.00 | $0.00 | $2,000.00 |
| Administrative Fees | $175.00 | $325.00 | $0.00 | $0.00 | $0.00 | $500.00 |
| Right-of-way - Land Acquisition | $350.00 | $650.00 | $0.00 | $0.00 | $0.00 | $1,000.00 |
| | **$95,550.00** | **$69,650.00** | **$0.00** | **$0.00** | **$107,800.00** | **$273,000.00** |

### *Budget Narrative*

**Budget Narrative:**

Preliminary engineering feasibility study was supported by $99,500 in funding from the Project Sponsors (Sargent County WRD, Sargent County Park District). The NDSWC has approved cost share for 40% of project expenses

### *Bid Attachments*

| Description | File Name | Type | Size | Upload Date |
|---|---|---|---|---|
| | No files attached. | | | |

### *Match Funding*

| Match Amount | Funding Source | Match Type |
|---|---|---|
| $0.00 | | |
| $107,800.00 | North Dakota State Water Commission | Cash |
| $69,650.00 | Sargent County Water Resource District / Sargent County Park District | Cash |
| **$177,450.00** | | |

### *In-Kind*

**In-Kind Total:** $0.00

## Description

### Directives

**Major Directive*:** Directive A
Choose One

**Additional Directive:** Directive A,Directive C,Directive D
Choose All That Apply

**Type of Agency*:** Political Subdivision
Choose One

### Abstract/Executive Summary

**Abstract/Executive Summary*:**

Silver Lake Dam, located on the Wild Rice River in Rutland Township of Sargent County, is owned by the Sargent County Park District. The dam was originally built in 1937 and permitted by the North Dakota State Water Commission under Water Permits No. 03544 and 05109. The dam has a storage volume of 1,600 ac-ft. at max pool elevation. Since it was constructed, the dam has served as a source of public recreation and flood protection for properties along the Wild Rice River. Silver Lake is the only public camping park owned by Sargent County that provides multiple recreation opportunities including fishing with five fishing piers, two boat landings, and a fish cleaning station, two swimming beaches, two playgrounds, volleyball courts, Frisbee golf, ATV trails, an enclosed pavilion, multiple shelters, and 85 camping spots 69 with electrical hookups, 3 dump stations, and bathrooms/showers available. 20 campsites are primitive sties and more are being added every year. Just recently a second play station, 30 new picnic tables, 2 piers, 3 docks, and a handicap accessible bathroom ramp were added. The dam also creates freshwater habitat which supports multiple freshwater fish species. Silver Lake Park is home to annual activities including a 4th of July parade with fireworks show, tractor run, fishing derbies, an eco-ed day, 4H and Scout outings and many more.

A report dated February 2016 titled "Silver Lake Embankment Seepage Investigation" by the North Dakota State Water Commission detailed the present conditions of Silver Lake Dam as well as identified that uncontrolled seepage conditions are present in the dam embankment. The objective of a remedial project is to alleviate the safety concerns of water seepage through the embankment of Silver Lake Dam, and to protect the currently available recreational and natural resources that the dam has created. In October of 2019, Moore Engineering, Inc. completed an in-depth feasibility study of project alternatives to address seepage through the dam embankment. The study reviewed a full breach which would result in a loss of the Silver Lake reservoir and many of the recreational and natural resources present, relocation of the dam embankment while maintaining or improving the present recreational and natural resources, which was found to be infeasible based on current North Dakota State dam design standards, or remedial work to the embankment. The result of the study was a recommendation that included the installation of a toe drain along the embankment east of the existing spillway. This project would alleviate the concern of uncontrolled seepage through the dam embankment while achieving the objective of maintaining the reservoir and the recreational and natural resources, while continuing the protection to downstream structures.

The total project cost is estimated at $273,000, and is planned to be completed in 2020. The North Dakota State Water Commission is currently a project partner.

### Project Duration

**Project Duration*:**

Final design will be completed in Spring/Summer 2020. Bidding is expected in June 2020 with construction in the June to November 2020 time period.

# Narrative

### *Narrative*

Briefly summarize your organization's history, mission, current programs and activities. Include an overview of your organizational structure, including board, staff and volunteer involvement.

**Organization Information*:**

This project is a joint effort between the Sargent County Water Resource District (WRD) and the Sargent County Park District (PD)

The PD has been in existence for over 50 years and is governed by a 5 person board plus a park chairman and vice chairman. Sue Seelye is the park administrator. The responsibility of the PD is to maintain and improve Silver Lake Park, the only camping/recreational park within Sargent County. The PD has historically worked with multiple organizations to stabilize shorelines, expand Silver Lake, expand swimming beaches, and install modern campgrounds, amenities and a pavilion, as well as maintain natural resources including the planting of trees and wildflowers.

The WRD has been in existence for many decades and is governed by a 5 person board. It has the responsibility within the county to manage, conserve, protect, develop and control waters of the state, the control of floods, the prevention of damage to property therefrom, all to the benefit of public purposes. It is the policy of the WRD to provide for management, conservation, protection, development and control of water resources on a watershed basis, to work cooperatively with other resource agencies to strengthen and mutually support related programs, and to protect and promote the health, safety and general welfare of the people. The WRD has one part time staff member and obtains financial management services from the Sargent County Auditor. To accomplish program goals the WRD retains professional services for legal and engineering needs when necessary.

Important ongoing PD projects include: Replacement of trees, removal of old outhouses and construction of new bathroom facilities, installation of rock ramps for docks, rebuilding the fish station and several other ongoing small projects.

Volunteer work is very important to the operations of Silver Lake Park. Volunteers help with garbage collection, cut firewood and set up events, weed flowerbeds, and help with painting.

**Describe the proposed project identifying how the project will meet the specific directive(s) of the Outdoor Heritage Fund Program.**

Identify project goals, strategies and benefits and your timetable for implementation. Include information about the need for the project and whether there is urgency for funding. Indicate if this is a new project or if it is replacing funding that is no longer available to your organization. Identify any innovative features or processes of your project.

Note: if your proposal provides funding to an individual, the names of the recipients must be reported to the Industrial Commission/Outdoor Heritage Fund. These names will be disclosed upon request.

If your project involves an extenuating circumstance to exempted activities please explain.

**Purpose of Grant*:**

The goal of the project is to alleviate the safety concerns of uncontrolled seepage through the dam embankment. The project will install a toe drain along the downstream side of the embankment east of the existing spillway. The project will benefit the existing recreational and natural resources that exist as a result of the reservoir of the Silver Lake Dam by extending the life of the dam by increasing the stability of the embankment by cutting off and draining the seepage path within the dam embankment. There is an urgency for funding due to dam safety measures that need to be completed as soon as possible.

This project specifically meets Objective A. The Silver Lake Dam creates a reservoir home to multiple freshwater fish species, and has facilities to allow for fishing. The removal of the Silver Lake Dam due to safety concerns would greatly impact the fishing opportunities, and this project will allow for these facilities to be preserved into the future. Silver Lake is the only camping and recreational lake within Sargent County.

This project also meets Objective C. The Silver Lake Dam has created a reservoir that provides aquatic and wetland habitat home to multiple freshwater fish species including northern pike, crappie, perch, and walleye. The purpose of the project is to alleviate the safety concerns that exist at the dam and eliminate the need to remove the embankment and preserve the natural resources created.

This project also meets Objective D. The Silver Lake Recreation area provides multiple recreation facilities for swimming, boating, picnicking, camping, and sports. The removal of the Silver Lake Dam due to safety concerns would greatly impact the facilities, and this project will allow for these facilities to be preserved into the future.

Final design will be completed in Spring/Summer 2020. Bidding is expected in June 2020 with construction in the June to November 2020 time period.

**Please list the counties that would be impacted by this project:**

**Counties*:** Sargent

**Is This Project Part of a Comprehensive Conservation Plan?*:** No

**Does Your Project Involve an Extenuating Circumstance?*:** No

Provide a description of how you will manage and oversee the project to ensure it is carried out on schedule and in a manner that best ensures its objectives will be met. Include a brief background and work experience for those managing the project.

**Management of Project*:**

The Sargent County Park Board and the Sargent County WRD will be managing the project jointly as county entities. Management of the final design and construction would be by the Sargent County WRD, using the services of Moore Engineering, Inc. The Sargent County WRD selected Moore Engineering as their provider of engineering services following the requirements of the North Dakota Century Code 54-44.7. Moore Engineering, Inc. and the Sargent County WRD have a 3-Year Master Services Agreement in place for engineering services. It was Moore Engineering who completed the preliminary design and Opinion of Probable Construction Cost for the Project and they have completed projects for other county water resources districts for many years.

Indicate how the project will be funded or sustained in future years. Include information on the sustainability of this project after OHF funds have been expended and whether the sustainability will be in the form of ongoing management or additional funding from a different source.

**Sustainability*:**

The Sargent County Park Board and Sargent County Water Resource District will be responsible for maintenance of the project and continuing maintenance to the recreational and natural resources created by the dam. Operation of the park and campgrounds is the responsibility of the Park Board.

Indicate how the project will be affected if less funding is available than that requested.

**Partial Funding*:**

The ND State Water Commission cost share has been applied for and was approved at 40% of eligible costs. If only partial funding was approved by OHF, the Park District and WRD would have to determine alternate funding options to pay for the project.

If you are a successful recipient of Outdoor Heritage Fund dollars, how would you recognize the Outdoor Heritage Fund partnership? * There must be signage at the location of the project acknowledging OHF funding when appropriate. If there are provisions in that contract that your organization is unable to meet, please indicate below what those provisions would be.

**Partnership Recognition*:**

The Sargent County Park District would provide a sign at the entrance of the Silver Lake Recreational area that will acknowledge OHF funding of the project. This could be a requirement of the construction documents.

Do you have any supporting documents, such as maps or letters of support that you would like to provide? If so, please provide them in a single file.

**Supporting Documents*:** Yes

**If Yes, Please Provide Copies in a Single File:** SilverLakeAttachment.pdf

Awarding of Grants - Review the appropriate sample contract for your organization. Sample Contract

**Can You Meet All the Provisions of the Sample Contract?*:** Yes

# Tasks

### *Tasks*

| Task | Start Date | Completion Date |
|---|---|---|
| Bidding | 06/01/2020 | 06/30/2020 |
| Construction | 07/01/2020 | 11/30/2020 |
| Final Design | 04/01/2020 | 06/01/2020 |

### *Description of Tasks*

**Please Describe Tasks:**

Final design will be completed in Spring/Summer 2020. Bidding is expected in June 2020 with construction in the June to November 2020 time period.

# Deliverables

***Deliverables***

| Deliverable | Quantity | Unit of Measurement, if applicable |
|---|---|---|
| Construction photos and as built drawings | 0.000 | |

# Certification

***Certification***

**Certification:** Yes

**Name:** Joshua Hassell
First Name Last Name

**Title:** Engineer
Title

**Date:** 03/13/2020

***Internal Application Number***

**#/ID:** 16-10



# Sargent County Water Resource District

355 Main Street S, Suite 1
Forman ND 58032
Phone: (701) 724-6241 Ext 115
FAX: (701) 724-6244

Lucas Siemieniewski, Geneseo
Bruce Speich, Milnor
Michael Wyum, Rutland
Todd Stein, Cogswell
Roger Zetocha, Stirum


March 13, 2020

To whom it may concern:

The Sargent County Water Resource District in conjunction with the Sargent County Park Board are in the process of developing the Silver Lake Dam Improvement Project. The District has authorized Moore Engineering, Inc. to prepare and submit the application for funding from the Outdoor Heritage Funds on the District's behalf. They have worked closely with the Park Board preparing the application for funding. Please regard this email as official correspondence for the purpose of submitting the application in a timely fashion. The District will provide further correspondence in the form of a signed letter after their next regular scheduled meeting on Thursday, March 19th.

Sincerely,

Sherry Hosford


Sherry Hosford,
Secretary-Treasurer
Sargent County Water Resource District
355 Main St SW Suite 1
Forman, ND 58032


**Silver Lake Dam**
**Sargent County, North Dakota**

Created By: AKS Date Created: 10-02-2019 Date Saved: 12/02/19 Date Plotted: NEVER Date Exported: 12/18/19
Plotted By: andrew.smith Parcel Date: N/A Aerial Image: 2017 County NAIP SIDS Elevation Data: Lidar
Horizontal Datum: NAD 1983 UTM Zone 14N Vertical Datum: NAVD1988
T:\Projects\20400\20438\SilverLake.mxd

moore engineering, inc.


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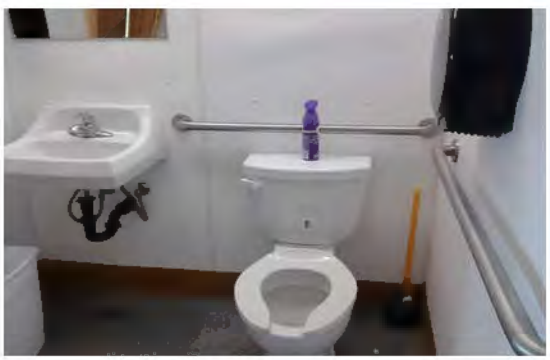
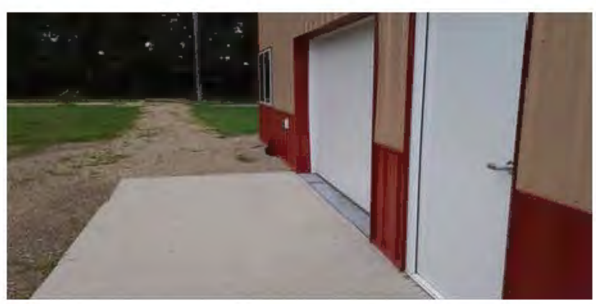
Silver Lake
Sargent County
Lake Statistics
Surface Area (acres) 127.5
Volume (acre/feet) 1,013.8
Average Depth (feet) 8.0
Max Depth (feet) 11.7
Shoreline (miles) 3.2
* Based on Full Pool Elevation
North Dakota Game and Fish Department
Map Features
Boat Ramp
Fishing Pier
Vault Toilet
Max. Depth
1 ft contours
Depth (feet)
0-1
1-2
2-3
3-4
4-5
5-6
6-7
7-8
8-9
9-10
10-11
>11
0
250
500
Yards
3
6
9
3 miles west, 2 miles south of Rutland


RAVE
RAVE


to Silver Lake Pavilion





Project # 20438
Date Created March 12, 2020

**Silver Lake Dam Improvements**
**Sargent County Water Resource District**
**Sargent County, North Dakota**

*Engineer's Opinion of Probable Cost - Toe Drain*

| | ITEM | UNIT | QUANTITY | UNIT PRICE | TOTAL | FUNDING SOURCES | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | NDSWC (40%) | OHF (35%) | Local (25%) |
| | **Construction Items** | | | | | | | |
| 1. | Mobilization | L.S. | 1 | $15,000.00 | $15,000.00 | $6,000.00 | $5,250.00 | $3,750.00 |
| 2. | Dewatering | L.S. | 1 | $10,000.00 | $10,000.00 | $4,000.00 | $3,500.00 | $2,500.00 |
| 3. | Temporary Coffer Dam | L.S. | 1 | $100,000.00 | $100,000.00 | $40,000.00 | $35,000.00 | $25,000.00 |
| 4. | Clearing & Grubbing | L.S. | 1 | $10,000.00 | $10,000.00 | $4,000.00 | $3,500.00 | $2,500.00 |
| 5. | Excavation - Common | C.Y. | 625 | $10.00 | $6,250.00 | $2,500.00 | $2,187.50 | $1,562.50 |
| 6. | Drainage Sand (ASTM C33) | C.Y. | 140 | $55.00 | $7,700.00 | $3,080.00 | $2,695.00 | $1,925.00 |
| 7. | Drainage Gravel (ASTM D448) | C.Y. | 60 | $60.00 | $3,600.00 | $1,440.00 | $1,260.00 | $900.00 |
| 8. | PVC - 8" Perforated | L.F. | 220 | $50.00 | $11,000.00 | $4,400.00 | $3,850.00 | $2,750.00 |
| 9. | Filter Fabric | S.Y. | 650 | $3.00 | $1,950.00 | $780.00 | $682.50 | $487.50 |
| 10. | Embankment - Import Clay | C.Y. | 230 | $10.00 | $2,300.00 | $920.00 | $805.00 | $575.00 |
| 11. | Riprap - Class III | C.Y. | 10 | $85.00 | $850.00 | $340.00 | $297.50 | $212.50 |
| 12. | Riprap - Filter Fabric | S.Y. | 15 | $3.00 | $45.00 | $18.00 | $15.75 | $11.25 |
| 13. | Seeding - Type III | L.S. | 1 | $3,000.00 | $3,000.00 | $1,200.00 | $1,050.00 | $750.00 |
| 14. | Material Testing | ALLOWANCE | 1 | $15,000.00 | $15,000.00 | $6,000.00 | $5,250.00 | $3,750.00 |
| 15. | Storm Water Management | L.S. | 1 | $5,000.00 | $5,000.00 | $2,000.00 | $1,750.00 | $1,250.00 |
| | | | | Total Construction | $191,695.00 | $76,678.00 | $67,093.25 | $47,923.75 |
| | | | | Engineering - Design | $19,000.00 | $7,600.00 | $6,650.00 | $4,750.00 |
| | | | | Engineering - Construction | $19,000.00 | $7,600.00 | $6,650.00 | $4,750.00 |
| | | | | Engineering - Geotech | $10,000.00 | $4,000.00 | $3,500.00 | $2,500.00 |
| | | | | Contingencies | $18,805.00 | $7,522.00 | $6,581.75 | $4,701.25 |
| | | | | Permitting | $7,500.00 | $3,000.00 | $2,625.00 | $1,875.00 |
| | | | | Cultural Clearance - Class III | $3,500.00 | $1,400.00 | $1,225.00 | $875.00 |
| | | | | Legal Fees | $2,000.00 | $0.00 | $700.00 | $1,300.00 |
| | | | | Aministrative Fees | $500.00 | $0.00 | $175.00 | $325.00 |
| | | | | Right-of-Way - Land Acquisition | $1,000.00 | $0.00 | $350.00 | $650.00 |
| | | | | **TOTAL PROJECT COST** | **$273,000.00** | **$107,800.00** | **$95,550.00** | **$69,650.00** |



moore engineering, inc.

# SILVER LAKE DAM IMPROVEMENTS FEASIBILTY STUDY REPORT
# SARGENT COUNTY, ND

Prepared for

**Sargent County Water Resource District,**
**Sargent County Park Board,**
**and**
**Sargent County Board of Commission**

October 2019


Prepared by
Joshua Hassell, PE, CFM
Ben Kugler, EI, CFM


I hereby certify that this 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 North Dakota.

_____________Joshua Hassell /s/____________
Joshua Hassell, PE, CFM
ND Registration No. PE-9132
Date:____10/8/2019________

This document was originally issued
and sealed by
Joshua Hassell
PE-9132,
on 10/08/2019 and the original
document is stored at:
Moore Engineering Inc.
925 10th Ave E.
West Fargo, ND 58078

## Table of Contents

# List of Tables



# List of Figures

# 1. Background

## 1.1 Purpose and Scope

A report dated February 2016 titled “Silver Lake Embankment Seepage Investigation” by the North Dakota State Water Commission (NDSWC) [1] detailed the present conditions of Silver Lake Dam as well as uncontrolled seepage conditions present. This report can be found in Appendix A. The purpose of this study is to analyze and determine the feasibility of multiple alternatives to alleviate concerns of water seepage through Silver Lake Dam, located in Sargent County, North Dakota (Figure 1.1). Alternatives include reconstruction of the dam in place or downstream of the current site, geotechnical options to reduce seepage, or a full breech of the dam. Any alterations to the outlet configuration or embankment elevation would need to include an analysis that shows the dam meets hydrologic and hydraulic design standards set forth by the State of North Dakota (ND).

## 1.2 Vertical Datum

The elevations discussed within this report reference the North American Vertical Datum of 1988 (NAVD88).

## 1.3 Location and Basin Description

Silver Lake Dam is located on the Wild Rice River in Sections 33 and 34 of T130N, R55W as well as Sections 3 and 4 of T139N R55W in Sargent County, ND approximately 5 miles southwest of Rutland, ND. The dam can be accessed from Rutland, ND by traveling west on County Highway 3 for 3 miles and then south on 135$^{th}$ Ave SE for approximately 1.5 miles.

## 1.4 Dam Description and History

Silver Lake Dam was constructed in 1937 by the Works Progress Administration “WPA” across the Wild Rice River to raise Silver Lake adjacent to the river. The dam is primarily utilized for enhancement of recreational facilities, but does provide minor flood risk reduction for a short area downstream of the dam. The dam originally consisted of an earthen embankment, concrete structural spillway, and a grassed earthen emergency spillway. In 1967 the primary spillway was reconstructed through a combined effort of the U.S. Bureau of Outdoor Recreation, the Sargent County Park Board, and the NDSWC. In 1994 the SWC [2] recommended eliminating the existing emergency spillway, raising the elevation of the 70 feet wide concrete primary spillway weir 2 feet to an elevation of 1,226.7, and raising the top of the dam embankment from 1,228.1 to 1,230.4 feet. The concrete spillway and top of dam were raised as recommended, however, it is not known if the emergency spillway had been completely filled in. Silver Lake is circled by 135$^{th}$ Ave SE on the east side of the Lake. In order to raise the level of the lake, the 1994 SWC report also recommended raising 135$^{th}$ Ave SE to a minimum elevation of 1,229.9.

## 1.5 Previous Studies

As previously mentioned, the NDSWC completed the “Preliminary Engineering Report Silver Lake” in 1994 which included some recommendations to modify the existing dam. This report can be found in

Appendix A. The design recommendations in the 1994 study were based on a Low Hazard Dam Class 1 classification. Per the North Dakota Dam Design Handbook [3], Low Hazard, Class 1 Dams must be designed to two criteria. One criteria is that the dam must pass a 10-Year event with acceptable velocities as defined in Table 5.2 of the Design Handbook. The second criteria is that that the dam must not overtop during the freeboard hydrograph or in this case, the 25-Year event, or the velocity hydrograph plus wave action, whichever is higher. The 1994 report appears to show that the dam meets both the velocity event and the freeboard event. However, the report does not appear to compare the free board event to the velocity event plus wave action.

The 1994 report lists Silver Lake Dam as a Low Hazard dam as defined in the North Dakota Dam Design Handbook as, "located in rural or agricultural areas where there is little possibility of future development. Failure of low hazard dams may result in damage to agricultural land, township and county roads, and farm buildings other than residences. No loss of life is expected if the dam fails."

Additionally, the dam was listed as Class I which means the height of the dam from the river invert to the top of the embankment was less than 10 feet. However, the report provides recommendations to raise the spillway and to raise the dam embankment two feet. This raise increases the height of the dam to 11 feet therefore, changing the classification from a Class I to a Class II (which is the current classification per the NDSWC database). While the dam is still considered a Low Hazard Dam, the change in classification requires larger events to be analyzed to verify that the Dam meets current design standards. Class II Low Hazard Dams are required to pass the 25-Year event with acceptable velocity, and pass the 50-Year event or 25-Year event plus wave height (whichever event is greater) without overtopping the dam. In the 1994 report, the 25-Year event passed at an elevation of 1,229.5. This is a freeboard of 0.9 feet utilizing their recommended top of dam elevation of 1,230.4. If the dam was analyzed as a Class II Low Hazard dam, this 25-Year event would have to pass with sufficient freeboard along with wave height. The existing dam does not meet the 25-yr event criteria. A memorandum recommending the approval of the construction permit for the primary spillway raise and elimination of the emergency spillway dated August 26, 1997 from Cory Backstrand [4] states that the dam should be categorized as Class II dam. It states that Edgar Schmidt, Dam Safety Engineer reviewed the hydrology and that the dam could safely pass the 50-year event. No mention was made of the 25-year event plus wave action criterion.

## 1.6 Existing Data

The Silver Lake Dam watershed is located within the Wild Rice River watershed. A HEC-HMS model was developed for the Wild Rice River watershed by BARR Engineering & Moore Engineering Inc. for the Fargo-Moorhead Metro Basin-Wide Modeling Approach study [5] That model was updated by Moore Engineering Inc. during the Wild Rice River detention study dated December 16, 2013. [6] These two studies included base data such as time of concentration, NRCS curve numbers, and precipitation grids which were utilized as the basis for the Silver Lake Dam HEC-HMS model for this study.  Light Detection and Ranging (LiDAR) was collected for the study area in 2008, and was utilized in the delineation of the Silver Lake Dam watershed.

## 1.7 Permitting

Any and all modifications to the existing dam structure will require a Construction Permit from the Office of the State Engineer. Per comments made at a Water Resource District Meeting on June 20, 2019 by Matt Lindsay (Regulatory Division Chief at the Office of the State Engineer), if significant improvements are made to the existing dam (i.e. raise or lower the dam, changing spillway elevations or capacity), then the dam would need to be brought into compliance with current dam design standards. However, the OSE reviews all permit requests independent of each other. The addition of a toe drain or cutoff wall to prevent, reduce, or eliminate seepage and to improve dam safety may be considered an incremental improvement and would not require the dam to be brought up to current design standards. Further discussion with the OSE is necessary if a project is determined to be feasible.

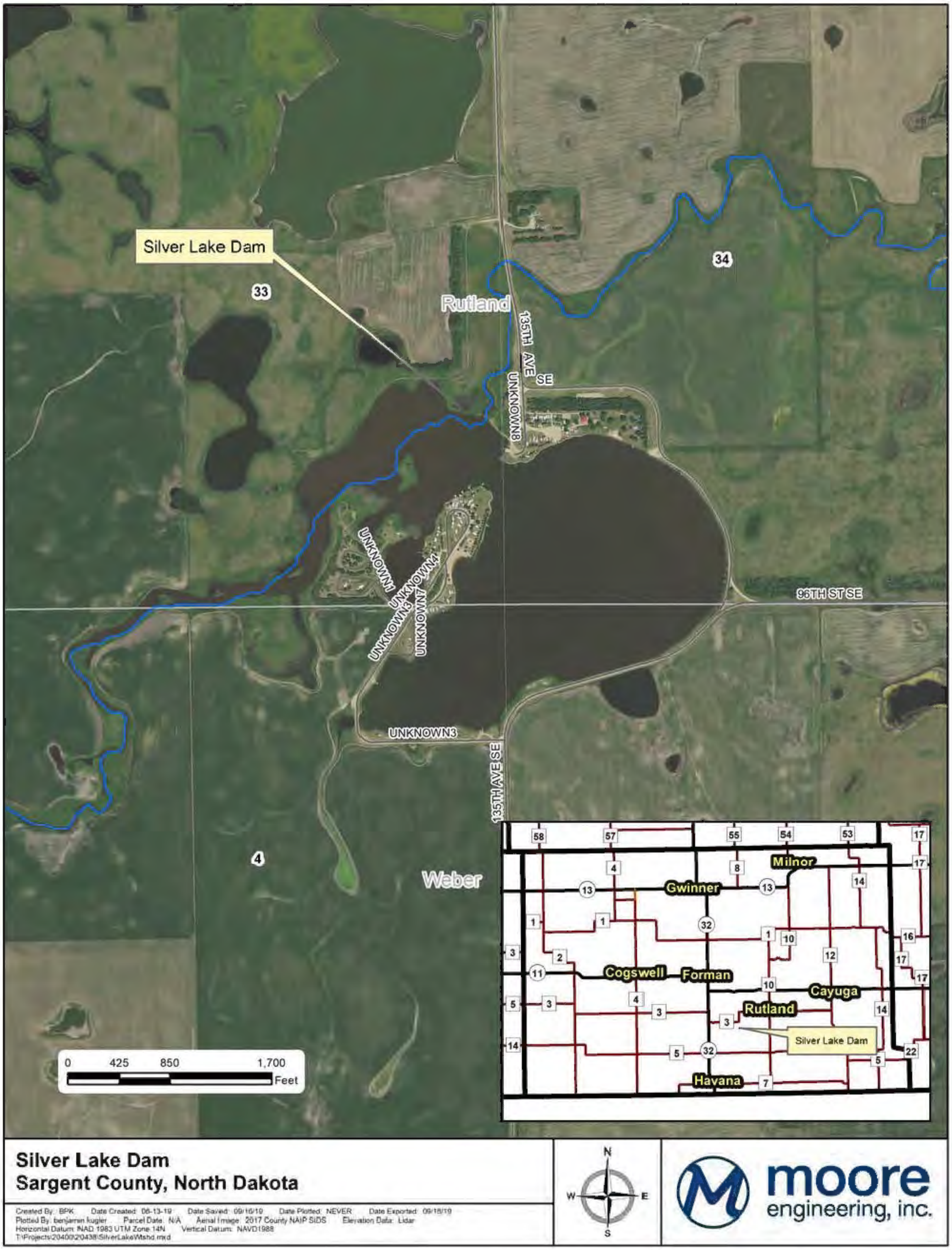



*Figure 1.1 – Silver Lake Dam Location*

# 2. Hydrology

## 2.1 Delineation

Watershed delineation for Silver Lake Dam was completed utilizing HEC-GeoHMS tools within ArcGIS. Figure 2.1 shows the resulting delineated watershed. The watersheds contributing to Silver Lake Dam from the Wild Rice River Detention Study were combined into a single watershed to allow for calibration.

## 2.2 Basin and Routing Characteristics

Basin characteristics were determined utilizing characteristic rasters from the Wild Rice River Detention Study and zonal statistics tools within ArcGIS. Basin baseflow was assumed to be the sum of all the baseflows to the component basins from the Wild Rice Detention Study model. The calculated basin characteristics can be seen in Table 2.1. Figure 2.1 shows the basin modeled within HEC-HMS.

Table 2.1 – Basin Characteristics

| Silver Lake Dam Drainage Area | |
|---|---|
| Drainage Area | 478.55 sq mi |
| Non-Contributing Area | 65.48 sq mi |
| Contributing Drainage Area | 413.07 sq mi |
| 24-Hour Curve Number | 69.58 |
| 10-Day Curve Number | 52.71 |
| Time of Concentration | 87.47 hr |
| Calibrated R value | 203.8 |

## 2.3 Rainfall and Runoff Distribution and Depths.

24-hour and 10-day rainfall event depths were calculated utilizing point precipitation data from NOAA Atlas 14 [7]. 24-hour rainfall followed the latest MSE 3 distribution obtained from the North Dakota Supplement of the National Engineering Handbook Part 650, Chapter 2 [8].Rainfall depths can be seen below in Table 2.2. Runoff depth values were obtained from the 100-year runoff rainfall grids from the Fargo-Moorhead Metro Basin-Wide Modeling Approach study and multiplying by the correct correction factor from NRCS TR-60 [9] to obtain smaller return period events. Precipitation events were modified with a 0.78 areal reduction factor from the North Dakota Hydrology Manual [10]

Table 2.2 – Event Depths

| Calibrated Event | Depth (in) |
|---|---|
| 2-Year, 24-Hour | 1.86 |
| 5-Year, 24-Hour | 2.36 |
| 10-Year, 24-Hour | 2.79 |
| 25-Year, 24-Hour | 3.44 |
| 50-Year, 24-Hour | 3.98 |
| 25-Year, 10-Day | 5.31 |
| 50-Year, 10-Day | 5.98 |
| 25-Year Runoff* | 2.50 |
| 50-Year Runoff* | 3.04 |

*Runoff Depth

## 2.4 Watershed Calibration

In their 1994 Report, the SWC utilized the USGS Gage 05051600 Wild Rice River near Rutland, ND as a basis to calibrate to. Their runoff events were calibrated to a Log Pearson Type III distribution done on the gage. This study utilized a similar method to calibrate the model. An updated Log Pearson Type III distribution completed in 2011 as part of the "Fargo-Moorhead Metro Basin-Wide Modeling Approach Hydrologic Modeling" report. This analysis resulted in significantly higher flows than what was seen for the same return period event from the previous analysis. The analysis conducted in 1994 does not include stream gage records past the date of the report. The watershed has since experienced multiple high flow rate events and this additional data has increased the flow rates for the given return periods. Table 2.3 shows the comparison of Log Pearson Type III distributions. The Silver Lake Dam basin "R" value was adjusted so that the 25-Year Runoff event approximately matched the interpolated 25-Year peak discharge calculated from the more recent Log Pearson Type III distribution. The peak flow rates to the dam utilizing the calibrated flows are shown in Table 2.4

Table 2.3 – Log Pearson Type III Distribution comparison

| Log Pearson Type III Distribution for USGS Gage 05051600 Wild Rice River Near Rutland, ND | | |
|---|---|---|
| Event | 2011 Report Discharge (cfs) | 1994 SWC Report Discharge (cfs) |
| 100-Year | 4,055 | 1,696 |
| 50-Year | 3,023 | 1,312 |
| 25-Year | - | 969 |
| 20-Year | 1,882 | - |
| 10-year | 1,193 | 584 |

Table 2.4 – Silver Lake Dam calibrated inflow rates

| Frequency (yr) | 2 | 5 | 10 | 25 | 50 | 25 | 50 | 10 | 25 | 50 |
|---|---|---|---|---|---|---|---|---|---|---|
| Duration | 24-hr | 24-hr | 24-hr | 24-hr | 24-hr | 10-day | 10-day | RO | RO | RO |
| Q, Inflow (cfs) | 195.9 | 401.5 | 626.6 | 1015.2 | 1374.9 | 842.6 | 1130.8 | 1181.4 | 2098.5 | 2545.1 |

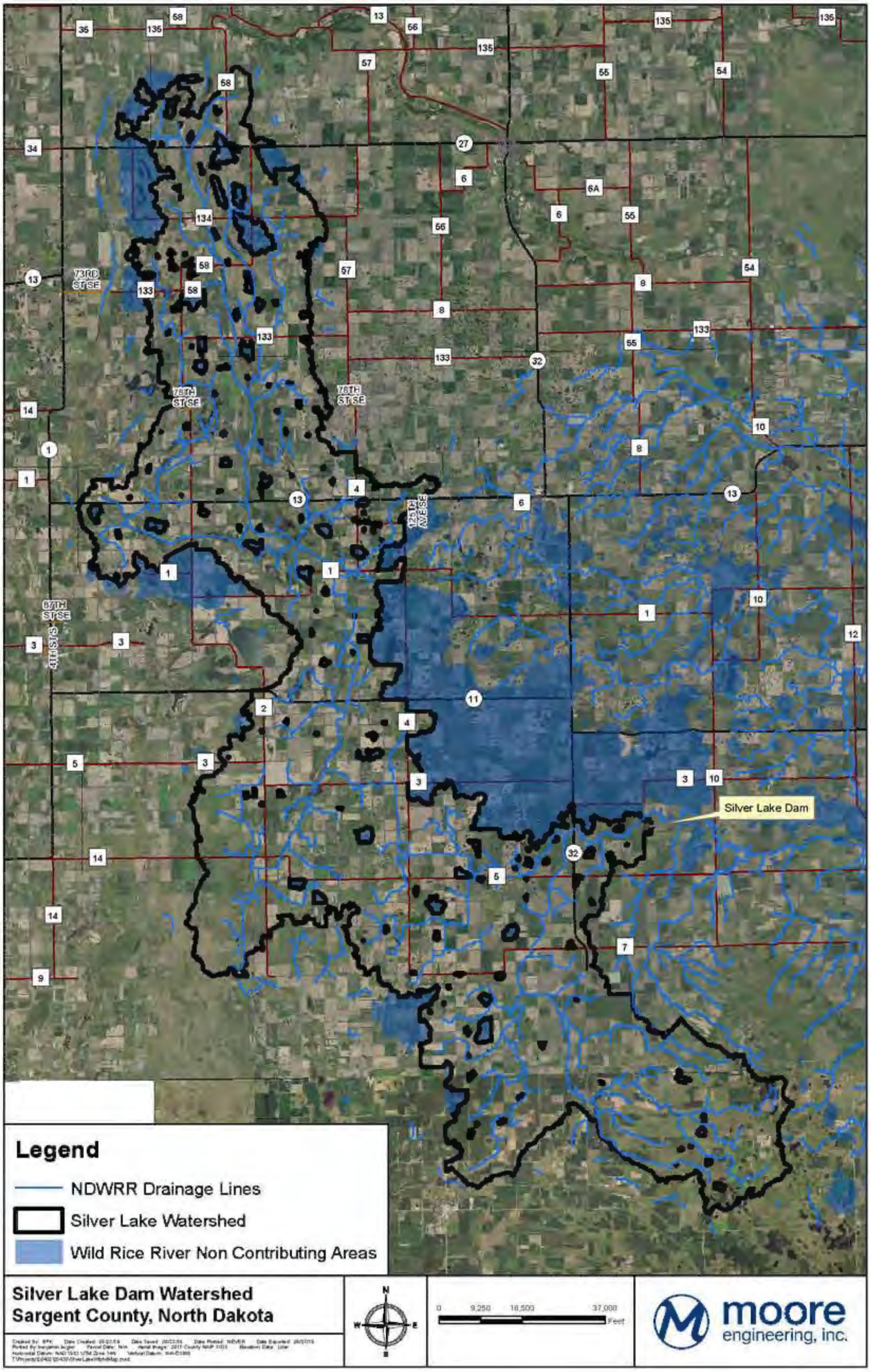



*Figure 2.1 – Silver Lake Dam Watershed*

# 3. Alternatives

## 3.1 Alternatives to be Investigated

Five potential alternatives were analyzed in this feasibility study. A number of goals were established and set as a priority to evaluate alternatives. Those goals were:

1: Address the existing seepage issues

2: Maintain a dam for recreational purposes

3: Impact the existing pool upstream of the dam as little as possible

4: Have minimal to no impact on existing structures upstream and have minimal to no impact on the County Highway Department Project.

With those goals in mind, the following alternatives were analyzed:

- Do Nothing Alternative
- Dam Breach and Removal
- Relocate Dam Downstream
- Reconstruction of Dam at existing site
- Geotechnical Rehabilitation or Mitigation

## 3.2 Alternative 1-Do Nothing Alternative

Silver Lake Dam is experiencing seepage through the embankment. Based on Braun Intertec’s site visit there are currently no signs of global or surficial slope instability at this time, but seepage can cause issues over time resulting in decreased embankment stability and result in a more costly situation than taking action now. This alternative meets all goals except for addressing the seepage through the dam.

## 3.3 Alternative 2-Dam Breach and Removal

The second option available is the abandonment of the project including breaching the dam and removal of the embankment and spillway structure. The purpose of the dam is the enhancement of recreational facilities. This option would address any potential dam safety issues in regard to seepage, but this would not allow the dam to be available for recreational purposes as it will greatly impact the upstream pool. This alternative would not create any additional impacts from flooding to upstream structures, but would eliminate access to the dam pool.

## 3.4 Alternative 3-Dam Relocation Downstream

The third alternative considered was the relocation of the dam downstream of the current location and then subsequently remove the existing dam. This would eliminate the seepage issue as well as provide some additional recreational benefits. The location of the dam downstream of the current site would allow for an expansion of Silver Lake by approximately 15.6 acres. A low flow fish passage would need to be installed to allow for fish to travel upstream and downstream of the dam. Due to the nature of the recreational use of the lake and the presence of multiple structures adjacent to the lake, the constraint was set to maintain the existing top of dam and primary spillway elevations to allow the level of the lake to be maintained. For this preliminary investigation, it was assumed that a 4 foot wide weir would account for the flow of a low flow fish passage. This would be set at the current weir elevation of the primary concrete spillway of 1,226.7 ft. The remainder of the capacity was assumed to be from a concrete weir set 0.5 ft. higher than the low flow spillway at 1,227.2 ft. The maximum top of dam elevation would also be set at the recommended top of dam elevation from the 1994 SWC report of 1230.4 ft. If the dam were to be raised, it would potentially result in the need to protect or relocate multiple structures in the vicinity of Silver Lake, as well as require a road raise of significant portions of 135$^{th}$ Avenue SE. The preliminary centerline alignment for Alternative 3 is shown in Figure 3.1

### 3.4.1 Design Requirements

This dam would have to be designed to meet the current dam crossing standards. LiDAR shows the existing channel bottom at the location of the preliminary alignment to be approximately 1,217 feet. This would mean the proposed dam would also be a Low Hazard Class II dam. The hydrologic and hydraulic criteria for Class II dams requires passing the 25-year event with acceptable velocity, and passing the 50-Year event or 25-Year event plus wave height (whichever event is greater) while maintaining acceptable freeboard. It was assumed that the spillway structure would be constructed of concrete, so the velocity criteria was not checked in this study.

### 3.4.2 Additional Storage Volume

Dam storage volume was calculated using surface volume tools within ArcGIS and 2008 LiDAR. The additional storage available from moving the dam downstream was calculated and a combined proposed storage volume curve was calculated. An elevation- storage curve was developed, and flood storage was assumed to start at elevation 1,226.7, which is the primary spillway invert. The elevation-area-capacity curve can be seen below in Figure 3.2.

### 3.4.3 Alternative Analysis

The first freeboard criterion checked was the 25-year event plus wave height. The calculated wave height utilizing the provided equation in the North Dakota Dam Design Handbook, with an assumed design wind speed of 80 mph, is 2.64 feet with a fetch length of 0.36 miles. Due to design considerations present at the dam, the elevations of both the spillway and top of dam are required to be fixed. Both the low flow and primary spillway weirs were assumed to have a weir coefficient of 3.1 for this analysis. With the current elevations there is 3.7 feet of freeboard (1,230.4-1,226.7) from the top of the dam to the low flow weir crest. Accounting for the 2.64 feet of wave action would mean the 25-Year event peak water surface in Silver Lake would have to be kept at 1,227.8, only 1.1 feet above the low flow crest elevation, and 0.6 feet above the primary spillway weir elevations. Due to these limitations, an extremely large spillway structure would be required to meet the standards in the North Dakota Dam Design Handbook. Due to the costs and impacts caused by this alternative, the study sponsors decided to forgo any additional analysis on options that would involve modifications to the dam’s spillway structures.


*Figure 3.1 – Preliminary Silver Lake Dam Relocation Alignment*

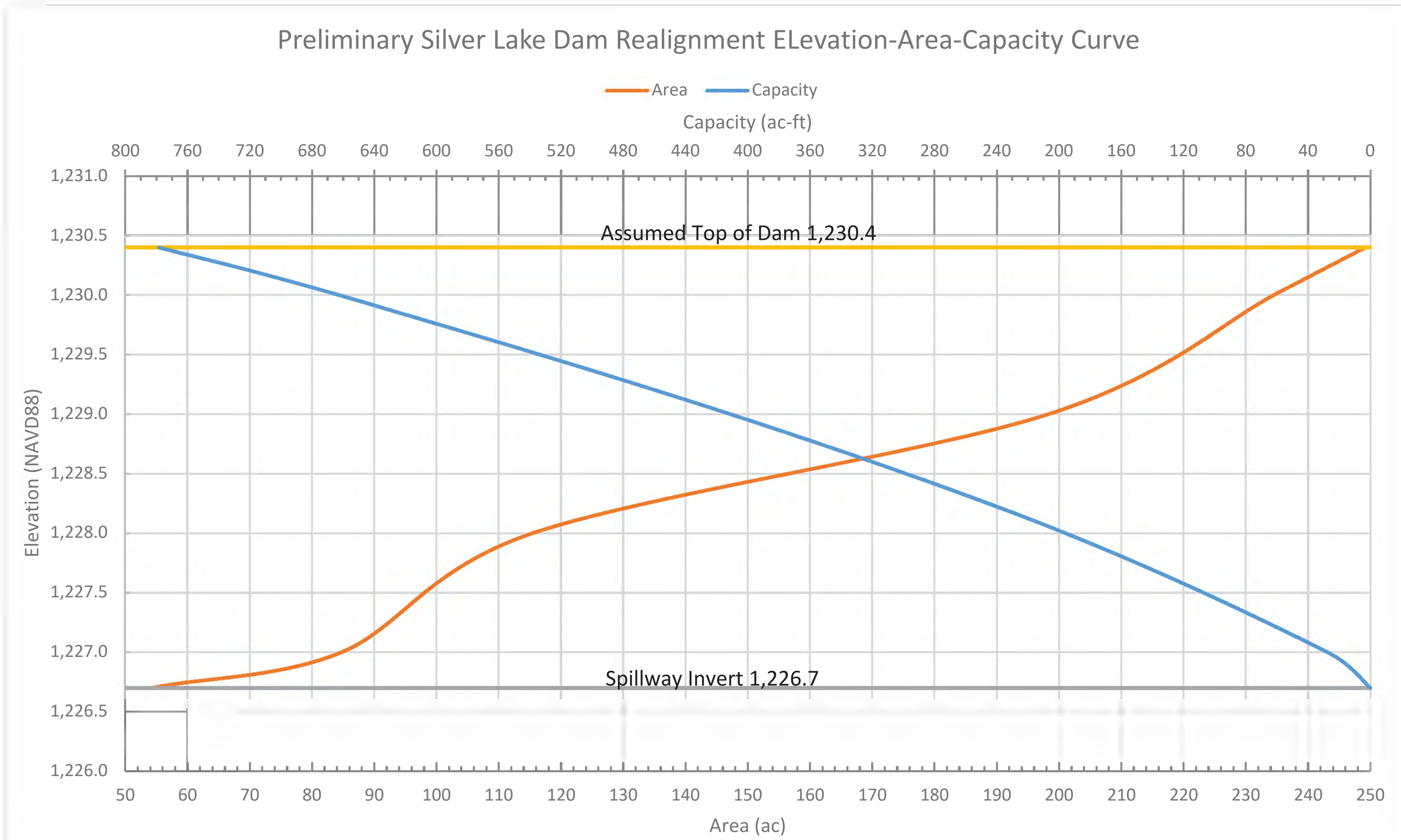



*Figure 3.2 – Measured Elevation-Area-Capacity Curve for Alternative 3 Dam Realignment*

## 3.5 Alternative 4-Dam Reconstruction

The fourth alternative analyzed was reconstruction of the dam embankment at the current location. Three preliminary soil borings were taken by Braun Intertec along the current dam alignment to analyze soil properties of the existing embankment material. Reconstruction of the embankment would likely constitute a significant improvement and thus would require the dam to be constructed to meet current dam design standards. As this would result in the same problems presented in Alternative 3, this alternative was also not selected for further analysis.

## 3.6 Alternative 5-Geotechnical Options

### 3.6.1 Geotechnical Investigation

Alternative 5 involves the use of geotechnical remediation methods to alleviate issues with seepage through the embankment. Braun Intertec was contracted to complete a geotechnical assessment of the site, as well as propose a method to mitigate the seepage through the embankment. Braun Intertec's analysis and results are contained within their full report titled, "Geotechnical Evaluation Report Silver Lake Dam" [11]. This report is available in Appendix B. Three borings were completed along the existing dam embankment. Vibrating Wire Piezometers were installed in each boring. The soil samples recovered from the borings underwent moisture content, mechanical sieve-hydrometer, unit density, Aterberg limit, falling-head permeability, and #200 wash analyses. Steady state seepage analysis and slope stability analysis was completed utilizing data from the boring samples with SEEP/W and SLOPE/W software. Additional details can be seen in Appendix B.

### 3.6.2 Recommendations

Based on the data collected from soil boring, the installation of Vibrating Wire Piezometers, and the SEEP/W and SLOPE/W analyses, Braun Intertec recommended the installation of a toe drain on the portion of the embankment that is east of the existing spillway. Braun Intertec's report states:

> "We recommend installing the toe drain along the downstream toe of the embankment extending east from the spillway. While a comprehensive remediation package could specify toe drain construction along both dam segments, there is currently no evidence of seepage to the west. If a case is to be made for toe drain construction to the west, it would need to bear on our slope stability results, which show the influence of drainage collection on slope stability. In the absence of documentation citing seepage to the west of the spillway, it is our opinion that the western dam segment can simply be cleared of weeds, shrubs and other rooted vegetation taller than the predominant grass (compliant with typical guidance on encroachments) to facilitate further, regular inspections of the dam."

This alternative would have a positive impact to the uncontrolled seepage of the dam, and allow for the pool to be maintained for recreation while not impacting the upstream structures.

# 4. Cost Estimation

A preliminary cost estimate was prepared for Alternative 2, which includes breaching the dam and removal of the embankment and Alternative 5, which includes the installation of a toe drain on the eastern portion of the dam embankment. A breakdown of these costs can be seen below in Table 4.1. Both of these cost estimates would include removal of the large tree on the embankment, as well as general vegetation clearing. Alternative 5 cost includes significant construction cost for a temporary cofferdam. As indicated in the geotechnical report, a temporary coffer dam may be necessary to limit seepage through the dam during construction. It was assumed that this cofferdam will be sheet piling to limit the potential impacts to the lake elevation during construction. This will also aid in the permitting of the project. The distribution of costs is based on current NDSWC cost share policy. The current NDSWC cost share policy can be found in Appendix C.

*Table 4.1 – Preliminary Alternative Cost Estimate*

| | Alternative | |
|---|---|---|
| | 2 - Dam Breach and Removal | 5 - Toe Drain Installation |
| Total Cost | $121,000.00 | $273,000.00 |
| NDSWC Funding | $83,325.00 | $187,725.00 |
| Local Share | $37,675.00 | $85,275.00 |

# 5. Conclusion

## 5.1 Summary

Five different alternatives were presented and analyzed within this study. Alternative 1 is the Do Nothing alternative. This alternative was abandoned as not mitigating the seepage problems with Silver Lake dam could result in future dangerous conditions. Alternative 2, removal of the dam, would go against the consideration of maintaining the existing pool elevation to maintain the current recreational facilities, but is an option if no other feasible options are available. Alternative 3 involved the relocation of the dam downstream and removal of the current embankment. Due to the two constraints of maintaining the existing pool elevation and existing top of dam elevation, reconstructing the dam to meet current dam design standards is not feasible. Alternative 4 involved reconstruction of the dam at the current site. This alternative also involved the same constraints as Alternative 3 and reconstruction with the constraints present to meet current dam design standards is not feasible. The last alternative analyzed were geotechnical seepage mitigation options. Braun Intertec determined that the installation of a toe drain on the eastern portion of the embankment would result in effective mitigation of seepage within the embankment.

## 5.2 Recommendations

Alternatives 2 and 5 are recommended for consideration by all parties involved. Alternative 2 would remove the recreational benefits of the dam and is not the preferred of the two alternatives, but it is a viable option if no other method is available. Further, this would be the cheaper of the two recommended alternatives. The installation of a toe drain would result in decreased seepage pressures within the dam and would help mitigate potential issues with embankment stability as a result of excessive seepage through the embankment while maintaining the existing pool elevation and not causing additional impacts to structures adjacent to Silver Lake. Alternative 5 would be the more expensive of the two recommended alternatives but is the only alternative that preserves and maintains the existing use and benefit of the dam structure. Recreational benefits would be preserved with Alternative 5.

## 5.3 Permitting

Final permitting and regulatory requirements will need to be followed with either selected alternative. Close coordination with the Office of the State Engineer will be required.

## 6. References


[1] North Dakota State Water Commission. “Silver Lake Embankment Seepage Investigation”. February 2016.

[2] North Dakota State Water Commission. “Preliminary Engineering Report Silver Lake”. January 1994.

[3] North Dakota State Water Commission. “North Dakota Dam Design Handbook”. June 1985.

[4] Dwight Comfort. “Memorandum: Application to Construct or Modify a Dam #1280-5109”. August 29, 1997

[5] Houston Engineering Inc. “Fargo-Moorhead Metro Basin-Wide Modeling Approach Hydrologic modeling Appendix L – Wild Rice River Watershed”. December, 2011.

[6] Moore Engineering, Inc. “Wild Rice River Watershed Comprehensive Detention Plan” December, 2013

[7] NOAA. “Atlas 14 Point Precipitation Frequency Estimates”. https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html. April, 2017

[8] USDA NRCS. “National Engineering Handbook Part 650 Chapter 2 North Dakota Supplement including the Implementation of NOAA Atlas 14 Rainfall Data”

[9] USDA NRCS. “Earth Dams and Reservoirs TR-60”. July, 2005.

[10] USDA NRCS. “Hydrology Manual for North Dakota”.

[11] Braun Intertec. “Geotechnical Evaluation Report Silver Lake dam”. August, 2019

# Appendix A – Previous Reports

North Dakota State Water Commission
900 East Boulevard Ave • Bismarck ND 58505
swc.nd.gov/project_development/special_investigations

# Silver Lake Embankment Seepage Investigation

## Sargent County, North Dakota

Investigation Report

February 2016

*Original document has been sealed.*

# Silver Lake Embankment Seepage Investigation

Sargent County, North Dakota

*SWC Project #391*
*North Dakota State Water Commission*
*900 East Boulevard*
*Bismarck, ND 58505-0850*

**Prepared for:**
Sargent County Water Resource District

February 2016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# 1. Introduction

In December of 2006, the North Dakota State Water Commission (SWC) and the Sargent County Water Resource District (SCWRD) entered into an agreement to study rehabilitation alternatives to address the seepage at Silver Lake Dam. A copy of the investigation agreement is located in Appendix A. The agreement outlined the responsibilities of the SWC, which are listed below.

a. Conduct topographic surveys of the upstream and downstream faces of the existing dam in the area where seepage is occurring.
b. Develop and evaluate alternatives to address the uncontrolled seepage through the embankment.
c. Prepare preliminary designs for the proposed rehabilitation.
d. Develop preliminary cost estimates of alternatives.
e. Prepare a preliminary engineering report summarizing the proposed designs and estimated costs.

The purpose of this report is to provide the SCWRD with alternatives that could address the seepage occurring at Silver Lake Dam in accordance with the Agreement.

# 2. Site Location

Silver Lake Dam is located in Sections 33 and 34, Township 130 North, Range 55 West, near the city of Rutland in Sargent County in southeast North Dakota.


**Figure 1.** Project Location.

# 3. Background

Silver Lake Dam is an earthen embankment dam constructed in 1937 by the Works Progress Administration to raise the water level of Silver Lake and provide recreational opportunities. Silver Lake Dam has a watershed contributing area of approximately 344 square miles. The lake level is controlled by a concrete spillway at elevation 1223.8 mean sea level and has a maximum depth of approximately 11 feet with an average depth of 7.3 feet and a volume of 830 acre-feet.

All dams in North Dakota are classified by their hazard level. The "North Dakota Dam Design Handbook" provides that dams can be categorized as low, medium, or high hazard described as follows:

**Low Hazard**- dams located in rural or agricultural areas where there is little possibility of future development. Failure of low-hazard dams may result in damage to agricultural land, township and county roads, and farm buildings other than residences. No loss of life is expected if the dam fails.

**Medium Hazard-** dams located in predominantly rural or agricultural areas where failure may damage isolated homes, main highways, railroads, or cause interruption of minor public utilities. The potential for the loss of a few lives may be expected if the dam fails.

**High Hazard-** dams located upstream of developed and urban areas where failure may cause serious damage to homes, industrial and commercial buildings, and major public utilities. There is a potential for the loss of more than a few lives if the dam fails.

Using these definitions, Silver Lake Dam can be classified as a low hazard dam based on its rural location. If a complete failure of the embankment occurred, the flood wave would at most damage several county roads and agricultural land.

After the hazard classification is made, based on the dam's location and likelihood of loss of life, the hazard is classified based on its height. This classification is made using the following table provided in the "North Dakota Dam Design Handbook":

**Table 1.** Dam Design Classification based on height.

| Dam Height (Feet) | Low | Medium | High |
|---|---|---|---|
| Less than 10 | I | II | IV |
| 10 to 24 | II | III | IV |
| 25 to 39 | III | III | IV |
| 40 to 55 | III | IV | V |
| Over 55 | III | IV | V |

Silver Lake Dam is thus classified as a Class I Low Hazard embankment based on its height being less than 10 feet.

A two dimensional hydraulic model was created by Gannett Fleming as part of a hazard classification project. The model estimated the effects of a dam failure due to a Probable Maximum Flood (PMF). A PMF is the largest predicted flood event, created by a combination of the most severe meteorological and hydrologic conditions. The model was produced using a 10-meter digital elevation model. **Figure 2** is the inundation outline of the PMF at Silver Lake Dam produced by the Gannett Flemming model.

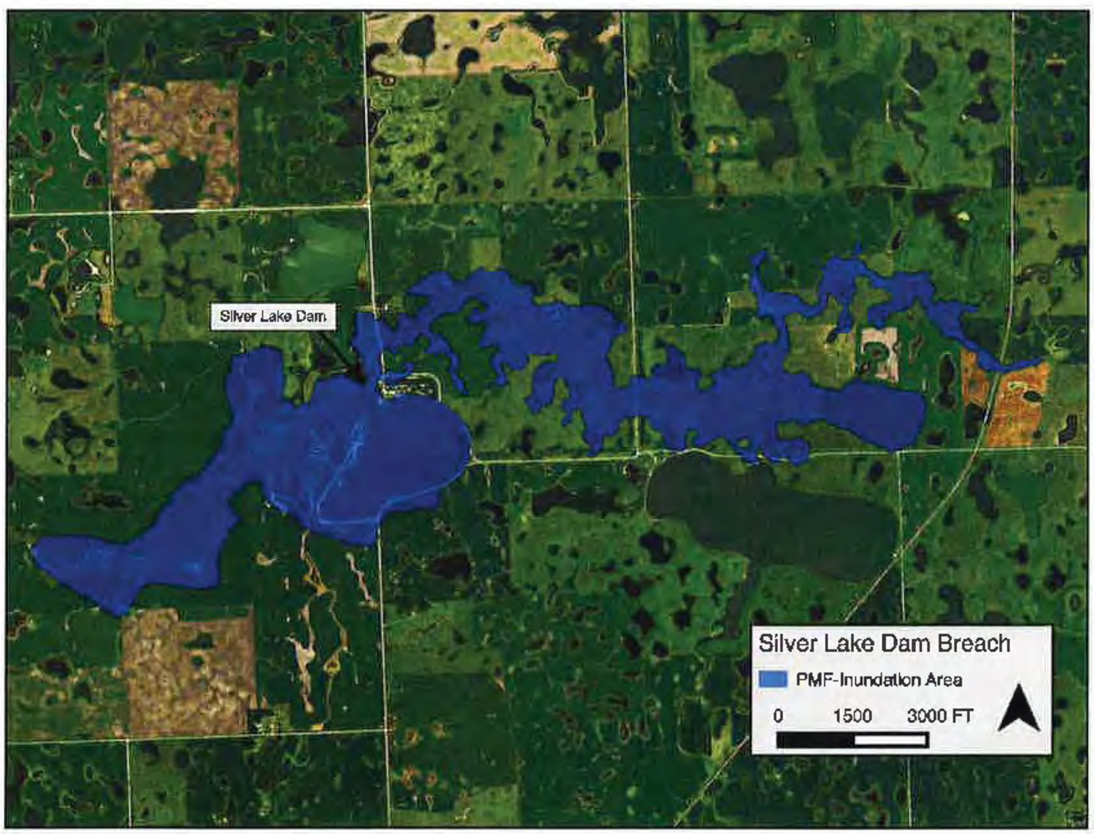



**Figure 2.** PMF inundation area.

A preliminary engineering report completed by the SWC in 1994 evaluated the water level of Silver Lake and suggested raising the spillway 2 feet to enhance recreational opportunities. Since the dam has a Class I Low Hazard classification the spillway must pass a 25-year frequency event. The preliminary engineering report validated the area's hydrology and the newly designed spillway's ability to pass a 25-year frequency event. The SWC construction crew completed the 2 foot spillway raise in 1998.

After the completion of the spillway raise in 1998 a letter was written documenting seepage through Silver Lake's embankment. A letter (**Appendix A**) dated August 23, 2006, noted that seepage was occurring several years before the dam raise and appeared to have increased shortly afterward.

## 4. Dam Seepage

Dam seepage is the flow of water through, under, or around a dam. Seepage can be an extremely complex and serious issue for the stability of an embankment. If soil particles are being transported, this flow of water can cause internal erosion (a.k.a. piping), decreasing the stability of the embankment and can lead to dam failure.

Seepage is often monitored to determine if the seep is carrying sediment out of the embankment. Seeps containing clear water, with no sediment load, should be monitored, but do not typically call for immediate action. Seeps containing sediment, however, could have serious implications for the dam stability and public safety.

## 5. Site Visit

On December 4$^{th}$ of 2015, water resource engineers David Nyhus, Joon Hee Lee, and Chris Korkowski visited the site to examine the conditions of the embankment and evaluate design alternatives to mitigate the embankments seepage. One large tree and many small diameter willows were seen growing out of the embankment (**Figure 3**). Large amounts of cattails were observed on the downstream side of the embankment and they appear to be flourishing.

**Figure 3.** Silver Lake Dam, right embankment (photograph taken from downstream side).

A culvert was found downstream of the right embankment, discharging into the Wild Rice River. The culvert was in a road providing access to the spillway. This 30-inch culvert had nearly an inch of water flowing through it, towards the river. Due to the seasonal conditions at the time of the visit, existing snowpack and freezing temperatures, this flow indicates considerable seepage through the right embankment. After viewing the flow through the culvert, the toe of the embankment was investigated to determine whether the seepage was coming through or under the embankment.

A small seep was located several yards east of the large tree in **Figure 3**. **Figure 4** shows the small seep in location to the culvert, and **Figure 5** is a photograph of the seep. The seep does not appear to produce the amount of flow observed at the culvert.


**Figure 4.** Shows the small observed seep in location to the culvert and the embankments.

**Figure 5.** Seep on the right embankment east of the large tree.

After observing a discrepancy in flows between these points, it is apparent that another flow source is contributing to the flow at the culvert. This source could be from flow moving from the east edge of the embankment below the stagnant surface water or from flow under the embankment though a permeable seam flowing into the cattails to the north of the right embankment.

# 6. Seepage Control Alternatives

Several primary objectives must be met when designing seepage control.

- Prevent piping and internal erosion.
- Limit pore pressure, uplift, and seepage forces.
- Prevent slope instability and surface sloughing.
- Prevent "wet spots" and surface erosion.

A secondary objective of seepage rehabilitation is to limit the loss of water in the reservoir. This option, however, does not directly relate to the dam's safety.

After the objectives of the project are defined, alternatives can be selected to fulfill the project needs. In general there are two broad categories of seepage rehabilitation alternatives. The first category is collection and control and the second category is seepage reduction.

## *6.1 Collection & Control*

Collection and control alternatives meet the primary objectives but fail to prevent or reduce the flow of water through the embankment. The goal of collection and control measures is to move the water through the embankment without causing erosion or producing destabilizing forces. Filters are the most common collection and control alternatives and can be designed to service most embankments. Filters consist of sand and gravel layers allowing water to flow without removing fine particles from the embankment. A geotechnical investigation is needed to determine the depth, extent, and material size of the filter.

## *6.2 Seepage Reduction*

Unlike collection and control alternatives, seepage reduction alternatives can meet both the primary and secondary objectives of an embankment rehabilitation project. The goal of seepage reduction alternatives is to create an impervious layer preventing the flow of water through the embankment and its foundation. Geotechnical analysis of the embankment and foundation are crucial to designing seepage reduction measures. The geotechnical analysis can help estimate seepage flow paths and help determine whether the embankment core or foundation is impervious. Grouting, impermeable blankets, and barrier walls are the most common methods to reduce seepage.

Grouting consists of boring holes and filling them with concrete while following the seepage path through the embankment. Although grouting fills the boring holes with impermeable concrete, it is extremely expensive and is more likely to fail than other methods.

Impermeable blankets are typically impermeable clay or geotextile placed on the upstream face of the embankment and possibly out on to the floor of the reservoir, but require draining the reservoir for placement. Impermeable blankets are also expensive and require extensive knowledge of the existing seep in order to properly place the blanket.

Barrier walls are the most common of the three methods for earthen embankments. Barrier walls consist of placing impermeable clay in a trench down to the impermeable foundation. Barrier walls have a high success rate if the wall is placed down to and keyed into the impermeable foundation.

Seepage reduction alternatives can be viewed as either complete or partial cutoff alternatives. Understanding the design of the existing right embankment is crucial to determine cutoff alternatives that could improve the dam's safety and reduce seepage. The "North Dakota Dam Design Handbook" states, "Generally, design class I and II dams have homogenous embankments, are constructed without extensive moisture control, and do not have foundation and embankment drains." (ND Dam Design Handbook). Silver Lake Dam being categorized as a class I dam and the age of the embankment may point to the embankment being constructed with only homogenous materials on a pervious foundation. The USACE "General Design and Construction Considerations for Earth and Rock-Fill Dams" states that "when the dam foundation consists of a relatively thin deposit of pervious alluvium, the designer must decide whether to make a complete cutoff or allow a certain amount of under seepage to occur under controlled conditions. It is necessary for a cutoff to penetrate a homogenous isotropic foundation at least 95 percent of the full depth before there is any appreciable reduction in seepage beneath the dam. The effectiveness of a partial cutoff in reducing the quantity of seepage decrease as the ratio of the width of the dam to the depth of the penetration of the cutoff increases. Partial cutoffs are effective only when they extend down into an intermediate stratum of lower permeability. This stratum does not negate the effectiveness of a partial cutoff." (USACE). Based on this, more information in the form of a geotechnical investigation is needed to determine the makeup of the soils and the location of an impervious layer, if any, before a seepage reduction alternative can be considered for Silver Lake's right embankment. Excessive amounts of material would likely need to be removed in order to place an impervious layer deep enough to reduce the seepage. Seepage reduction alternatives would likely be infeasible when compared to collection and control alternatives due to cost. For this reason, seepage reduction alternatives were not examined in this report.

Two things must be accomplished for each alternative. The first is a complete geotechnical analysis of the site, and the second is removal of the large tree and brush on the right embankment.

# 7. Project Alternatives

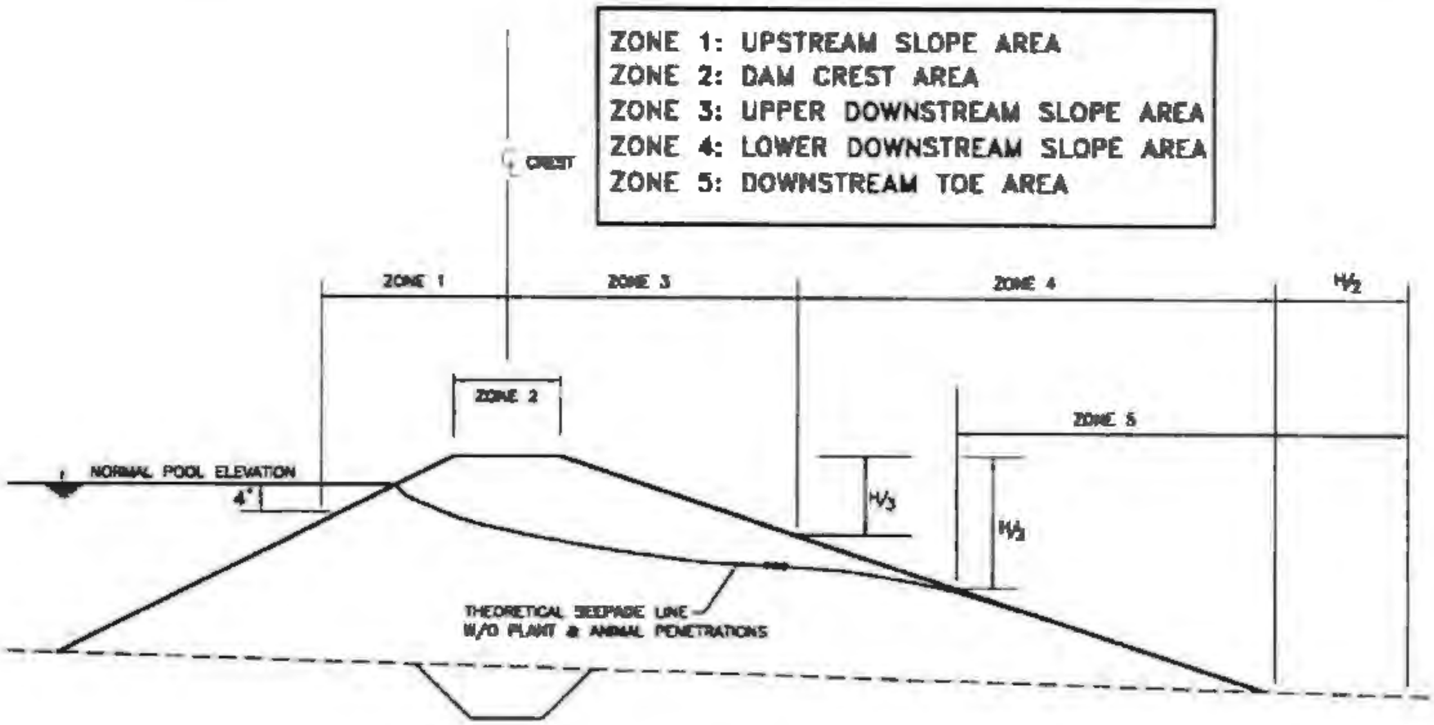
## *7.1 Geotechnical Analysis*

A geotechnical analysis of the site is needed to improve the understanding of how the embankment is seeping and determining which embankment rehabilitation alternatives would have the best chance of success. Soil borings of the embankment and downstream cattail slough would provide information on the composition of the embankment and foundation, leading to an understanding of the flow path the seep is following. The recommended geotechnical analysis would include at least five soil borings, four would be at a depth of 50-feet and one at 100-ft along with a geotechnical report to provide sufficient information to create rehabilitation designs. A preliminary cost estimate, provided by a geotechnical consulting firm in the region, was $20,000. Adding contingency of 20 percent to this estimate to account for review and overages brings estimated cost of the geotechnical analysis of the site to about $24,000. This initial geotechnical investigation may result in a recommendation for more borings and testing.

## *7.2 Embankment Maintenance*

Clearing the embankment of woody vegetation is necessary to maintain embankment integrity. Woody vegetation, such as shrubs or trees, grow extensive root systems that can grow through the embankment leaving flow paths along each root. This can cause erosion of the embankment, which can lead to the failure of the embankment. Each year, dam operators should examine the embankment making sure there are no new trees or shrubs growing on the embankment.

The large tree growing in the right embankment presents a hazard to the dam and should be removed regardless of which alternative is chosen. Removal of this tree will require excavation to remove its root system which could lead to the failure of the embankment if proper construction methods aren't used. FEMA details several inspection and evaluation zones in an earthen embankment and the significance of having woody vegetation in each zone. **Figure 6,** from FEMA's "Technical Manual for Dam Owners", details the inspection and evaluation zones. The large tree located on Silver Lake's embankment is located in Zone 4. "Zone 4 is one of the two most critical zones relative to dam safety issues associated with tree and woody vegetation growth as well as other potential dam safety issues. This zone typically contains the interceptions of both the zone of saturation and the seepage line with the downstream slope. The close proximity of the zone of saturation and seepage line to the surface of the downstream embankment slope in this zone is a critical factor relative to dam safety issues associated with tree and woody vegetation growth" (FEMA Dam Owners). For these reasons, FEMA guidelines suggest complete removal of trees having a diameter greater than about six inches. The repairs of the tree removal process on page 6-9 of FEMA's "Technical Manual for Dam Owners", recommends a subdrain or filter be installed in the root ball cavity. The filter system installed would need to connect to a major subdrain such as a toe drain.




REMEDIAL DAM REPAIR ZONES

**Figure 8**

**Figure 6.** Inspection and evaluation zones for wooded vegetation (FEMA Dam Owners, 4-14).

Many small diameter willows are also located in Zone 4 of Silver Lake's right embankment. FEMA guidelines for removing trees of this diameter in Zone 4 call for removing the tree flush with the ground and treating the stumps with wood preservative.

Based on FEMA's guidelines for tree removal in Zone 4, consideration should be placed on stabilizing the embankment during tree removal. A temporary cofferdam on the upstream side of the right embankment near the large tree, would reduce the surface pressure the water would place on the embankment and reduce the risk of dam failure while removing the tree. The void left by removing the tree's root ball would be filled with drain material and capped with an impervious clay material. After repairs are made, the temporary cofferdam could be removed. The cofferdam required to maintain the stability of the embankment during the root ball removal along with drain placement makes removing a tree in Zone 4 expensive.

### *7.3 Alternative 1- No-Change Alternative*

Alternative 1 is a no-change alternative. A no-change alternative would leave the embankment in its existing condition, but would not comply with standard dam maintenance practices. Removal of the large tree and the willows is necessary maintenance.

The seep through the right embankment would likely continue as it has for the last 17 years. The site visit on December 4th of 2015 indicates that the seep is not currently carrying sediment.

The first priority of a seepage rehabilitation project is to insure dam safety. Silver Lake Dam is classified as a low hazard dam that would provide no imminent danger if it failed. Figure 2 shows the flood wave dissipating within a few miles downstream, likely causing minor erosion to agricultural land and county roads. The seep as viewed on December 4th appears to be causing no erosion. The cattail slough downstream of the embankment may be acting as a natural filter, capturing eroding particles and preventing them from moving downstream.

Besides dam safety concerns, maintaining the pool in Silver Lake would also be a concern with Alternative 1. The seep could continue and create issues with loss of recreational use, however, this does not currently seem to be an issue due to the ongoing wet cycle.

A cost estimate was prepared using "RSMeans Heavy Construction Cost Data 2014" and estimates based on previously constructed projects. **Table 3** is a cost estimate for alternative 1, the removal of the wooded vegetation from the right embankment. The cost estimate includes a cofferdam, which is necessary to maintain the stability of the dam during tree removal. A spreadsheet detailing the costs of individual lines of work is located in Appendix C.

**Table 2**. Alternative 1 cost estimate.

| Alternative 1 | |
|---|---|
| Geotechnical Analysis | $24,000 |
| Cost of Materials and Construction | $34,500 |
| 15% Mobilization | $5,000 |
| 10% Design Contingency | $3,500 |
| 20% Contingency | $7,000 |
| **Total Cost** | **$74,000** |

### *7.4 Alternative 2- Filter System*

Alternative 2 would involve the installation of a collection and control structure known as a filter. Filters can be designed to meet a variety of different seepage issues. FEMA describes the types of filters in four separate classes. Using the classification system, "Table 2-1" of FEMA's "Filters for Embankment Dams Best Practices for Design and Construction October 2011", and assuming the foundation and embankment at Silver Lake are pervious, a toe drain would be an appropriate filter system for the right embankment.

Toe drains are composed of sand and gravel layers allowing the passage of water to a perforated drain while blocking particles eroding due to the seep. The drain then conveys the seepage downstream of the embankment. **Figure 7** is the general cross section view of a toe drain edited from "Figure 2-12" from FEMA's "Filters for Embankment Dams Best Practices for Design and Construction October 2011". The designed toe drain would run parallel to the embankment along the downstream toe.

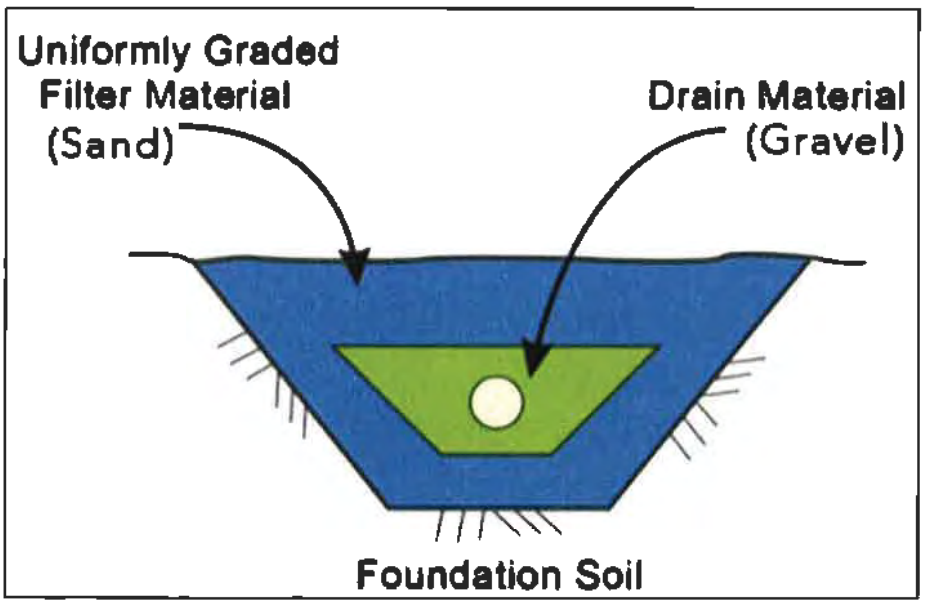



**Figure 7.** Cross section view of a standard toe drain.

Correctly sizing the sand and gravel layers is crucial in preventing soil particles of the embankment from eroding and to maintain the dam's stability. Due to lack of soil samples, general design criteria are used to determine the size of filter materials. "In lieu of complete design, experience has shown that a modification to fine concrete aggregated designated in ASTM C33 meets the design requirements for many foundation materials." (FEMA Filter, 129). **Table 3** is the gradation for ASTM C33 concrete sand.

**Table 3.** ASTM C33 Concrete Sand (FEMA Filter, 129).

| Sieve Size | Percent Passing by Weight |
|---|---|
| 3/8-in | 100 |
| No. 4 | 95-100 |
| No. 8 | 80-100 |
| No. 16 | 50-85 |
| No. 30 | 25-60 |
| No. 50 | 5-30 |
| No. 100 | 0-10 |
| No. 200 | 0-2 |

"In a similar manner, when modified C33 concrete sand is used as a filter, standard materials can be used as the gravel drain that surrounds the pipe. Several materials in ASTM D448 have been checked against modified C33 concrete sand and are included in Table 6-4. When using modified C33 concrete sand, the D448 materials do not have to be checked since the filters size is fixed." (FEMA Filter). **Table 4** is ASTM D448 gradation from Table 6-4 of FEMA's "Filters for Embankment Dams – Best Practices for Design and Construction.". Using these standard materials tested by FEMA, a preliminary toe drain design can be developed for Silver Lake's right embankment.

**Table 4.** ASTM D448 gradation, percent passing by weight (FEMA Filter, 130).

| Sieve Size | Blend 5791 | No.8 | No. 89 |
|---|---|---|---|
| 2-in | - | - | - |
| 1-1/2-in | 100 | - | - |
| 1-in. | 90-100 | - | - |
| 3/4-in. | 75-85 | - | - |
| 1/2-in. | - | 100 | 100 |
| 3/8-in | 45-60 | 85-100 | 90-100 |
| No. 4 | 20-35 | 10-30 | 20-55 |
| No. 8 | 5-15 | 0-10 | 5-30 |
| No. 16 | 0-5 | 0-5 | 0-10 |
| No. 50 | - | - | 0-5 |

The minimum requirements for designing toe drains from the Bureau of Reclamation were used to develop the drains cross sectional layout and determine volumes of materials needed to construct the drain. The preliminary drain design, however, is based on standard specifications for a toe drain design since no geotechnical analysis has been completed. After a geotechnical analysis is complete, the depth of the filter can be designed to meet the projects objectives. **Figure 8** is a preliminary cross section view of the toe drain designed for Silver Lake's right embankment and **Figure 9** is the approximate footprint of the toe drain. Approximate quantities for construction materials to complete the toe drain are in **Table 5** below. Volumes were calculated using the geometry in Figure 6 and given a 15 percent buffer to account for compaction.

**Table 5.** Toe drain material quantities.

| Material | Volume (C.Y.) | Length (ft) | Fitting (unit) |
|---|---|---|---|
| ASTM C33 sand or comparable | 304 | - | - |
| ASTM D448 or comparable | 45 | - | - |
| Clay (gradation to be determined) | 445 | - | - |
| 8-in perforated double wall HDPE | - | 260 | - |
| 8-in HDPE Tee Adaptor | - | - | 1 |
| 8-in HDPE 22.5 Degree Bend Adaptor | - | - | 3 |
| 8-in HDPE 45 Degree Bend Adaptor | - | - | 1 |

A cost estimate for the construction of the drain designed above was created using several methods. The costs of materials were estimated by contacting local construction firms and material providers, while construction costs were estimated using "RSMeans Heavy Construction Cost Data 2014". The cost estimate includes the removal of the wooded vegetation and creation of a toe drain to control the embankment seepage. A spreadsheet detailing the costs of individual lines of work is located in Appendix C.

**Table 6.** Alternative 2 cost estimate.

| Alternative 2 | |
|---|---|
| Geotechnical Analysis | $24,000 |
| Cost of Materials and Construction | $93,00 |
| 15% Mobilization | $14.000 |
| 10% Design Contingency | $9,000 |
| 20% Contingency | $18,000 |
| **Total Cost** | **$158,000** |

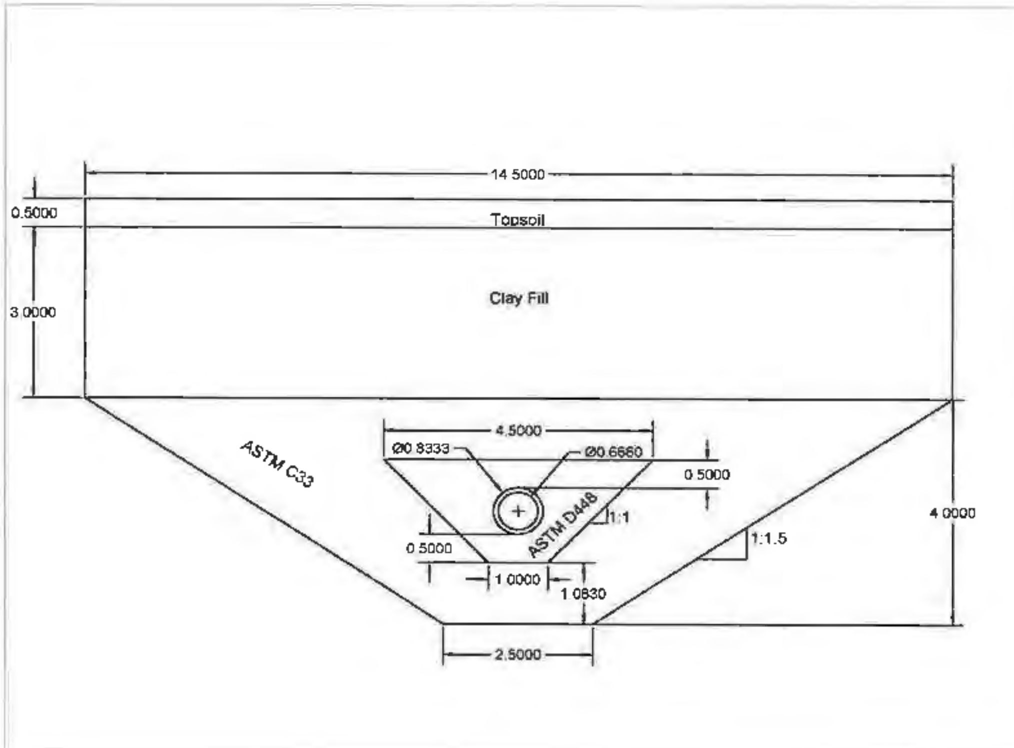



**Figure 8.** Silver Lake proposed toe drain design (dimensions in feet).

North Dakota
State Water Commission

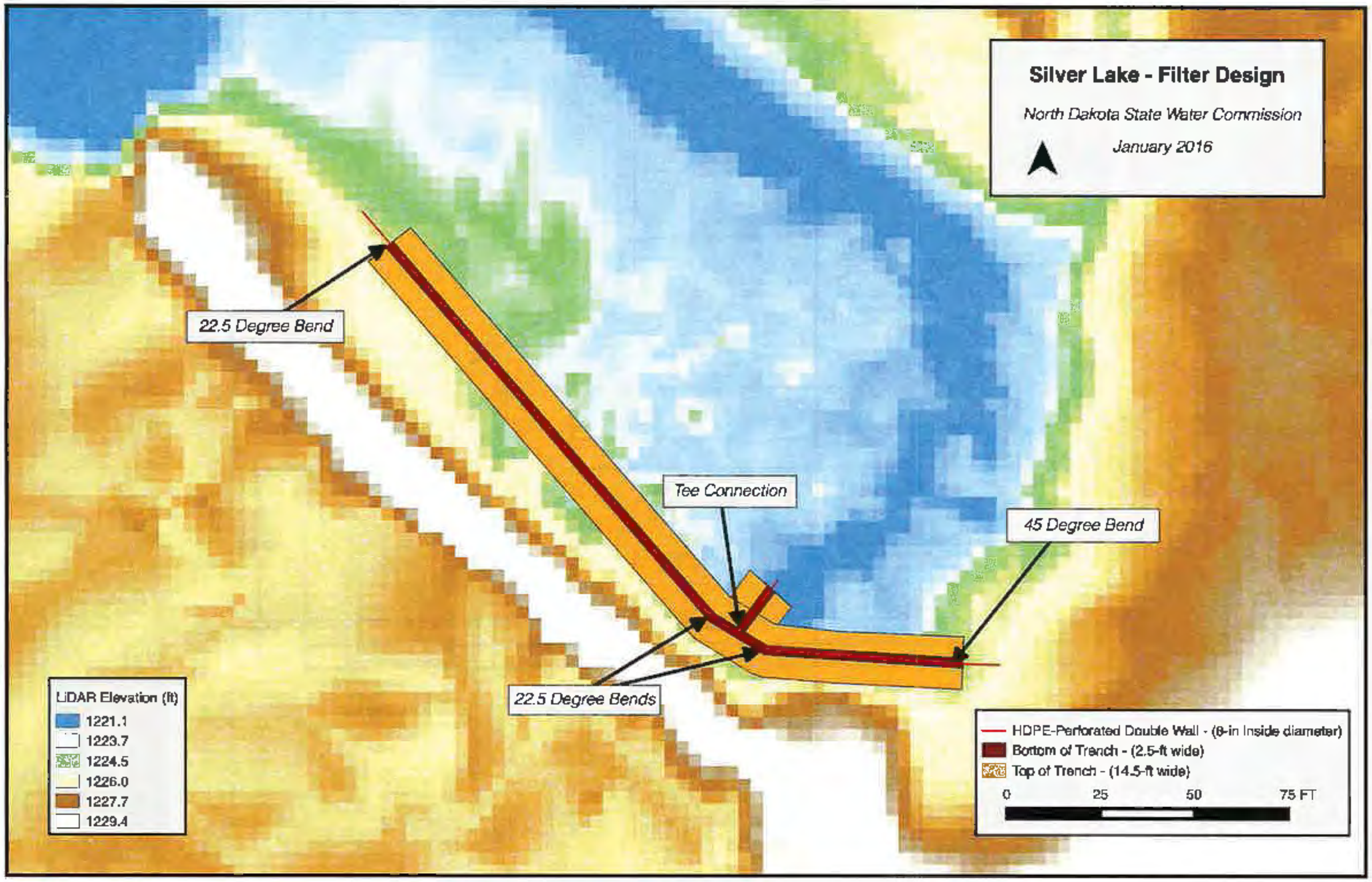



**Figure 9.** Silver Lake proposed toe drain footprint.

## 8. Summary & Recommendation

Two alternatives are detailed in this report, the no-change alternative and the toe drain alternative. Each alternative has advantages and disadvantages that should be carefully considered.

The no-change alternative would require the removal of woody vegetation from the embankment and the creation of a small drain in the void left by the large tree being removed. This alternative would allow uncontrolled seepage to continue through the embankment. The advantage of this alternative is the low cost, **$74,000** compared to toe drain alternative, if the embankment survives. The disadvantages of this alternative are possible loss of recreational use due to low water during dry cycles, and the possibility of soil erosion from the embankment leading to failure of the embankment.

The toe drain alternative would require the removal of wooded vegetation along with the creation of a toe drain. The toe drain would reduce the risk of dam failure due to particle erosion from the seep. The advantages of this alternative is the reduction of dam failure potential. The disadvantage of this alternative is the cost, $158,000 in addition to 50,000 dollars for tree removal in Alternative 1 for a total of **$208,000**.

We recommend the SCWRD proceed with Alternative 2.

## 9. Citations


(FEMA Filter) Filters for Embankment Dams - Best Practices for Design and Construction. Washington, D.C.: U.S. Dept. of Homeland Security, FEMA, 2011. Print.

(FEMA Dam Owners) Technical Manual for Dam Owners Impacts of Plants on Earthen Dams. Washington, D.C.: U.S. Dept. of Homeland Security, FEMA, 2005. Print.

(ND Dam Design Handbook) Moum, A. Richard, and Dale L. Frink. North Dakota Dam Design Handbook. Bismarck, N.D.: North Dakota State Engineer, 1985. Print.

(Reclamation) Bureau of Reclamation (1990). *Design Standards No. 13, Embankment Dams*, Chapter 11: Instrumentation. U.S. Department of the Interior, Bureau of Reclamation, Technical Service Center, Denver, Colorado.

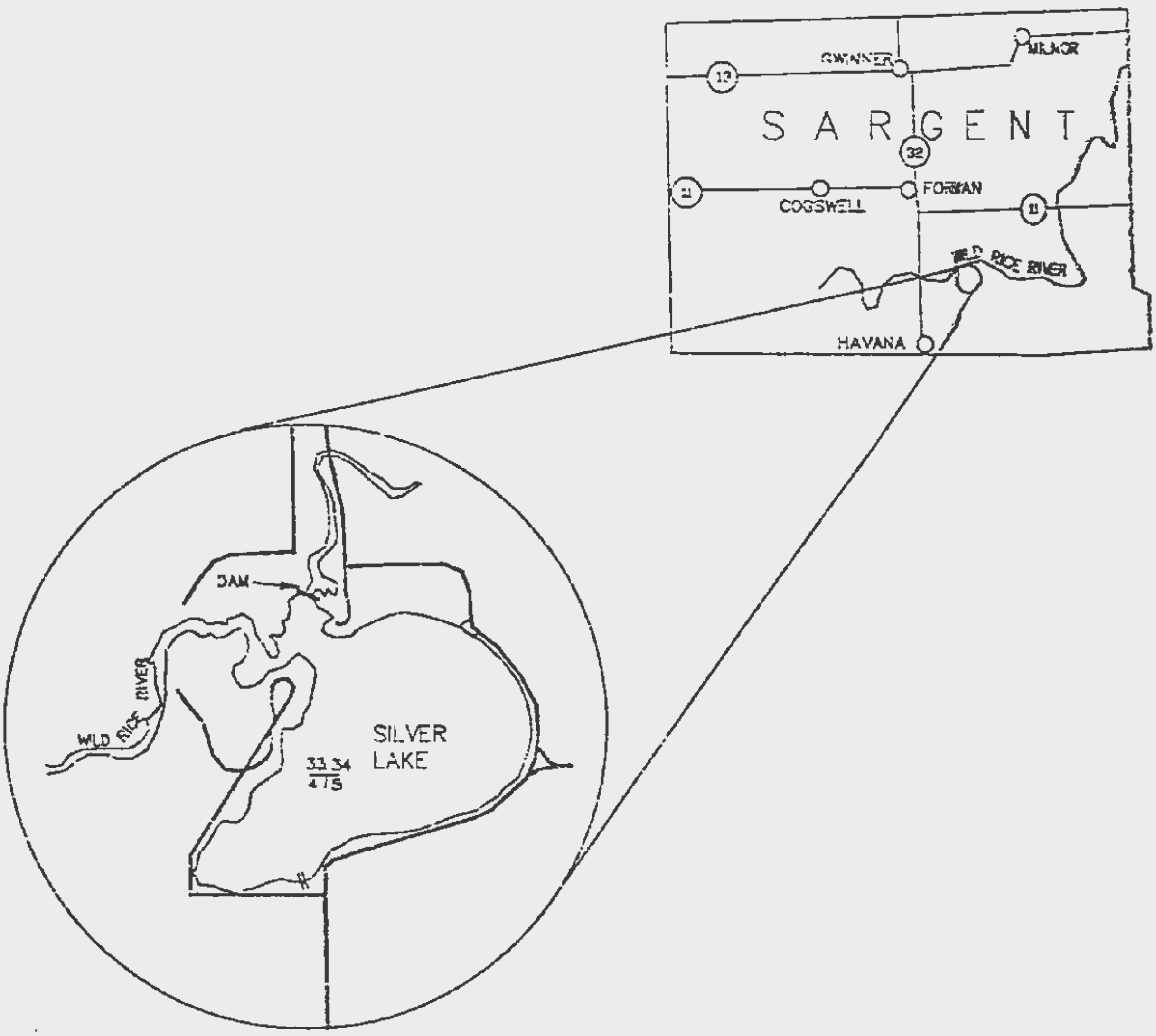
(RSMeans) Fortier, Robert. Heavy Construction Cost Data 2014. 28th Annual ed. Norwell: Reed Construction Data LLC, 2014. Print.

(USACE) "General Design and Construction Considerations for Earth and Rock-Fill Dams." United States Army Corp of Engineers, 30 July 2004. Web. 8 Jan. 2016.

# PRELIMINARY ENGINEERING REPORT

# SILVER LAKE

SWC NO. 391
SARGENT COUNTY




NORTH DAKOTA
STATE WATER COMMISSION

January 1994

# PRELIMINARY ENGINEERING REPORT

Silver Lake
SWC Project #391

January 1994

North Dakota State Water Commission
900 East Boulevard
Bismarck, North Dakota 58505-0850

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### APPENDICES

# I. INTRODUCTION

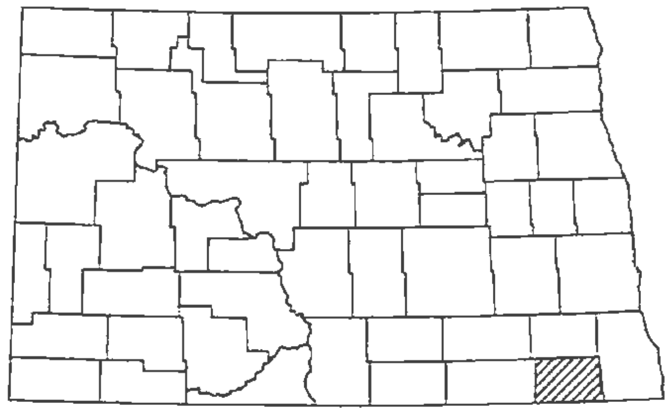
## Study Objectives:

In March of 1992, the North Dakota State Water Commission and the Sargent County Water Resource District entered into an agreement to investigate the feasibility of raising the water level in Silver Lake approximately 2 feet. The agreement called for the State Water Commission to conduct a field survey of the embankment and land adjacent to the reservoir including topographic data, area-capacity data, and bridge and channel geometry; conduct a study of the hydrology of the watershed upstream of the dam; design the outlet works necessary to pass the design flood through the dam; prepare a preliminary cost estimate for the modifications; and prepare a preliminary engineering report presenting the results of the investigation. A copy of the agreement is contained in Appendix A.

## Project Location and Purpose:

Silver Lake is located in Sections 33 and 34, Township 130 North, Range 55 West, and Sections 3 and 4, Township 129 North, Range 55 West in Sargent County, approximately 5 miles southwest of the city of Rutland, North Dakota. Figure 1 shows the location of Silver Lake within the state of North Dakota.

Silver Lake was constructed in 1937 by the Works Progress Administration (WPA). The dam was constructed across the Wild Rice River to raise the water level in the lake, which lies adjacent to



# SILVER LAKE

## SWC # 391

## LOCATION MAP

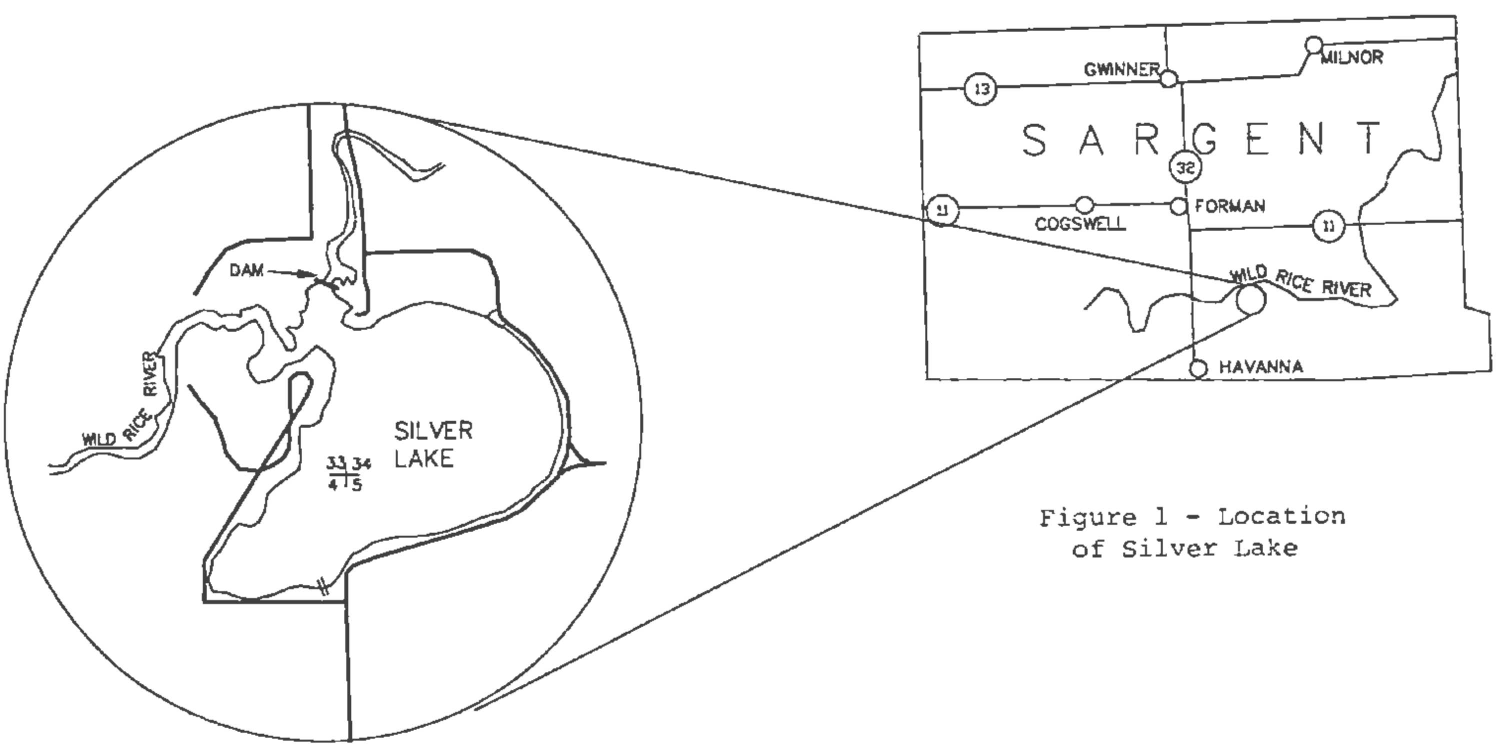



Figure 1 - Location of Silver Lake

the river. The spillway for the dam consists of a 70-foot wide weir. The crest of the weir lies approximately 4 feet above the channel bottom. The spillway was reconstructed in 1967 through a joint effort of the U.S. Bureau of Outdoor Recreation, the Sargent County Park Board, and the State Water Commission.

Silver Lake provides recreational opportunities for a large number of residents in southeast North Dakota. The lake and associated recreation complex provide opportunities for fishing, swimming, boating, camping, picnicking, and other water-based recreational activities.

The water level in Silver Lake fluctuates significantly, depending on the amount of flow in the Wild Rice River, which flows intermittently. Low water levels in recent years have limited the recreational opportunities associated with Silver Lake. This investigation will evaluate the feasibility of raising the water level in Silver Lake 2 feet. A higher water level will enhance the use of Silver Lake and its associated recreational facilities.

## II. GEOLOGY AND CLIMATE

Silver Lake is located adjacent to the Wild Rice River. The Wild Rice River drainage basin rises in the glaciated uplands in western Sargent County, and extends easterly through Lake Tewaukon before turning northward to join the Red River in Cass County, 8 miles south of Fargo. The topography of the basin varies greatly from its source to its mouth. From the headwaters north of the Sisseton Hills to Lake Tewaukon, the river flows through an area of drift prairie characterized by morainic hills, large swamps, low swales and potholes with no well-established drainage system. As the river continues on towards its confluence with the Red River, the valley depth diminishes then completely disappears.

The climate for the Wild Rice River Basin is characterized by warm summers and cold winters. Frequent spells of hot weather and occasional cool days characterize the summer. Temperatures are very cold in the winter, when arctic air frequently surges over the area. The average temperature for the basin is 42 degrees Fahrenheit. The annual precipitation for the basin is 19.0 inches, most of which falls during the growing season. During summer, most precipitation comes from thunderstorms, which produce heavy rainfalls in short periods over small areas. The prevailing wind direction is from the northwest.

## III. COMPUTER MODELS

**HEC-1:**

A hydrologic analysis of the Wild Rice River Watershed upstream of Silver Lake was performed using the HEC-1 computer model, developed by the U.S. Army Corps of Engineers. The model was used to determine the peak discharges and flow volumes of various frequency storms. It formulates a mathematical hydrologic model of the watershed based on the following data: the amount of rainfall, the rainfall distribution, soil type, land use, and the hydraulic characteristics of the channels and drainage areas. The HEC-1 model is designed to compute the surface runoff of the watershed in relation to precipitation by representing the basin as an interconnected system of hydrologic and hydraulic components. Each component of the model represents an aspect of the precipitation-runoff process within a portion of the subbasin. These components were put into the model to determine the magnitude and duration of runoff from hydrologic events with a range of frequencies.

The model was developed to determine the hydrologic response of the Wild Rice River watershed. The results obtained through the use of the model include: (1) inflow hydrographs, (2) reservoir stage hydrographs, and (3) outflow hydrographs.

HEC-2:

A hydraulic analysis of the channel downstream of Silver Lake was performed using the HEC-2 computer model, developed by the U.S. Army Corps of Engineers. HEC-2 computes water surface profiles for steady, gradually varied flow in natural or man-made channels for flows due to various precipitation events. The data needed to perform these computations includes: flow regime, starting water surface elevation, discharge, loss coefficients, cross-section geometry, and reach lengths. The computational procedure used by the model is based on the solution of the one-dimensional energy equation with energy loss due to friction evaluated with Manning's equation. This computation is generally known as the Standard Step Method.

## IV. PRELIMINARY DESIGN

Dam Classification:

The first step in the investigation of Silver Lake was to determine the dam classification. Design criteria are based on hazard classification and the height of the dam. Hazards are potential loss of life or damage to property downstream of the dam due to releases through the spillway or complete or partial failure of the structure. Hazard classifications listed in the "North Dakota Dam Design Handbook" are as follows:

**Low** - dams located in rural or agricultural areas where there is little possibility of future development. Failure of low-hazard dams may result in damage to agricultural land, township and county roads, and farm buildings other than residences. No loss of life is expected if the dam fails.

**Medium** - dams located in predominantly rural or agricultural areas where failure may damage isolated homes, main highways, railroads, or cause interruption of minor public utilities. The potential for the loss of a few lives may be expected if the dam fails.

**High** - dams located upstream of developed and urban areas where failure may cause serious damage to homes, industrial and commercial buildings, and major public utilities. There is a potential for the loss of more than a few lives if the dam fails.

Considering that it is located in a rural area, and that no loss of life is expected if the dam fails, Silver Lake is classified as a low-hazard dam.

After a dam has been given a hazard category, it can be classified according to its height. The following table was listed in the "North Dakota Dam Design Handbook":

**Table 1 - Dam Design Classification**

| | Hazard Categories | | |
|---|---|---|---|
| Dam Height (feet) | Low | Medium | High |
| Less than 10 | I | II | IV |
| 10 to 24 | II | III | IV |
| 25 to 39 | III | III | IV |
| 40 to 55 | III | IV | V |
| Over 55 | III | IV | V |

Silver Lake has a low hazard classification and an embankment height of less than 10 feet. Based on this, it is given a Class I classification for design purposes.

For a Class I dam, the spillway must pass the flow due to a 25-year precipitation event without overtopping the dam, and pass the flow due to a 10-year precipitation event within an acceptable velocity.

## Hydrology:

The watershed above Silver Lake was defined using USGS 7.5-minute quadrangle maps of the area. The contributing drainage area for the dam was calculated to be 344 square miles. Figure 2 shows the drainage basin above Silver Lake.

Stream gage records from a gage located approximately 6 miles downstream of Silver Lake near the city of Rutland, North Dakota, were incorporated into the hydrology for the project. Records of yearly peak flow dating back to 1960 were input into a Log Pearson Type III distribution to determine the flow due to various recurrence interval precipitation events. Table 2 contains the results of the Log Pearson Type III distribution that was performed on the Rutland stream gage data.

**Table 2 - Results of Log Pearson Type III Distribution**

| Recurrence Interval | Flow (cfs) |
|---|---|
| 10-year | 584 |
| 25-year | 969 |
| 50-year | 1,312 |
| 100-year | 1,696 |

The peak flow resulting from the 1978 spring runoff at the Rutland stream gage was 600 cfs. This event was approximated as a 10-year precipitation event for design purposes. The flow volume at the Rutland stream gage for the 1978 spring runoff was calculated to be 9,200 acre-feet.

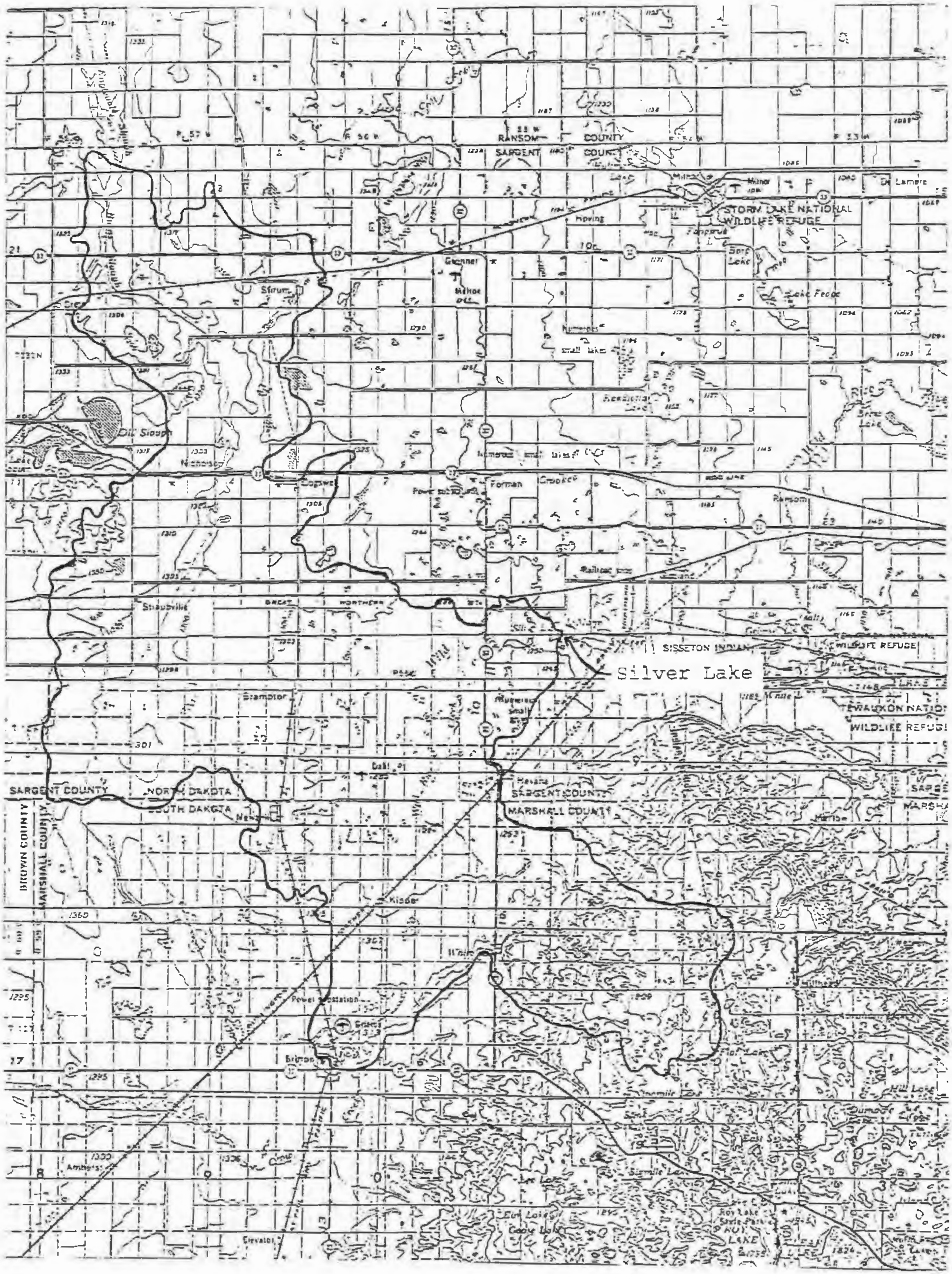



Figure 2 - Drainage Basin Above Silver Lake

The contributing drainage area upstream of the Rutland stream gage was determined to be 352 square miles. Approximately 8 square miles of the drainage area lies downstream of Silver Lake. An HEC-1 model was developed to simulate the 1978 spring runoff at the Rutland stream gage. The HEC-1 model yielded a peak flow of 583 cfs and a total inflow volume of 10,970 acre-feet. Figure 3 shows a comparison of the hydrographs resulting from the 1978 spring runoff and the HEC-1 model used to approximate the 1978 spring runoff.

The 10-year precipitation event at Silver Lake was modelled by removing the 8 square miles of drainage area lying downstream of Silver Lake from the HEC-1 model developed to simulate the 1978 spring runoff at the Rutland stream gage. The 25-year precipitation event at Silver Lake was modelled by changing the precipitation data for the 10-year model. Table 3 shows the resulting peak inflows and total inflow volumes for Silver Lake resulting from the HEC-1 computer model.

**Table 3 - Peak Inflows and Volumes for Design Frequency**

| Event | Peak Inflow (cfs) | Total Inflow Volume (acre-feet) |
|---|---|---|
| 10-year snowmelt | 574 | 10,730 |
| 25-year snowmelt | 1,035 | 19,161 |

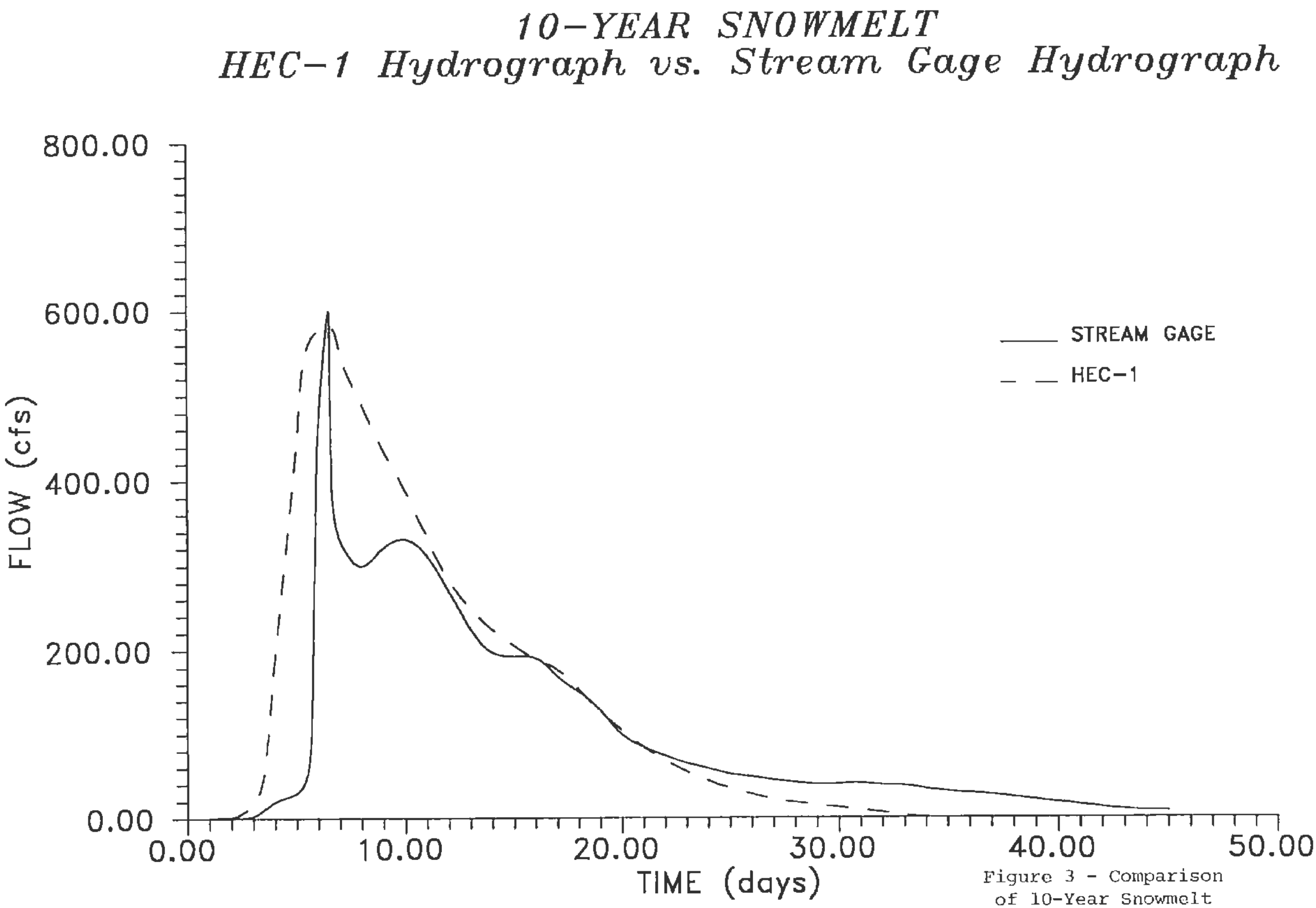



Figure 3 - Comparison of 10-Year Snowmelt Hydrographs

**Reservoir Level:**

The level of Silver Lake is currently controlled at an elevation of 1223.8 msl. At this level, the lake has a maximum depth of approximately 11 feet, an average depth of 7.3 feet, and a volume of 830 acre-feet.

The water level of Silver Lake fluctuates significantly from year to year due to the intermittent flows in the Wild Rice River. Therefore, it is proposed that the water level of Silver Lake be raised approximately 2 feet to enhance the use of the lake and its associated recreational facilities. The new water level will be 1225.8 msl. At this level, Silver Lake will have a maximum depth of approximately 13 feet, a volume of 1,067 acre-feet, and an average depth of 8.5 feet.

**Hydraulic Design:**

The HEC-1 computer model was used to simulate the precipitation versus runoff response for the Wild Rice River Basin upstream of Silver Lake and to route the flows through the dam. The area-capacity curve for the lake and the rating curve for the spillway were needed in order to use the HEC-1 model. The area-capacity curve for Silver Lake was developed using existing information and survey data obtained for the investigation. Figure 4 shows the area-capacity curve. The rating curve for the principal spillway was calculated using the equation for weir flow. The rating curve for the emergency spillway was calculated using

# SILVER LAKE AREA-CAPACITY CURVE

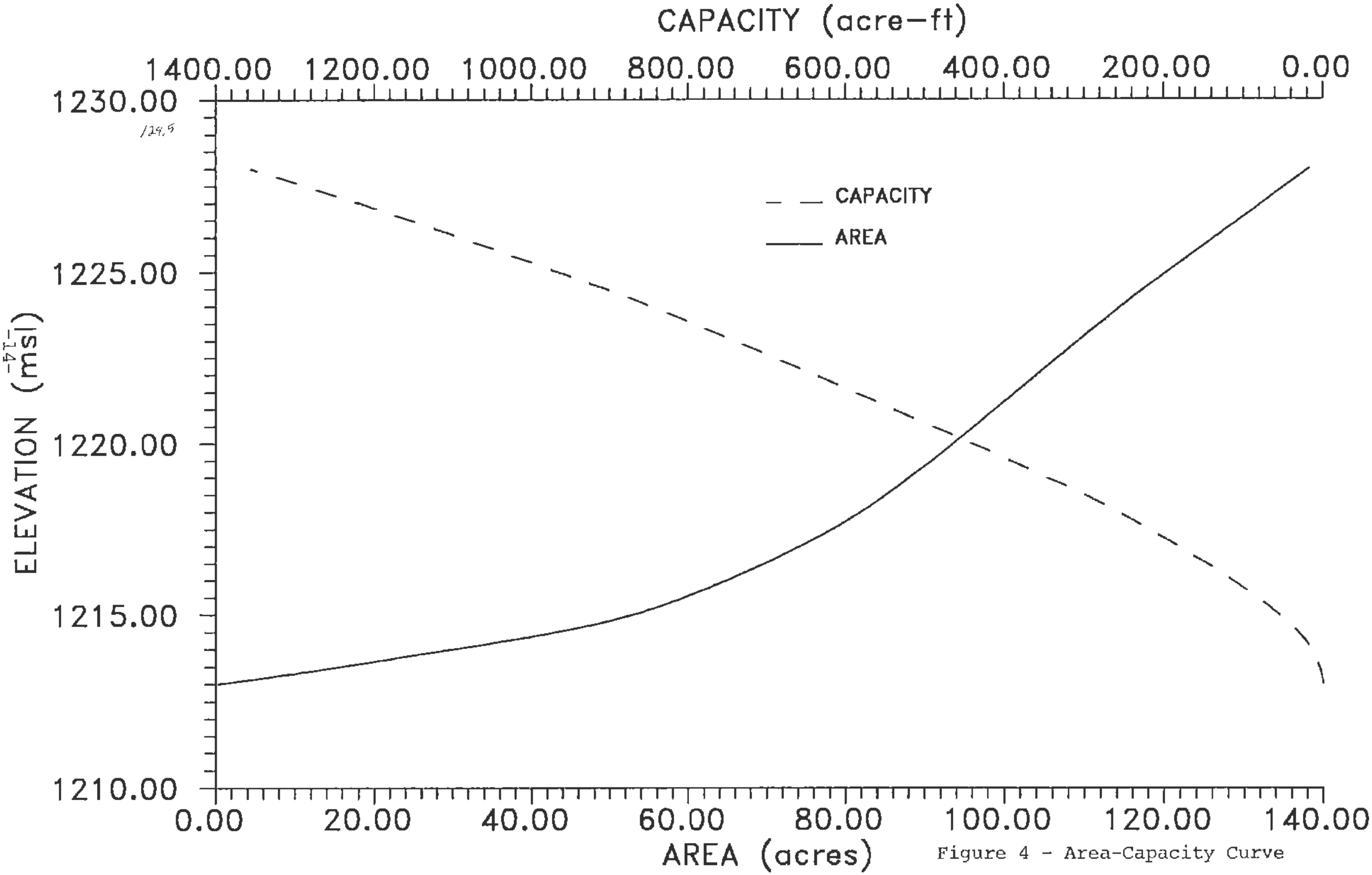



Figure 4 - Area-Capacity Curve

the HEC-2 computer model. The rating curve for the existing spillway on Silver Lake is contained in Table 4.

**Table 4 - Spillway Rating Curve**

| Elevation | Q-Principal (cfs) | Q-Emergency (cfs) | Q-Total (cfs) |
|---|---|---|---|
| 1223.8 | - | - | - |
| 1224.0 | 19 | - | 19 |
| 1224.5 | 127 | - | 127 |
| 1225.0 | 285 | - | 285 |
| 1226.0 | 481 | - | 481 |
| 1226.3 | 858 | 0 | 858 |
| 1226.5 | 963 | 13 | 976 |
| 1227.0 | 1,242 | 47 | 1,289 |
| 1227.2 | 1,360 | 83 | 1,443 |

Table 5 shows the inflow, outflow, and stage for the 10-year and 25-year frequency snowmelt precipitation events as generated using the HEC-1 computer model for existing conditions.

**Table 5 - Results of Hydrologic Study on Existing Conditions**

| Event | Inflow (cfs) | Outflow (cfs) | Stage (msl) |
|---|---|---|---|
| 10-year 10-day snowmelt | 574 | 573 | 1225.7 |
| 25-year 10-day snowmelt | 1,035 | 1,034 | 1226.6 |

**Spillway Modifications:**

The spillway for Silver Lake consists of a 70-foot wide weir. The crest of the weir is currently set at an elevation of 1223.8 msl. The dam also has a 100-foot wide emergency spillway located at the west edge of the embankment. The crest of the emergency spillway is at an elevation of 1226.3 msl. The top of the embankment is at an elevation of 1227.2 msl.

Raising the water level in Silver Lake by 2 feet will require that the crest of the weir be raised to an elevation of 1225.8. By raising the weir, the difference in elevation between the crest of the weir and the control elevation of the emergency spillway is reduced to only 0.5 feet. Considering this, the limited capacity of the emergency spillway, and the difficulty involved in raising the control elevation of the emergency spillway, the emergency spillway on Silver Lake could be eliminated. A Class I dam is required to pass the flows due to a 25-year precipitation event (freeboard precipitation event) without overtopping. Therefore, the principal spillway will be required to pass the freeboard design event. Table 6 shows the rating curve for the spillway on Silver Lake with the increased water level.

**Table 6 - Spillway Rating Curve for Modified Spillway**

| Elevation | Spillway Discharge (cfs) |
|---|---|
| 1225.8 | 0 |
| 1226.0 | 19 |
| 1226.3 | 77 |
| 1226.5 | 127 |
| 1227.0 | 285 |
| 1227.2 | 359 |
| 1227.5 | 481 |
| 1228.0 | 708 |
| 1228.5 | 963 |
| 1229.0 | 1,242 |
| 1229.5 | 1,544 |

Table 7 shows the inflow, outflow, and stage for the 10-year and 25-year frequency snowmelt precipitation events as generated using the HEC-1 computer model for the modified spillway. Figure 5 shows the inflow-outflow hydrograph for Silver Lake during a 25-year precipitation event.

**Table 7 - Results of Hydrologic Study for Modified Spillway**

| Event | Inflow (cfs) | Outflow (cfs) | Stage (msl) |
|---|---|---|---|
| 10-year 10-day snowmelt | 574 | 572 | 1227.7 |
| 25-year 10-day snowmelt | 1,035 | 1,034 | 1228.6 |

The results of the preliminary investigation show that a 2-foot raise in the water level of Silver Lake will require that the top of the dam be raised to a minimum elevation of 1228.6 msl to allow the passage of the freeboard precipitation event without overtopping the dam. Raising the dam to an elevation of 1229.5 msl will allow the modified spillway to have a capacity equal to the capacity of the existing spillway. Therefore, it is recommended that the dam be raised approximately 2.3 feet to an elevation of 1229.5 msl. The raised embankment will have a top width of 10 feet and 3:1 (3 Horizontal to 1 Vertical) side slopes.

<u>Roadway Modifications</u>:

Raising the water level and embankment for Silver Lake will cause several stretches of roadway around the lake to be inundated more frequently. These areas should be raised to a minimum

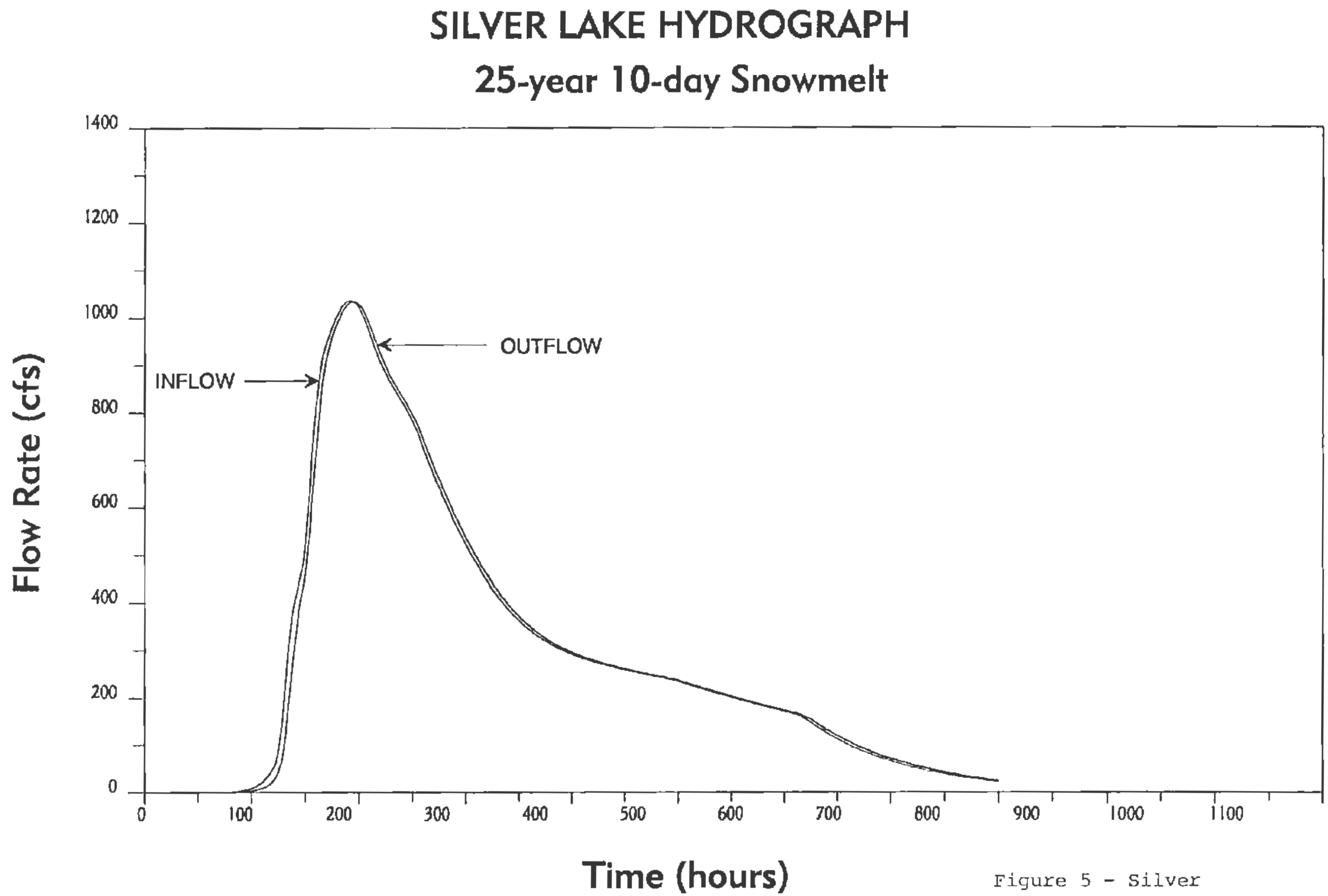



Figure 5 - Silver Lake Hydrograph

elevation of 1229.0 msl. This will ensure that the roads are passable when a 25-year frequency precipitation event is passed through the dam. Figure 6 shows the reaches of road that should be raised and the current center line elevation of the road. The higher water level and steep banks will increase the potential for erosion in these stretches of roadway. Therefore, the banks should be riprapped in these areas to protect the road.

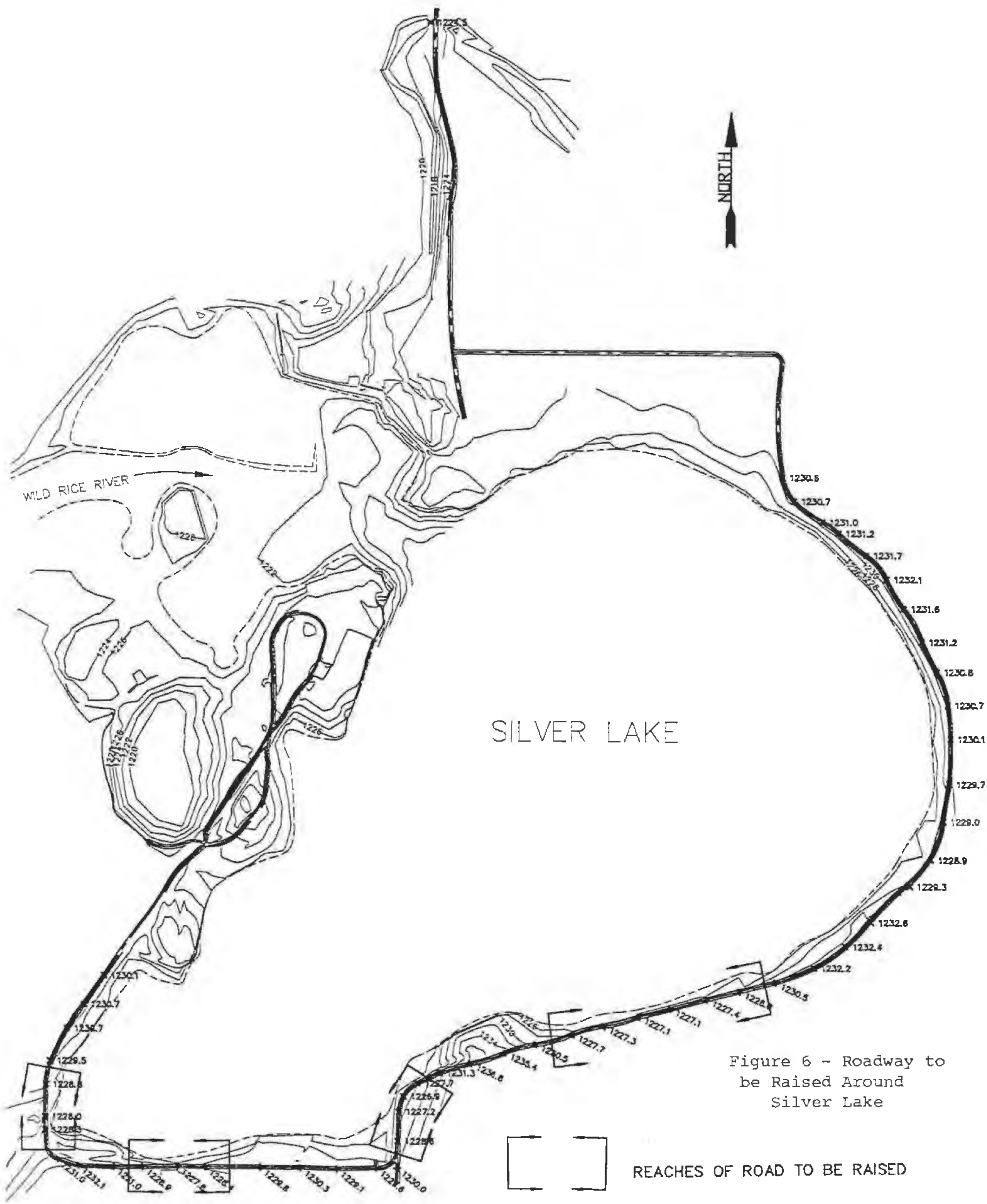



Figure 6 - Roadway to be Raised Around Silver Lake

## V. FISH BARRIER

The Game and Fish Department requested that a fish barrier be designed as part of the investigation to reduce the movement of fish into and out of Silver Lake. The barrier will be located across the channel connecting Silver Lake to the Wild Rice River. Figure 7 shows the location of the fish barrier.

Two alternative fish barriers were considered. The first alternative consists of a rock riprap barrier. The barrier will have a 10-foot top width and 2:1 side slopes. The top of the barrier will be set at an elevation of 1228 msl. The barrier will be approximately 270 feet long and 12 feet high at the maximum section. The top of the barrier will be covered with a gravel overlay to improve access for anglers. Figure 8 shows a typical section of a rock riprap fish barrier. The cost to construct a rock riprap fish barrier is estimated to be $90,000. Table 8 shows the cost estimate for this alternative.

**Table 8 - Cost Estimate for Rock Riprap Fish Barrier**

| Item | Quantity | Unit | Unit Price | Total |
|---|---|---|---|---|
| Mobilization | 1 | LS | $3,000.00 | $ 3,000 |
| Rock Riprap | 2,630 | CY | 25.00 | 65,750 |
| Gravel | 1 | LS | 15.00 | 750 |
| Subtotal | | | | $69,500 |
| Contingencies | | | (+/- 10%) | 6,833 |
| Contract Administration | | | (+/- 10%) | 6,834 |
| Engineering | | | (+/- 10%) | 6,834 |
| Total | | | | $90,000 |

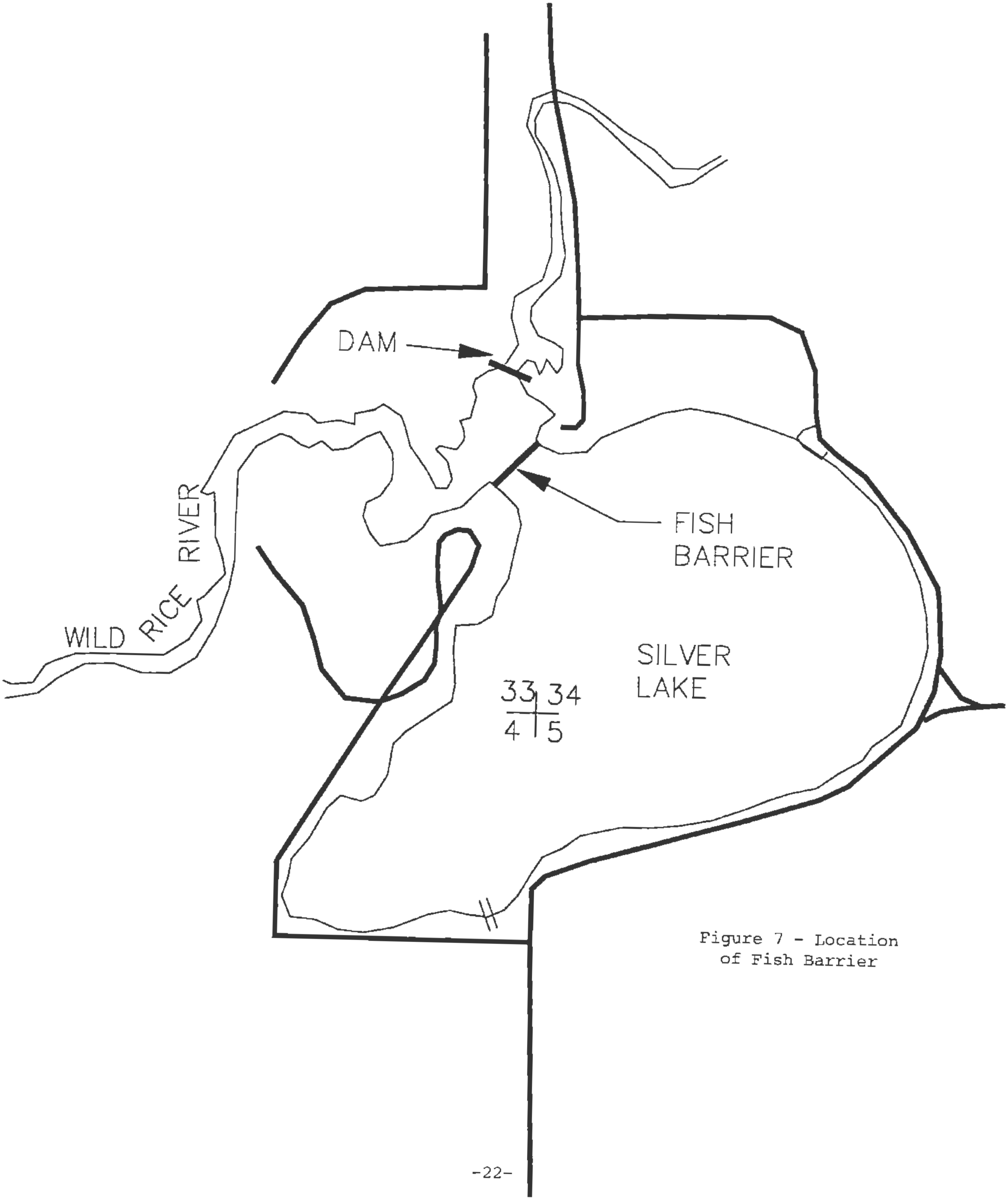
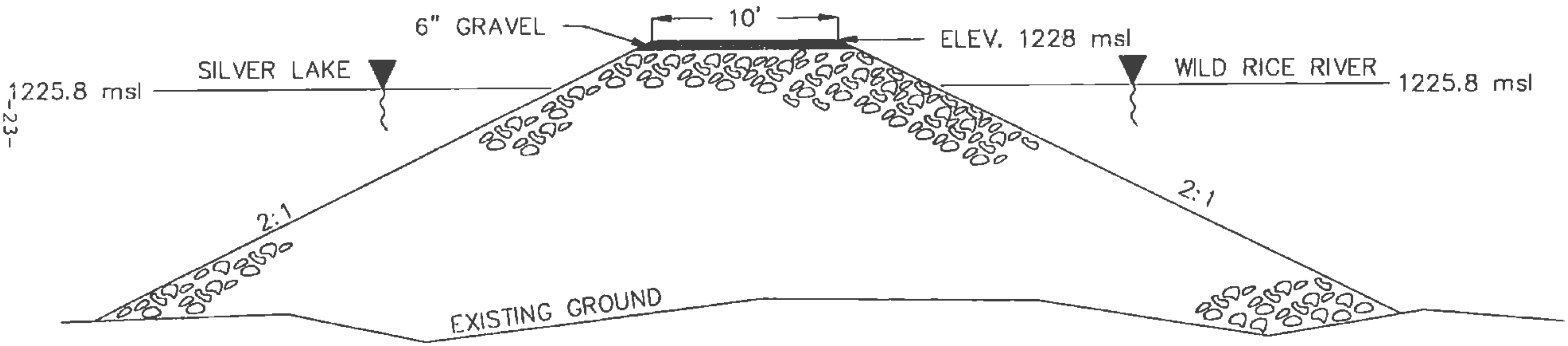



Figure 7 - Location of Fish Barrier




ROCK RIPRAP FISH BARRIER

TYPICAL SECTION

Figure 8 - Typical Section of Rock Riprap Fish Barrier

The second type of fish barrier that was considered consists of a rock-filled gabion structure. The barrier will be constructed by placing sack gabions across the opening between Silver Lake and the Wild Rice River. The gabion structure will be 6 feet wide at the top. The top of the gabion structure will be covered with a gravel overlay to improve access for anglers. The top of the gabion structure will be set at an elevation of 1228 msl. The barrier will be approximately 270 feet long and 12 feet high at the maximum section. Figure 9 shows a typical section of a gabion fish barrier. The cost to construct a gabion fish barrier is estimated to be $70,000. Table 9 shows the cost estimate for this alternative.

**Table 9 - Cost Estimate for Gabion Fish Barrier**

| Item | | Quantity | Unit | Unit Price | Total |
|---|---|---|---|---|---|
| Mobilization | | 1 | LS | $4,000.00 | $ 4,000 |
| Gabions | | | | | |
| (a) 6' long x 3' diameter | | 285 | Ea. | 35.00 | 9,975 |
| (b) 9' long x 3' diameter | | 160 | Ea. | 50.00 | 8,000 |
| (c) 6' long x 2' diameter | | 35 | Ea. | 30.00 | 1,050 |
| Rock Riprap | | 850 | CY | 35.00 | 29,750 |
| Gravel | | 60 | CY | 15.00 | 900 |
| | Subtotal | | | | $53,675 |
| | Contingencies | | | (+/- 10%) | 5,442 |
| | Contract Administration | | | (+/- 10%) | 5,441 |
| | Engineering | | | (+/- 10%) | 5,441 |
| | Total | | | | $70,000 |

A problem associated with constructing a fish barrier across the channel connecting Silver Lake to the Wild Rice River is the potential for sediment to deposit in the fish barrier. Over time, the sediment could become sufficient to reduce the flow of water into Silver Lake. On years when there is low flow in the Wild Rice River, Silver Lake could end up with less water because the flows in the Wild Rice River would pass without much water flowing into the lake. Removing the sediment from the fish barrier, once it becomes a problem, would be very costly.

## VI. LAND AND WATER RIGHTS

Raising the water level in Silver Lake 2 feet will cause additional land around the lake to be flooded. Any private land that will be affected by the increase in water level will require flood easements or purchase. Land acquisition is the responsibility of the local project sponsor. In addition, some of the recreational facilities surrounding Silver Lake, such as the boat ramps and swimming beach, may require some modification to accommodate the higher water level.

There are two water permits relating to the use of water in Silver Lake. Water Permit #648, held by Louis Silseth, authorizes the use of 125 acre-feet of water to irrigate 127 acres. Water permit #3544, held by the Sargent County Park Board, authorizes the appropriation of 590 acre-feet of water (354 acre-feet for storage and 236 acre-feet for annual use to cover evaporative losses) for recreation and fish and wildlife uses. Water permit #648 has a priority date of July 27, 1955, and water permit #3544 has a priority date of March 4, 1982. Since water permit #648 has an earlier priority date, water permit #648 is senior to permit #3544.

Raising the water level in Silver Lake will require an additional water permit for 354 acre-feet of water (286 acre-feet for additional storage and 68 acre-feet for additional annual use for evaporative losses). The new water permit will have a lower priority than the existing water permits on the Wild Rice River.

## VII. PRELIMINARY COST ESTIMATE

As proposed, the cost to raise Silver Lake is estimated to be $73,000. This cost estimate does not include the cost of the fish barrier or the cost of any land acquisition. Table 8 shows the cost breakdown for raising Silver Lake.

**Table 10 - Silver Lake Cost Estimate**

| Item | Quantity | Unit | Unit Price | Total |
|---|---|---|---|---|
| Mobilization | 1 | LS | $5,000.00 | $ 5,000 |
| Clearing and Grubbing | 1 | LS | 3,000.00 | 3,000 |
| Stripping & Spreading Topsoil | 3,500 | SY | 0.25 | 875 |
| Fill | 2,300 | CY | 1.20 | 2,760 |
| Concrete | 20 | CY | 300.00 | 6,000 |
| Reinforcing Steel | 2,800 | Lbs | 0.50 | 1,400 |
| Rock Riprap | 500 | CY | 25.00 | 12,500 |
| Filter Material | 250 | CY | 15.00 | 3,750 |
| Seeding | 1 | Ac. | 300.00 | 300 |
| Roadway Modifications | | | | |
| (a) Fill | 3,130 | CY | 1.20 | 3,756 |
| (b) Gravel | 250 | CY | 15.00 | 3,750 |
| (c) Rock Riprap | 400 | CY | 25.00 | 10,000 |
| (d) Filter Material | 200 | CY | 15.00 | 3,000 |
| Subtotal | | | | $56,091 |
| Contingencies | | | (+/- 10%) | 5,636 |
| Contract Administration | | | (+/- 10%) | 5,636 |
| Engineering | | | (+/- 10%) | 5,637 |
| Total | | | | $73,000 |

## VIII. SUMMARY

The feasibility of raising the water level on Silver Lake approximately 2 feet has been examined. Silver Lake is located in Sections 33 and 34, Township 130 North, Range 55 West, and Sections 3 and 4, Township 129 North, Range 55 West in Sargent County, approximately 5 miles southwest of the city of Rutland, North Dakota. The dam is located on the Wild Rice River and raises the water level in the Silver Lake, which lies adjacent to the river. A higher water level in Silver Lake will enhance the use of the lake and its associated recreational facilities.

Silver Lake is located in a rural area. Failure may result in damage to a county road, but no loss of life is anticipated. Considering this, the dam is classified in the low hazard category. Based on a 9-foot embankment height and a low hazard classification, Silver Lake is classified as a Class I dam for design purposes.

Design events for the hydraulic structures are as follows: 1) the emergency spillway must pass the flows due to a 25-year precipitation event without overtopping the dam; and 2) the emergency spillway must pass the flows due to a 10-year precipitation event within an acceptable velocity. Since the emergency spillway for Silver Lake has a small capacity, and will be difficult to raise, it will be eliminated and the principal

WEIR CAPACITY

C = 3.3
L = 70

$Q = CLH^{3/2} = 3.3(70)H^{3/2} = 231\ H^{3/2}$

$Q = Q_w$

| $H_w$ | $Q_w$ |
|---|---|
| 1 | 231 |
| 2. | 653.368 |
| 3. | 1,200.276 |

spillway will be designed to pass the flows due to a 25-year precipitation event without overtopping the dam.

The principal spillway for Silver Lake consists of a 70-foot wide weir. The crest of the weir controls the water level in Silver Lake at an elevation of 1223.8 msl. Raising the water level in the lake 2 feet will require that the crest of the weir be raised to an elevation of 1225.8 msl.

The HEC-1 computer model was used to simulate the precipitation versus runoff response for the Wild Rice River Basin upstream of Silver Lake and to route the flows through the dam. Analysis with the HEC-1 model indicates that a 2-foot raise in the water level of Silver Lake will require that the top of the dam be raised to an elevation of 1229.5 msl.

Raising Silver Lake 2 feet will cause additional land around the lake to be inundated. Any private land that will be affected by the raise will require easements or purchase. A water permit will also be required for the additional water needed to raise the lake.

The cost to raise the water level in Silver Lake 2 feet is estimated to be $73,000. This does not include the cost of any land acquisition that may be required for the project. The cost to construct a fish barrier between Silver Lake and the Wild Rice

River is estimated to be $90,000 for a rock riprap barrier and $70,000 for a rock-filled gabion barrier.

## IX. RECOMMENDATIONS

The water level in Silver Lake fluctuates significantly due to intermittent flows in the Wild Rice River, varying weather conditions, and withdrawals from the lake for irrigation. Low water levels in recent years have limited the recreational opportunities associated with Silver Lake. Raising Silver Lake 2 feet will not solve the problem of fluctuating lake levels, but it will enable the storage of additional water when it is available. This will enhance the use of Silver Lake and its associated recreational facilities. Therefore, it is recommended that Silver Lake be raised 2 feet. The decision to proceed with this project is the responsibility of the Sargent County Water Resource District.

# APPENDIX A - COPY OF AGREEMENT

SWC Project #391
December 2, 1991

# A G R E E M E N T

## Investigation of Raising the Water Level in Silver Lake

### I. PARTIES

**THIS AGREEMENT** is between the North Dakota State Water Commission, hereinafter Commission, through its Secretary, David A. Sprynczynatyk; and the Sargent County Water Resource District, hereinafter District, through its Chairman, Danny Jacobson.

### II. PROJECT, LOCATION, AND PURPOSE

The District has requested the Commission to investigate the feasibility of raising the water level in Silver Lake approximately 2 feet. The Project is located in Section 33, Township 130 North, Range 55 West. The District feels the additional water will help maintain a higher water level during dry periods, ensuring the use of their multi-use outdoor recreation complex.

### III. PRELIMINARY INVESTIGATION

The parties agree that further information is necessary concerning the proposed project. Therefore, the Commission shall conduct the following:

1. A field survey of the embankment and land adjacent to the reservoir including topographic data, area-capacity data, and bridge and channel geometry;

2. A study of the hydrology of the watershed upstream of the dam;

3. A preliminary design of the outlet works necessary to pass the design flood through the dam;

4. A preliminary cost estimate for the modifications; and

5. Prepare a preliminary engineering report presenting the results of the investigation.

## IV. COSTS

The District shall deposit a total of $2500.00 with the Commission to help defray the field costs associated with this investigation.

## V. RIGHTS-OF-ENTRY

The District agrees to obtain written permission from any affected landowners for field investigations by the Commission, which are required for the preliminary investigation.

## VI. INDEMNIFICATION

The District agrees to indemnify and hold harmless the State of North Dakota, the Commission, its Secretary, their employees and agents, from all claims, suits or actions of whatsoever nature resulting out of the design, construction, operation, or maintenance of the project. In the event a suit is initiated or judgment is entered against the State of North Dakota, the Commission, its Secretary, their employees or their agents, the District shall indemnify any or all of them for all costs and expenses, including legal fees, and any judgment arrived at or satisfied or settlement entered.

## VII. MERGER CLAUSE

This agreement constitutes the entire agreement between the parties. No waiver, consent, modification or change of terms of this agreement shall bind either party unless in writing, signed by the parties, and attached hereto. Such waiver, consent, modification or change, if made, shall be effective only in the specific instance and for the specific purpose given. There are no understandings, agreements, or representations, oral or written, not specified herein regarding this agreement.

| NORTH DAKOTA STATE WATER COMMISSION | SARGENT COUNTY WATER RESOURCE DISTRICT |
| --- | --- |
| By: | By: |
| for DAVID A. SPRYNCZYNATYK<br>Secretary | DANNY JACOBSON<br>Chairman |
| WITNESS: | WITNESS: Sherry Hosford |
| DATE: 3 Dec 91 | DATE: 4 Mar 92 |

# APPENDIX B - SYMBOLS AND ABBREVIATIONS

## SYMBOLS AND ABBREVIATIONS

cfs - cubic feet per second

HEC - The Hydrologic Engineering Center

msl - mean sea level

SWC - State Water Commission

WPA - Works Progress Administration

USGS - United States Geological Survey

# Appendix B – Braun Intertec Geotechnical Report

# Geotechnical Evaluation Report

Silver Lake Dam
135the Avenue Southeast and Klefstad Access Road
Sargent County, North Dakota

*Prepared for*

## Moore Engineering, Inc.

**Professional Certification:**
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 North Dakota.

Ezra Ballinger, PE
Principal/Senior Engineer
Registration Number: PE-7328
August 16, 2019

REGISTERED PROFESSIONAL ENGINEER
EZRA
BALLINGER
PE 7328
DATE 8/16/2019
NORTH DAKOTA

Project B1900400

Braun Intertec Corporation

BRAUN INTERTEC
The Science You Build On.

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INTERTEC
The Science You Build On.

**Braun Intertec Corporation**
526 10th Street NE, Suite 300
P.O. Box 485
West Fargo, ND 58078

Phone: 701.232.8701
Fax: 701.232.7817
Web: braunintertec.com

August 16, 2019

Project B1900400

Joshua Hassell, PE, CFM
Moore Engineering, Inc.
444 Sheyenne Street, Suite 301
West Fargo, ND 58078

Re: Geotechnical Evaluation
Silver Lake Dam
135th Avenue Southeast & Klefstad Access Road
Sargent County, North Dakota

Dear Mr. Hassell:

We are pleased to present this Geotechnical Evaluation Report for the Silver Lake Dam in Sargent County, North Dakota.

Thank you for making Braun Intertec your geotechnical consultant for this project. If you have questions about this report, or if there are other services that we can provide in support of our work to date, please contact Ezra Ballinger at 701.205.2515 (eballinger@braunintertec.com)

Sincerely,

BRAUN INTERTEC CORPORATION

Ezra Ballinger, PE
Principal/Senior Engineer

Charles D. Hubbard, PE
Principal Engineer/Geologist

# Table of Contents

**Description** **Page**



BRAUN INTERTEC

# Table of Contents (continued)

# A. Introduction

## A.1. Project Description

This Geotechnical Evaluation Report addresses the remediation of seepage impacts to the Silver Lake Dam, which is located south of the intersection between 135th Avenue Southeast and Klefstad Access Road in Sargent County, North Dakota. A North Dakota State Water Commission (NDSWC) report from February 2016 reported seepage exiting the downstream side of the dam, marked by tell-tale cattails and other hydrophilic plant growth. The dam is approximately 10 feet high and includes a concrete spillway over which water flows out of Silver Lake into the Wild Rice River. The approximate location and configuration of the dam is highlighted in Figure 1.

**Figure 1. Google Earth aerial image with Silver Lake Dam segments highlighted yellow.**

Our original approved scope of work included both an evaluation of the existing dam structure for remediation purposes, and a preliminary evaluation of a possible new dam site. While drilling was in progress for the remediation effort, Moore Engineering, Inc. (Moore), put our evaluation of the new dam site on hold. Thus, the balance of this report addresses only the remediation effort.

## A.2. Site Conditions and History

Silver Lake Dam is located in Sections 33 and 34, Township 130 North, Range 55 west in Sargent County, North Dakota. It is an earthen embankment dam constructed in 1937 by the Works Progress Administration to raise the water level of Silver Lake and provide recreational opportunities. The lake level is controlled by a concrete spillway located near the midpoint of the alignment at elevation 1226.7 feet mean sea level. The impounded lake has a maximum depth of about 13 feet with an average depth just over 9 feet. The dam is categorized as a Class I Low Hazard embankment per the North Dakota Dam Design Handbook. In 1998 the concrete spillway and earth embankment were raised 2 feet to their current elevations. Observation reports by the NDSWC indicate that seepage was impacting the downstream side of the dam before and after the spillway/embankment raise.

## A.3. Purpose

The purpose of our geotechnical evaluation is to characterize subsurface geologic conditions at selected exploration locations along and beside the Silver Lake Dam to assist either with (1) efforts to mitigate seepage impacts to the existing dam or (2) the design and construction of a new dam. Given the suspension of activities involving a new dam, our findings were, as noted, directed only toward the seepage mitigation efforts.

## A.4. Background Information and Reference Documents

We reviewed the following information:

- *Preliminary Engineering Report, Silver Lake SWC Project #391,* prepared by the North Dakota State Water Commission and dated January 1994.
- *Silver Lake Embankment Seepage Investigation, Sargent County, North Dakota,* prepared by the North Dakota State Water Commission and dated February 2016.
- Topographic cross sections at the boring locations, collected by Moore and provided via email from Josh Hassell in February 2019.

We have described our understanding of the proposed construction and site to the extent others reported it to us. Depending on the extent of available information, we may have made assumptions based on our experience with similar projects. If we have not correctly recorded or interpreted the project details, the project team should notify us. New or changed information could require additional evaluation, analyses and/or recommendations.

## A.5. Scope of Services

We performed our scope of services for the project in accordance with our Proposal QTB089297 to Moore, dated November 26, 2018, which was authorized on January 10, 2019. The following list describes the geotechnical tasks completed in accordance with our authorized scope of services.

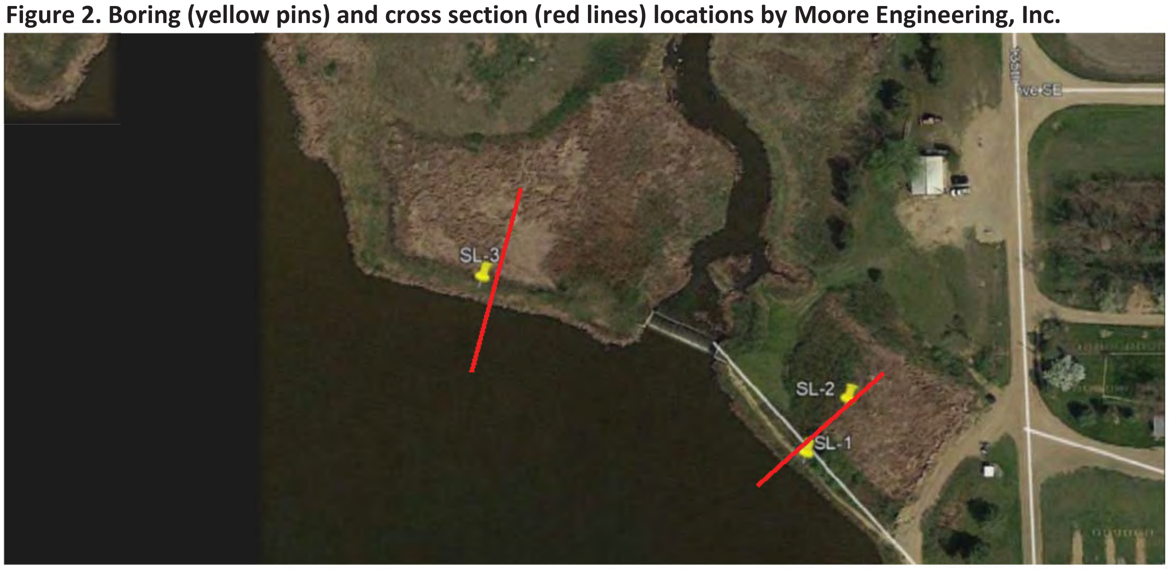
### A.5.a. Reconnaissance

We performed a reconnaissance of the dam on January 15, 2019. We took notes and photos of alignment features related to slope stability, ground cover and seepage.

### A.5.b. Penetration Test Borings

We drilled three standard penetration test (SPT) borings for the project. The approximate locations of the borings are shown in Figure 2.

**Figure 2. Boring (yellow pins) and cross section (red lines) locations by Moore Engineering, Inc.**



Due to snow cover or flood water preventing access on several occasions, drilling was completed on two different mobilizations to the site, one on February 28 and the other on May 7, 2019. Two of the borings, denoted SL-01 and SL-03 and advanced through the dam crest, were extended to a nominal depth of 61 feet; the third boring, denoted SL-02 and advanced through the dry-side grade downslope from the dam crest, was extended to a nominal depth of 41 feet. Standard penetration tests were performed continuously to 16 feet at Borings SL-02 and SL-03, but otherwise at 2 1/2-foot vertical intervals to a nominal depth of 40 feet, and at 5-foot intervals below. Bulk samples were taken of the existing embankment fill, and thin-walled tube samples were taken in cohesive filled and natural soils, as those soils were encountered.

Vibrating wire (VW) piezometers were installed in Borings SL-01 and SL-03 at nominal depths of 6 feet and either 15 or 20 feet, to help establish the piezometric surface within the dam's earth prism.

After the VW piezometers were installed, or drilling was completed, the boreholes were grouted.

Moore surveyed the as-drilled boring locations.

### A.5.c. Sample Review and Laboratory Testing

Recovered samples were returned to our laboratory, where they were visually classified and logged by a geotechnical engineer. To help classify the materials encountered and estimate their engineering properties, we performed 58 moisture content tests, 9 mechanical sieve-hydrometer analyses, 9 unit density determinations, 11 Atterberg limit tests, 2 falling-head permeability tests, and one #200 wash.

### A.5.d. Stability and Performance Analyses

We visually evaluated both of the cross sections shown in Figure 2 and selected the easterly cross section (aligned with Borings SL-01 and SL-02) for seepage and slope stability analyses. We used SEEP/W and SLOPE/W, from the 2019 suite of GeoStudio software by Geo-Slope International, to perform the seepage and slope stability analyses.

We performed steady state seepage analyses with SEEP/W on an analytical model of the existing dam as characterized by our borings and instrumentation, and on a modified model into which we incorporated a dual filter toe drain detail employed by the NDSWC. Elevation and pressure heads were tabulated and used to evaluate downstream toe uplift/heave potential, and the SEEP/W models were also coupled to SLOPE/W analyses used to determine existing and modified downstream slope stability factors of safety.

# B. Results

## B.1. Site Reconnaissance

We initially visited the site in January 2019 when there was snow on portions of the embankment. As a result, we revisited the site in May 2019. The existing embankment does not show signs of global or surficial slope instability. We did not observe scarps, slumps, or other features indicative of a slope stability concern. The cattails identified in the February 2016 NDSWC report are still in place, as is the tree identified in that report. In April 2019, we did note that water was flowing over the embankment west of the spillway in the vicinity of Boring SL-03. Pictures from our reconnaissance are provided below.

**Figure 3. Embankment east of spillway (note large tree through toe of embankment).**

**Figure 4. Embankment west of concrete spillway.**

**Figure 5. West end of embankment west of concrete spillway, note water running overland.**

**Figure 6. Looking east across embankment and spillway.**


## B.2. Geologic Overview

Silver Lake is located in an area of the state underlain by glacial till and glacial outwash deposited as glaciers advanced and retreated across the prehistoric landscape. The glacial till consists of an unsorted, unbedded mixture of rock, gravel and sand in a matrix of silt and clay. The glacial outwash consists of a sorted mix of particles of similar size that were deposited as melt water flowed out from the glaciers. The glacial till and outwash are overlain locally alluvial clays and sands deposited by the Wild Rice River.

We based the geologic origins used in this report on the soil types, laboratory testing, and available common knowledge of the geological history of the site. Because of the complex depositional history, geologic origins can be difficult to ascertain. We did not perform a detailed investigation of the geologic history for the site.

## B.3. Boring Results

Table 1 provides a tabulated summary of subsurface geologic conditions, in the general order we encountered the identified strata. Please refer to the Log of Boring sheets in the Appendix for additional details. The accompanying Descriptive Terminology sheets define the abbreviations given in Table 1.

**Table 1. Subsurface Profile Summary.**

| Strata | Soil Type - ASTM Classification | Range of Penetration Resistances | Commentary and Details |
|---|---|---|---|
| Fill[A] | CL | 3 to 9 BPF where not impacted by frost. | ▪ Encountered at Borings SL-01 and SL-03 with thicknesses of 5 and 7 feet, respectively.<br>▪ Contained variable amounts of sand, trace gravel and trace root matter throughout.<br>▪ Moisture condition generally moist. |
| Swamp deposits | OL | 2 BPF | ▪ Encountered from the surface in Boring ST-02 and was 2 feet thick.<br>▪ Fibrous organic clay that contained roots and was black in color. |
| Alluvial | SP-SM, SM, CL, CH | 2 to 10 BPF | ▪ General penetration resistance of 3 to 5 BPF.<br>▪ Total thickness ranged from about 8 to 13 feet and generally consisted of clay soils over fine-grained sand soils.<br>▪ Moisture condition generally moist at the top of the layer and transitioned to wet or waterbearing at the bottom of the layer. |
| Glacial deposits | SP-SM, SM | 4 to 14 BPF | ▪ General penetration resistance of 8 to 10 BPF.<br>▪ Intermixed layers of glacial outwash and till.<br>▪ Variable amounts of gravel; may contain cobbles and boulders.<br>▪ Moisture condition generally moist for glacial till and waterbearing in the glacial outwash. |
| | CL, CH | 3 to 16 BPF | |

[A] For simplicity, in this report, we define existing fill to mean existing, uncontrolled or undocumented fill.

## B.4. Groundwater

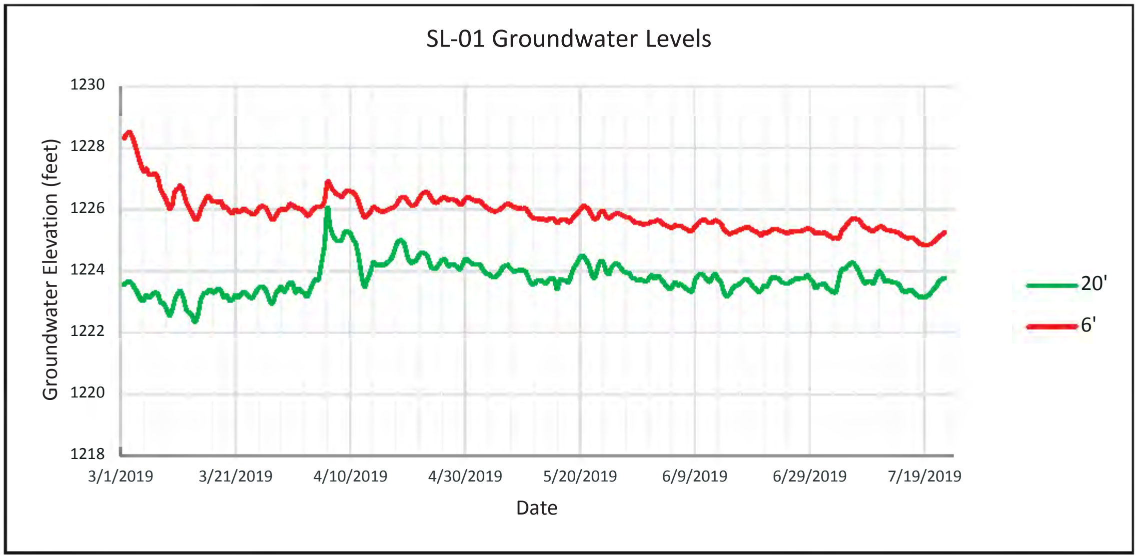
Table 2 summarizes the depths where we observed groundwater; the attached Log of Boring sheets in the Appendix also include this information and additional details.

**Table 2. Groundwater Summary.**

| Location | Surface Elevation | Measured or Estimated Depth to Groundwater (ft) | Corresponding Groundwater Elevation (ft) |
|---|---|---|---|
| SL-01 | 1230.4 | 12 | 1218.4 |
| SL-02 | 1223.1 | 7 | 1216.1 |
| SL-03 | 1229.7 | 12 | 1217.7 |

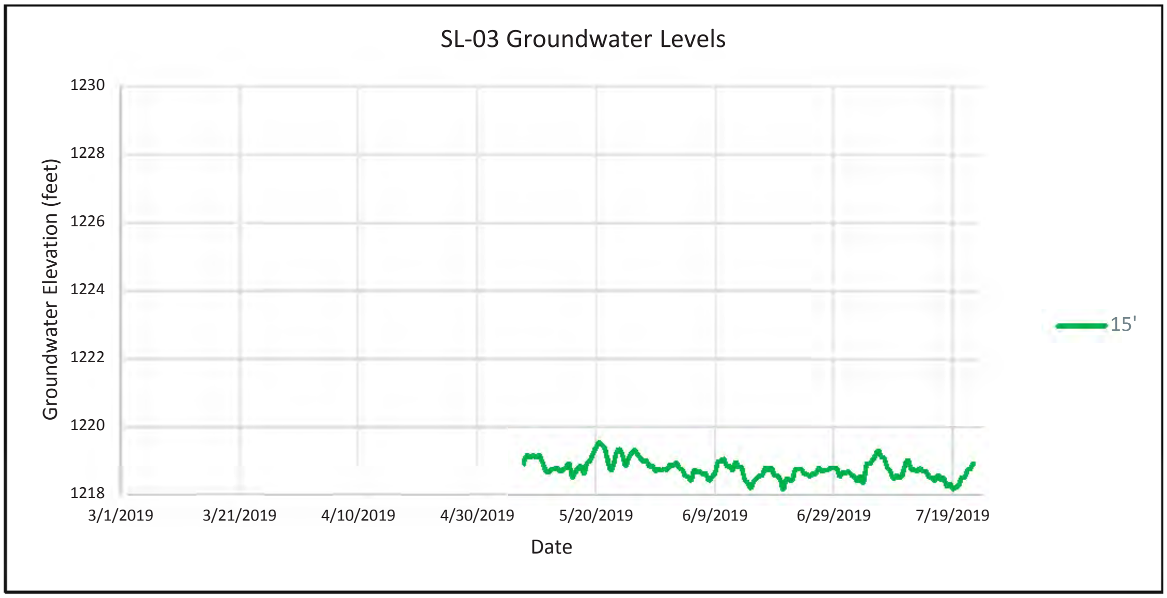
To obtain longer term groundwater level information, two VW piezometers were installed in each of Borings SL-01 and SL-03. The VW piezometers were connected to automatic data loggers to obtain continuous data. In Boring SL-01 the VW piezometers were installed on March 1, 2019 at depths of about 6 and 20 feet. In Boring SL-03 the VW piezometers were installed on May 7, 2019 at depths of 6 and 15 feet. Figures 7 and 8 below show the measured groundwater elevations at each of the VW piezometers (note the piezometers are identified by depth in the graph legend).

**Figure 7. Summary of VW Piezometer Readings in Boring SL-01.**



The VW installed at a depth of 6 feet in Boring SL-03 reported results which translated to water at an elevation about 5 to 6 feet above the surface of the boring. This would suggest that water was under pressure within the dam, which is not believed to be the case, and is not consistent with the higher April 2019 impoundment levels. In any case, whether due to equipment or installation issues, we were not able to obtain satisfactory results from that VW and thus only the results from the VW at 15 feet in Boring SL-03 are shown in Figure 8.

**Figure 8. Summary of VW Piezometer Readings in Boring SL-03.**




As indicated in Figure 7, the hydrostatic groundwater elevation at Boring SL-01 decreased with depth, indicating downward groundwater flow. The results indicate the groundwater elevation has been relatively steady to slightly lowering since about late April 2019. The groundwater level at SL-01 appears to be between the top of the embankment (1230 feet) and bottom of the embankment on the downstream side (1223). (We found consistency, too, in the measured versus analytically simulated water levels, suggesting our SEEP/W modeling was reliable.)

## B.5. Laboratory Test Results

The boring logs show the results of index testing we performed, next to the tested sample depth. We also performed sieve-hydrometer testing and falling head permeability testing. The Appendix contains the results of these tests.

The moisture content of the embankment fill materials varied from approximately 16 to 25 percent, indicating that the material is generally wet of its probable optimum moisture content. The native soils in the upper 10 feet of material below the bottom of the embankment generally had moisture contents of 17 to 38 percent (two samples of silty sand had moisture contents of 13 percent), indicating that they also are wet of their probable optimum moisture content.

Our mechanical analyses indicated that the native soils contained 17 to 81 percent silt and clay by weight. These results indicate the materials tested are classified as silty sand (SM), sandy lean clay (CL), or lean clay with sand (CL).

Liquid limits determined for the native clays ranged from 22 to 42; plastic limits ranged from 10 to 15. These results indicate that the soils tested are lean clay (CL). Two samples of the native sands were tested and were non-plastic, indicating they are silty sand (SM).

Falling head permeability tests performed on thin-walled tube samples obtained from within the embankment at Boring SL-01 and SL-03 had results of $2.3 \times 10^{-6}$ cm/sec and $2.1 \times 10^{-8}$ cm/sec, respectively.

## B.6. Stability and Seepage Analyses

### B.6.a. Cross Sections

Horizontal and vertical coordinates at grade breaks perpendicular to the dam along one cross section through Borings SL-01 and SL-02, and another through Boring SL-03, were inspected for incorporation into a single analytical model for the dam. The data for the cross section through Borings SL-01 and SL-02 was ultimately chosen for analysis as the embankment is higher in this location and is also subject to seepage at this location. Moore provided us upstream topography of the lake bottom from the NDSWC's January 1994 report.

### B.6.b. Material Properties

Based on our laboratory tests and a review of engineering correlations, we assigned the unit weight, shear strength, and hydraulic parameters shown in Table 3 for the material strata built into our analytical model. The table's colors correspond to the colors shown on our analytical output in the Appendix.

**Table 3. Material Properties.**

| Stratum Name | Unit Weight (pcf) | Cohesion (psf) | Friction Angle (degrees) | Horizontal Permeability (ft/day) | $K_y/K_x$ Ratio |
|---|---|---|---|---|---|
| Levee Fill | 125 | 0 | 30 | 3.0E-3 | 1.0 |
| Alluvial Clays | 115 | 0 | 30 | 6.0E-4 | 0.1 |
| Alluvial Sands | 115 | 0 | 29 | 0.1 | 0.1 |
| Glacial Clays | 130 | 0 | 32 | 7.0E-4 | 1.0 |
| Glacial Sands | 120 | 0 | 32 | 0.1 | 1.0 |
| Drainage Sand | 120 | 0 | 32 | 20.0 | 1.0 |
| Drainage Gravel | 135 | 0 | 35 | 100.0 | 1.0 |

For the modified model where drainage relief was added, we included strata representative of the dual filter specified in the NDSWC detail, along with a point-applied hydraulic boundary condition to represent the drainpipe.

### B.6.c. Analytical Results

Included in the Appendix is a series of analytical graphics illustrating the results of our seepage and slope stability analyses, followed by an exit gradient tabulation populated to demonstrate susceptibility or resistance to downstream toe uplift/heave. The graphics include piezometric conditions under steady state seepage, a toe detail showing Y-exit gradient contours and flow vectors, and theoretical slope stability failure limits with associated factor of safety. There is a set of graphics for the existing condition (no toe drain), and a set reflecting the construction of a toe drain.

From a seepage standpoint, our analytical graphics show a positive impact from toe drain construction. The gradient and flow details in particular show how the toe drain draws the steady state piezometric surface down below the dam's downstream embankment toe, effectively mitigating active seepage through and above the toe. The exit gradient tabulation shows that, while the existing condition is not considered vulnerable to downstream uplift/heave (factors of safety relative to critical gradient or opposing vertical forces exceeding 3.0), drain construction produces an approximate 50 percent increase in the gradient factor of safety.

Improvements in dam stability and performance are more pronounced from a slope stability standpoint, with a factor of safety increase from 1.32 for the existing condition to 2.24 for the drained condition. Of course our models assume homogenous conditions through and along the dam but the factor of safety improvements overall lend confidence to seepage mitigation through downstream toe drain construction.

## C. Recommendations

We recommend installing the toe drain along the downstream toe of the embankment extending east from the spillway. While a comprehensive remediation package could specify toe drain construction along both dam segments, there is currently no evidence of seepage to the west. If a case is to be made for toe drain construction to the west, it would need to bear on our slope stability results, which show the influence of drainage collection on slope stability. In the absence of documentation citing seepage to the west of the spillway, it is our opinion that the western dam segment can simply be cleared of weeds, shrubs and other rooted vegetation taller than the predominant grass (compliant with typical guidance on encroachments) to facilitate further, regular inspections of the dam.

### C.1. Cofferdam

We anticipate a cofferdam will be required to facilitate work on the dam east of the spillway. We recommend a cofferdam design be submitted for review, and the design may be based on the parameters provided in Table 4. We recommend material unit weights be adjusted to account for buoyancy where groundwater will not be drawn down, and that the basis for assumed or modeled hydrostatic pressures be defined.

The earth pressure coefficients provided in Table 4 assume a level backfill with no surcharge and would need to be revised for other conditions, including sloping backfill, and dead or live loads placed within a horizontal distance behind the cofferdam that is equivalent to the height of the structure.

**Table 4. Material Parameters for Lateral Earth Pressure Design.**

| Soil Type | Strata Boundary Elevations (feet) | Saturated Unit Weight (pcf) | Friction Angle (degrees) | $K_a$ | $K_o$ | $K_p$ |
|---|---|---|---|---|---|---|
| Levee Fill | Above 1221 | 125 | 30 | 0.33 | 0.50 | 3.00 |
| Alluvial Clays | 1221 – 1217 | 115 | 30 | 0.42 | 0.50 | 2.37 |
| Alluvial Sands | 1217 – 1211 | 115 | 29 | 0.35 | 0.52 | 2.88 |
| Glacial Sands | 1207 – 1194 | 120 | 32 | 0.31 | 0.47 | 3.25 |
| Glacial Clays | Below 1194 | 130 | 32 | 0.31 | 0.47 | 3.25 |

## C.2. Vegetation Removal

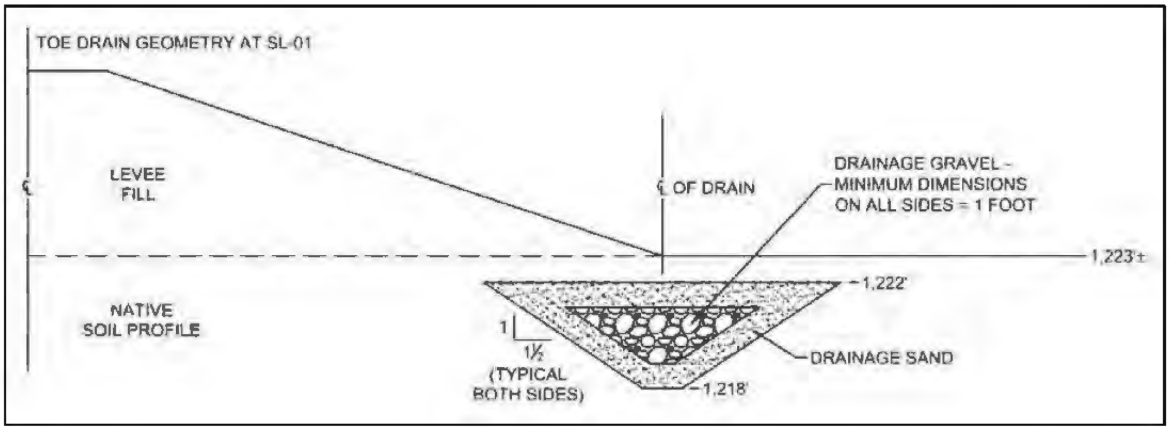
We recommend that all vegetation taller than the predominant embankment grass be removed from the downstream embankment slope, and from within 50 horizontal feet of the embankment toe, where practicable (this is a conservative but typical encroachment limit for dams). Vegetation such as small trees (less than 3-inch diameter trunks) and cattails should be cut off within 2 to 3 inches of the ground surface. Small tree trunks should be treated with preservative to seal the wood root system so it cannot grow any further. Large shrubs/trees over the toe drain alignment can be removed as excavations for drain construction commence.; this includes the aforementioned large tree at the east end of the dam embankment (removal should include the root ball). We anticipate removal of the large tree will need to occur subsequent to cofferdam installation.

## C.3. Toe Drain Construction

### C.3.a. Geometry

The toe drain geometry is illustrated in Figure 9. We recommend the toe drain slope down at a 5 percent gradient to the west, toward the spillway. We anticipate the drain can gravity discharge into the Wild Rice River just downstream from the spillway but this should be checked with the civil design based on the typical flow elevation of the channel.

**Figure 8. Toe Drain Geometry (Not to Scale).**




### C.3.b. Materials

The drainage sand should be sand that is able to achieve a permeability of at least $4.2 \times 10^{-4}$ cm/sec. We anticipate material classified as poorly graded sand (less than 5% of particles passing a #200 sieve) will achieve this classification. Material meeting the requirements of ASTM C33 would achieve this permeability.

The drainage gravel should be ¾-inch to 1 ½-inch diameter stone that is able to achieve a permeability of at least $1 \times 10^{-2}$ cm/sec. Material meeting the requirements of ASTM D448 will achieve this permeability.

# D. Procedures

## D.1. Penetration Test Borings

We drilled the penetration test borings with a flotation tire-mounted core and auger drill equipped with hollow-stem auger. We performed the borings in general accordance with ASTM D6151 taking penetration test samples at continuous, 2 1/2- or 5-foot intervals in general accordance to ASTM D1586. We collected thin-walled tube samples in general accordance with ASTM D1587 at selected depths. The boring logs show the actual sample intervals and corresponding depths. We also collected bulk samples of auger cuttings at selected locations for laboratory testing.

## D.2. Exploration Logs

### D.2.a. Log of Boring Sheets

The Appendix includes Log of Boring sheets for our penetration test borings. The logs identify and describe the penetrated geologic materials, and present the results of penetration resistance tests performed. The logs also present the results of laboratory tests performed on penetration test samples, and groundwater measurements.

We inferred strata boundaries from changes in the penetration test samples and the auger cuttings. Because we did not perform continuous sampling throughout the borings, the strata boundary depths are only approximate. The boundary depths likely vary away from the boring locations, and the boundaries themselves may occur as gradual rather than abrupt transitions.

### D.2.b. Geologic Origins

We assigned geologic origins to the materials shown on the logs and referenced within this report, based on: (1) a review of the background information and reference documents cited above, (2) visual classification of the various geologic material samples retrieved during the course of our subsurface exploration, (3) penetration resistance testing performed for the project, (4) laboratory test results, and (5) available common knowledge of the geologic processes and environments that have impacted the site and surrounding area in the past.

## D.3. Material Classification and Testing

### D.3.a. Visual and Manual Classification

We visually and manually classified the geologic materials encountered based on ASTM D2488. When we performed laboratory classification tests, we used the results to classify the geologic materials in accordance with ASTM D2487. The Appendix includes a chart explaining the classification system we used.

### D.3.b. Laboratory Testing

The exploration logs in the Appendix note most of the results of the laboratory tests performed on geologic material samples. The remaining laboratory test results follow the exploration logs. We performed the tests in general accordance with ASTM or AASHTO procedures.

### D.4. Groundwater Measurements

The drillers checked for groundwater while advancing the penetration test borings, and again after auger withdrawal. We then installed vibrating wire piezometers connected to automatic data loggers to monitor groundwater over a longer period, as noted on the boring logs.

## E. Qualifications

### E.1. Variations in Subsurface Conditions

#### E.1.a. Material Strata

We developed our evaluation, analyses and recommendations from a limited amount of site and subsurface information. It is not standard engineering practice to retrieve material samples from exploration locations continuously with depth. Therefore, we must infer strata boundaries and thicknesses to some extent. Strata boundaries may also be gradual transitions, and project planning should expect the strata to vary in depth, elevation and thickness, away from the exploration locations.

Variations in subsurface conditions present between exploration locations may not be revealed until performing additional exploration work, or starting construction. If future activity for this project reveals any such variations, you should notify us so that we may reevaluate our recommendations. Such variations could increase construction costs, and we recommend including a contingency to accommodate them.

#### E.1.b. Groundwater Levels

We made groundwater measurements under the conditions reported herein and shown on the exploration logs, and interpreted in the text of this report. Note that the observation periods were relatively short, and project planning can expect groundwater levels to fluctuate in response to rainfall, flooding, irrigation, seasonal freezing and thawing, surface drainage modifications and other seasonal and annual factors.

## E.2. Continuity of Professional Responsibility

### E.2.a. Plan Review

We based this report on a limited amount of information, and we made a number of assumptions to help us develop our recommendations. We should be retained to review the geotechnical aspects of the designs and specifications. This review will allow us to evaluate whether we anticipated the design correctly, if any design changes affect the validity of our recommendations, and if the design and specifications correctly interpret and implement our recommendations.

### E.2.b. Construction Observations and Testing

We recommend retaining us to perform the required observations and testing during construction as part of the ongoing geotechnical evaluation. This will allow us to correlate the subsurface conditions exposed during construction with those encountered by the borings and provide professional continuity from the design phase to the construction phase. If we do not perform observations and testing during construction, it becomes the responsibility of others to validate the assumption made during the preparation of this report and to accept the construction-related geotechnical engineer-of-record responsibilities.

## E.3. Use of Report

This report is for the exclusive use of the addressed parties. Without written approval, we assume no responsibility to other parties regarding this report. Our evaluation, analyses and recommendations may not be appropriate for other parties or projects.

## E.4. Standard of Care

In performing its services, Braun Intertec used that degree of care and skill ordinarily exercised under similar circumstances by reputable members of its profession currently practicing in the same locality. No warranty, express or implied, is made.

# Appendix

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# LOG OF BORING

**Braun Project B1900400**
**Geotechnical Evaluation**
**Silver Lake Dam**
**135th Avenue Southeast & Klefstad Access Road**
**Sargent County, North Dakota**

BORING: **SL-01**

LOCATION: See Figure 2.

DRILLER: G. Bevre | METHOD: 3 1/4" HSA, Autohammer | DATE: **2/28/19** | SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

| Elev. feet 1230.4 | Depth feet 0.0 | Symbol | Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908) | BPF | WL | MC % | qp tsf | Tests or Notes |
|---|---|---|---|---|---|---|---|---|
| | | FILL | FILL: Lean Clay with Sand, trace Gravel, brown, moist. | 37* | | | | *Influenced by frost to 2 feet. |
| | | | -brown and black with trace roots at 2 1/2 feet. | 9 | | 16 | | |
| 1225.4 | 5.0 | | | TW* | | 19 | 1/2 | *24 inch recovery. WD=130 pcf, DD=109 pcf |
| | | CL | LEAN CLAY with SAND, trace Gravel, brown and gray, moist, medium. (Alluvium) | | | | | |
| | | | | 6* | | 22 | | *3 inch recovery. |
| 1221.4 | 9.0 | CL | SANDY LEAN CLAY, with Silt seams, gray, moist. (Alluvium) | TW* | | 29 | | *24 inch recovery. WD=119 pcf, DD=92 pcf LL=37, PL=15, PI=22 |
| | | | | | ∇ | | | |
| 1217.4 | 13.0 | | | 5 | | | | An open triangle in the water level (WL) column indicates the depth at which groundwater was first observed while drilling. A solid triangle indicates the groundwater level in the boring on the date indicated. Groundwater levels fluctuate. |
| | | SM | SILTY SAND, fine-grained, gray, wet, loose. (Alluvium) | | | 13 | | |
| | | | -fine- to coarse-grained with a little Gravel at 15 feet. | 7 | | 24 | | |
| 1213.9 | 16.5 | SP-SM | POORLY GRADED SAND with SILT, fine- to medium-grained, brown and gray, wet, loose. (Alluvium) | 10 | | 13 | | |
| 1211.4 | 19.0 | CH | FAT CLAY, trace Gravel, gray, moist, very stiff. (Glacial Till) | 16 | | 24 | 3/4 | WD=130 pcf, DD=105 pcf |
| 1207.4 | 23.0 | | | 15 | | 19 | | |
| | | SM | SILTY SAND with GRAVEL, fine- to coarse-grained, gray, wet, loose to medium dense. (Glacial Outwash) | | | | | |
| | | | | 14 | | 12 | | LL=NP, PL=NP, PI=NP |
| | | | | 13 | | 12 | | |
| | | | | 14 | | 17 | | |
| | | | | | ▼ | | | |

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# LOG OF BORING

**Braun Project B1900400**
**Geotechnical Evaluation**
**Silver Lake Dam**
**135th Avenue Southeast & Klefstad Access Road**
**Sargent County, North Dakota**

BORING: **SL-01 (cont.)**

LOCATION: See Figure 2.

| DRILLER: G. Bevre | METHOD: 3 1/4" HSA, Autohammer | DATE: **2/28/19** | SCALE: **1" = 4'** |
|---|---|---|---|

| Elev. feet 1198.4 | Depth feet 32.0 | Symbol | Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908) | BPF | WL | MC % | qp tsf | Tests or Notes |
|---|---|---|---|---|---|---|---|---|
| | | | SILTY SAND with GRAVEL, fine- to coarse-grained, gray, wet, loose to medium dense. (Glacial Outwash) *(continued)* | 7 | | 17 | | |
| | | | -trace Gravel at 35 feet. | 9 | | 15 | | |
| 1193.9 | 36.5 | CL | SANDY LEAN CLAY, trace Gravel, gray, moist, medium to stiff. (Glacial Till) | 7 | | 15 | 1 | WD=135 pcf, DD=117 pcf |
| | | | | 9 | | 16 | 1 | LL=34, PL=11, PI=23 |
| | | | | 9 | | 15 | 1 1/2 | |
| | | | | 10 | | 14 | 1 1/4 | Installed two vibrating wire piezometers at a depth of 6 feet and 20 feet. |
| | | | | 10 | | 16 | 1 1/4 | |
| | | | | 12 | | 17 | 3/4 | |
| 1169.4 | 61.0 | | END OF BORING.<br>-Water observed at a depth of 12 feet while drilling.<br>-Water observed at a depth of 32 feet with 59 1/2 feet of hollow-stem auger in the ground.<br>-Boring then grouted with neat cement. | | | | | |

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\AX PROJECTS\2019\00400.GPJ BRAUN_V8_CURRENT.GDT 8/16/19 16:36

**BRAUN INTERTEC**

# LOG OF BORING

**Braun Project B1900400**
**Geotechnical Evaluation**
**Silver Lake Dam**
**135th Avenue Southeast & Klefstad Access Road**
**Sargent County, North Dakota**

BORING: **SL-02**

LOCATION: See Figure 2.

| DRILLER: G. Bevre | METHOD: 3 1/4" HSA, Autohammer | DATE: **5/7/19** | SCALE: **1" = 4'** |
|---|---|---|---|

| Elev. feet 1223.1 | Depth feet 0.0 | Symbol | Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908) | BPF | WL | MC % | Tests or Notes |
|---|---|---|---|---|---|---|---|
| 1221.1 | 2.0 | OL | ORGANIC CLAY, trace roots, and organic fibers, black, moist. (Swamp Deposit) | 2 | | | |
| 1219.1 | 4.0 | CL | LEAN CLAY, slightly organic, trace shells and Sand, gray, moist, soft. (Alluvium) | 2 | | 24 | |
| 1217.1 | 6.0 | CL | SANDY LEAN CLAY, gray, moist, soft. (Alluvium) | 2 | | 20 | LL=28, PL=12, PI=16 |
| | | SM | SILTY SAND, fine- to medium-grained, brown, waterbearing, very loose to loose. (Alluvium) | 4 | ▼ | 18 | |
| | | | -with Lean Clay seams at 9 feet. | 6 | | 18 | |
| 1211.1 | 12.0 | | | 9 | | 16 | |
| 1209.1 | 14.0 | CL | LEAN CLAY with SAND, trace Gravel, gray, moist, medium. (Glacial Till) | 5 | | 20 | LL=33, PL=10, PI=23 |
| | | CL | SANDY LEAN CLAY, trace Gravel, gray, moist, soft to stiff. (Glacial Till) | 5 | | 18 | LL=25, PL=10, PI=15 |
| | | | | 3 | | 19 | |
| | | | | 4 | | 18 | |
| | | | | 10 | | 14 | |
| | | | | 9 | | 15 | LL=22, PL=10, PI=12 |
| | | | | 10 | | 17 | |
| | | | | 9 | | 17 | |

(See Descriptive Terminology sheet for explanation of abbreviations)

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# LOG OF BORING

**Braun Project B1900400**
**Geotechnical Evaluation**
**Silver Lake Dam**
**135th Avenue Southeast & Klefstad Access Road**
**Sargent County, North Dakota**

BORING: **SL-02 (cont.)**

LOCATION: See Figure 2.

DRILLER: G. Bevre | METHOD: 3 1/4" HSA, Autohammer | DATE: **5/7/19** | SCALE: **1" = 4'**

| Elev. feet 1191.1 | Depth feet 32.0 | Symbol | Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908) | BPF | WL | MC % | Tests or Notes |
|---|---|---|---|---|---|---|---|
| | | | SANDY LEAN CLAY, trace Gravel, gray, moist, soft to stiff. (Glacial Till) *(continued)* | 9 | | 16 | WD=143 pcf, DD=123 pcf |
| | | | | 7 | | 15 | |
| | | | | 7 | | 19 | |
| 1182.1 | 41.0 | | | 8 | | 19 | WD=142 pcf, DD=119 pcf |
| | | | END OF BORING. | | | | |
| | | | Water observed at a depth of 7 feet while drilling. | | | | |
| | | | Water observed at a depth of 7 feet with 39 1/2 feet of hollow-stem auger in the ground. | | | | |
| | | | Boring then backfilled with neat cement. | | | | |

(See Descriptive Terminology sheet for explanation of abbreviations)

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# LOG OF BORING

**Braun Project B1900400**
**Geotechnical Evaluation**
**Silver Lake Dam**
**135th Avenue Southeast & Klefstad Access Road**
**Sargent County, North Dakota**

BORING: **SL-03**

LOCATION: See Figure 2.

DRILLER: G. Bevre | METHOD: 3 1/4" HSA, Autohammer | DATE: **5/7/19** | SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

| Elev. feet 1229.7 | Depth feet 0.0 | Symbol | Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908) | BPF | WL | MC % | Tests or Notes |
|---|---|---|---|---|---|---|---|
| 1227.7 | 2.0 | FILL | FILL: Lean Clay, trace sand and roots, dark brown, moist. | 5 | | 25 | |
| | | FILL | FILL: Lean Clay with Sand, trace roots and Gravel, brown, moist. | 4 | | 22 | |
| | | | | 3 | | 20 | |
| 1222.7 | 7.0 | | | TW* | | 27 | *24 inch recovery. WD=124 pcf, DD=98 pcf LL=42, PL=13, PI=29 |
| | | CL | LEAN CLAY with SAND, dark gray to black, moist, soft. (Alluvium) | 3 | | 29 | |
| | | | -trace shells at 11 feet. | 8 | ▼ | 21 | WD=133 pcf, DD=110 pcf |
| 1216.7 | 13.0 | | | | | | |
| 1215.7 | 14.0 | SM | SILTY SAND, fine-grained, gray, waterbearing, loose. (Alluvium) | 10 | | 17 | LL=NP, PL=NP, PI=NP |
| 1212.7 | 17.0 | SP-SM | POORLY GRADED SAND with SILT, fine- to coarse-grained, trace Gravel, gray, waterbearing, very loose. (Alluvium) | 4 | | 17 | |
| 1209.7 | 20.0 | CH | FAT CLAY with SAND, gray moist, soft. (Alluvium) | 2 | | 38 | |
| | | CL | LEAN CLAY with SAND, trace Gravel, gray, moist, medium. (Glacial Till) | 5 | | 15 | LL=29, PL=11, PI=18 |
| 1205.7 | 24.0 | | | 7 | | 16 | WD=144 pcf, DD=124 pcf |
| | | CL | SANDY LEAN CLAY, trace Gravel, gray, moist, medium. (Glacial Till) | 8 | | 13 | |
| 1200.7 | 29.0 | | | 8 | | 15 | LL=23, PL=12, PI=11 |
| | | SM | SILTY SAND, fine-grained, trace Gravel, gray, waterbearing, loose to medium. (Glacial Outwash) | 9* | | | * No recovery. |

**Braun Project B1900400**
**Geotechnical Evaluation**
**Silver Lake Dam**
**135th Avenue Southeast & Klefstad Access Road**
**Sargent County, North Dakota**

BORING: **SL-03 (cont.)**

LOCATION: See Figure 2.

DRILLER: G. Bevre | METHOD: 3 1/4" HSA, Autohammer | DATE: **5/7/19** | SCALE: **1" = 4'**

| Elev. feet 1197.7 | Depth feet 32.0 | Symbol | Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908) | BPF | WL | MC % | Tests or Notes |
|---|---|---|---|---|---|---|---|
| | | | SILTY SAND, fine-grained, trace Gravel, gray, waterbearing, loose to medium. (Glacial Outwash) *(continued)* | 11 | | 14 | P200=26% |
| | | | | 10 | | 14 | |
| 1193.2 | 36.5 | SP-SM | POORLY GRADED SAND with SILT, fine- to coarse-grained, trace Gravel, gray, waterbearing, very loose to medium. (Glacial Outwash) | 4 | | 12 | |
| | | | -SILTY SAND layers below 40 feet. | 4 | | 17 | |
| | | | -a little Gravel at 45 feet. | 11 | | 12 | |
| 1181.7 | 48.0 | CL | SANDY LEAN CLAY, trace Gravel, gray, moist, stiff. (Glacial Till) | 11 | | 32 | Installed two vibrating wire piezometers at a depth of 6 and 15 feet. |
| 1176.7 | 53.0 | SM | SILTY SAND, fine- to medium-grained, gray, waterbearing, loose to medium. (Glacial Outwash) | | | | |
| | | | -SANDY LEAN CLAY layers at 55 feet. | 10 | | 15 | |
| | | | | 13 | | 14 | |
| 1168.7 | 61.0 | | END OF BORING.<br>-Water observed at a depth of 12 feet while drilling.<br>-Water observed at a depth of 12 feet with 59 1/2 feet of hollow-stem auger in the ground.<br>-Boring then backfilled with neat cement. | | | | |

(See Descriptive Terminology sheet for explanation of abbreviations)

BRAUN INTERTEC

# LOG OF BORING

**Braun Project B1900400**
**Geotechnical Evaluation**
**Silver Lake Dam**
**135th Avenue Southeast & Klefstad Access Road**
**Sargent County, North Dakota**

BORING: **SL-04**

LOCATION: Moved east from staked location, drilled on shoulder. See Figure 2.

DRILLER: A. Horner | METHOD: 3 1/4" HSA, Autohammer | DATE: **1/17/19** | SCALE: **1" = 4'**

| Elev. feet 1227.0 | Depth feet 0.0 | Symbol | Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908) | BPF | WL | MC % | qp tsf | Tests or Notes |
|---|---|---|---|---|---|---|---|---|
| | | FILL | FILL: Lean Clay with Sand, trace roots, black, frozen then moist when thawed to moist. | FA* | | | | *Frost to 2 feet. |
| | | | | 3 | | 30 | | |
| 1221.5 | 5.5 | | | 7 | | 33 | | |
| | | CL | SANDY LEAN CLAY, brown with iron-staining, stiff, moist. (Glacial Till) | | | | | |
| | | | -brown and gray with iron-staining at 7 1/2 feet. | 9 | | 19 | | |
| 1218.0 | 9.0 | | | | | | | |
| | | SC | CLAYEY SAND, fine- to coarse-grained, trace Gravel, brown and gray with iron-staining, moist, medium dense. (Glacial Outwash) | 23 | ∇ | 16 | | |
| 1215.5 | 11.5 | | | | | | | |
| | | CL | SANDY LEAN CLAY, trace Gravel, brown and gray, moist, medium to stiff. (Glacial Till) | 15 | | 16 | 2 | WD=133 pcf, DD=114 pcf LL=33, PL=12, PI=21 |
| | | | -gray at 15 feet. | 13 | | 15 | 1 1/2 | LL=30, PL=13, PI=17 |
| | | | | 10 | | 13 | 1 1/4 | |
| | | | | 12 | | 16 | | |
| | | | | 7 | | 21 | 1/2 | LL=39, PL=13, PI=26 |

(See Descriptive Terminology sheet for explanation of abbreviations)

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BRAUN INTERTEC

# LOG OF BORING

| Braun Project B1900400<br>Geotechnical Evaluation<br>Silver Lake Dam<br>135th Avenue Southeast & Klefstad Access Road<br>Sargent County, North Dakota | BORING: **SL-04 (cont.)**<br>LOCATION: Moved east from staked location, drilled on shoulder. See Figure 2. |
|---|---|
| DRILLER: A. Horner — METHOD: 3 1/4" HSA, Autohammer | DATE: **1/17/19** — SCALE: **1" = 4'** |

| Elev. feet 1195.0 | Depth feet 32.0 | Symbol | Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908) | BPF | WL | MC % | qp tsf | Tests or Notes |
|---|---|---|---|---|---|---|---|---|
| | | | SANDY LEAN CLAY, trace Gravel, brown and gray, moist, medium to stiff. (Glacial Till) *(continued)* | | | | | |
| | | | | 10 | | 14 | 1/4 | WD=139 pcf, DD 122 pcf LL=32, PL=12, PI=20 |
| | | | | 10 | | 15 | | |
| 1186.0 | 41.0 | | | | | | | |
| | | | END OF BORING.<br>Water observed at a depth of 9 1/2 feet while drilling.<br>Water not observed to cave-in depth of 21 feet immediately after withdrawal of auger.<br>Boring then grouted. | | | | | |

(See Descriptive Terminology sheet for explanation of abbreviations)

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BRAUN INTERTEC

# LOG OF BORING

**Braun Project B1900400**
**Geotechnical Evaluation**
**Silver Lake Dam**
**135th Avenue Southeast & Klefstad Access Road**
**Sargent County, North Dakota**

BORING: **SL-05**

LOCATION: Moved east from staked location, drilled on shoulder. See Figure 2.

DRILLER: A. Horner | METHOD: 3 1/4" HSA, Autohammer | DATE: **1/17/19** | SCALE: **1" = 4'**

| Elev. feet 1228.0 | Depth feet 0.0 | Symbol | Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908) | BPF | WL | MC % | qp tsf | Tests or Notes |
|---|---|---|---|---|---|---|---|---|
| | | FILL | FILL: Lean Clay with Sand, trace roots, black, frozen then moist when thawed to moist. | FA* | | | | *Frost to 1/2 feet. |
| | | | | 11 | | 26 | | |
| 1222.0 | 6.0 | | -drillers noted what felt like Cobbles at 5 feet. | * | | | | *50/2 inches. |
| | | SM | SILTY SAND, fine- to coarse-grained, a little Gravel, brown and gray, wet, loose. (Glacial Outwash) | | ∇ | | | |
| 1218.0 | 10.0 | | | 8 | | 12 | | |
| 1216.5 | 11.5 | CL | SANDY LEAN CLAY, brown and gray, wet, stiff. (Glacial Till) | 11 | | 31 | | |
| | | CH | FAT CLAY, with Silt seams, a little Sand, dark gray, wet, soft. (Glacial Outwash) | 2 | | 46 | | LL=49, PL=24, PI=25 |
| 1211.0 | 17.0 | | | 3 | | 59 | | |
| | | CL | SANDY LEAN CLAY, trace Gravel, gray, moist, stiff. (Glacial Till) | | | | | |
| | | | -2 inch SAND layer, wet at 20 1/2 feet. | 10 | | 16 | | |
| | | | -trace Gravel at 25 feet. | 12 | | 15 | 3 1/4 | WD=140 pcf, DD=122 pcf LL=32, PL=14, PI=18 |
| | | | | | ▼ | | | |
| | | | | 12 | | 16 | 1 1/2 | |

(See Descriptive Terminology sheet for explanation of abbreviations)

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# LOG OF BORING

| Braun Project B1900400<br>Geotechnical Evaluation<br>Silver Lake Dam<br>135th Avenue Southeast & Klefstad Access Road<br>Sargent County, North Dakota | BORING: SL-05 (cont.)<br>LOCATION: Moved east from staked location, drilled on shoulder. See Figure 2. |
|---|---|
| DRILLER: A. Horner / METHOD: 3 1/4" HSA, Autohammer | DATE: 1/17/19 / SCALE: 1" = 4' |

| Elev. feet 1196.0 | Depth feet 32.0 | Symbol | Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908) | BPF | WL | MC % | qp tsf | Tests or Notes |
|---|---|---|---|---|---|---|---|---|
| | | | SANDY LEAN CLAY, trace Gravel, gray, moist, stiff. (Glacial Till) *(continued)* | | | | | |
| | | | | 10 | | 17 | 1 | |
| | | | | 11 | | 17 | 1 | |
| 1187.0 | 41.0 | | END OF BORING.<br><br>Water observed at a depth of 7 feet while drilling.<br><br>Water observed at a depth of 29 feet with 39 1/2 feet of hollow-stem auger in the ground.<br><br>Water not observed to cave-in depth of 14 feet immediately after withdrawal of auger.<br><br>Boring then grouted. | | | | | |

(See Descriptive Terminology sheet for explanation of abbreviations)

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BRAUN INTERTEC

# LOG OF BORING

**Braun Project B1900400**
**Geotechnical Evaluation**
**Silver Lake Dam**
**135th Avenue Southeast & Klefstad Access Road**
**Sargent County, North Dakota**

BORING: **SL-06**

LOCATION: Moved east from staked location, drilled on shoulder. See Figure 2.

DRILLER: A. Horner | METHOD: 3 1/4" HSA, Autohammer | DATE: **1/17/19** | SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

| Elev. feet 1230.0 | Depth feet 0.0 | Symbol | Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908) | BPF | WL | MC % | qp tsf | Tests or Notes |
|---|---|---|---|---|---|---|---|---|
| | | FILL | FILL: Sandy Lean Clay, trace Gravel and roots, brown and black, frozen then moist when thawed to moist. | FA* | | | | *Frost to 1 feet. |
| | | | | 9 | | 21 | | |
| 1226.0 | 4.0 | FILL | FILL: Sandy Lean Clay, trace Gravel, dark brown and gray, wet. | 4 | | 25 | | |
| | | | -trace roots, black and gray at 7 1/2 feet. | 4 | | 28 | | |
| | | | -black at 10 feet. | 5 | ∇ | 19 | | |
| 1219.5 | 10.5 | CL | SANDY LEAN CLAY, trace Gravel, gray, wet, medium. (Glacial Till) | | | | | |
| 1218.5 | 11.5 | CH | FAT CLAY, with Silt lenses, gray, wet, soft to medium. (Glacial Outwash) | 2 | | 32 | | |
| | | | -brown and gray at 15 feet. | 5 | | 40 | | OC=3% |
| 1212.0 | 18.0 | CL | SANDY LEAN CLAY, trace Gravel, gray, moist, soft to stiff. (Glacial Till) | | | | | |
| | | | | 7 | | 16 | 1 | LL=30, PL=11, PI=19 |
| | | | | | ▼ | | | |
| | | | | 4 | | 27 | | |
| | | | | 11 | | 19 | 1/2 | |

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# LOG OF BORING

| | |
|---|---|
| **Braun Project B1900400**<br>**Geotechnical Evaluation**<br>**Silver Lake Dam**<br>**135th Avenue Southeast & Klefstad Access Road**<br>**Sargent County, North Dakota** | BORING: **SL-06 (cont.)**<br>LOCATION: Moved east from staked location, drilled on shoulder. See Figure 2. |

| DRILLER: A. Horner | METHOD: 3 1/4" HSA, Autohammer | DATE: **1/17/19** | SCALE: **1" = 4'** |
|---|---|---|---|

| Elev. feet 1198.0 | Depth feet 32.0 | Symbol | Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908) | BPF | WL | MC % | qp tsf | Tests or Notes |
|---|---|---|---|---|---|---|---|---|
| | | | SANDY LEAN CLAY, trace Gravel, gray, moist, soft to stiff. (Glacial Till) *(continued)* | | | | | |
| | | | | 7 | | 19 | 1/4 | WD=139 pcf, DD=117 pcf |
| | | | | 8 | | 24 | 1/2 | |
| 1189.0 | 41.0 | | END OF BORING.<br><br>Water observed at a depth of 10 1/2 feet while drilling.<br><br>Water observed at a depth of 22 feet with 39 1/2 feet of hollow-stem auger in the ground.<br><br>Water not observed to cave-in depth of 9 feet immediately after withdrawal of auger.<br><br>Boring then grouted. | | | | | |

(See Descriptive Terminology sheet for explanation of abbreviations)

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The Science You Build On.

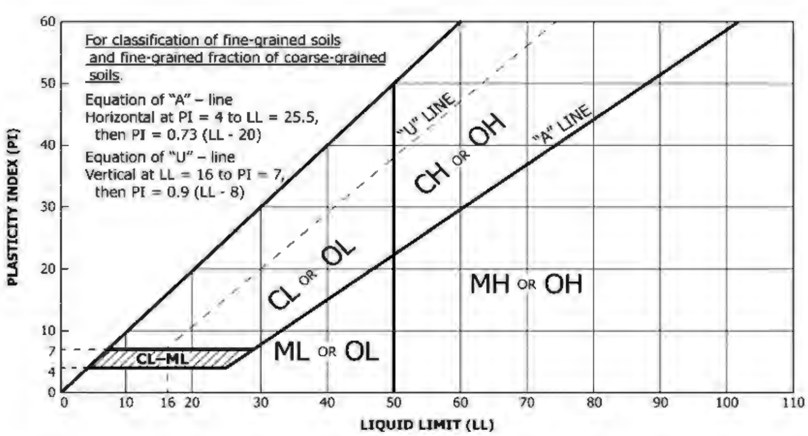
# Descriptive Terminology of Soil

Based on Standards ASTM D 2487-11/2488-09a

(Unified Soil Classification System)

| Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A] | | | | Soil Classification | |
|---|---|---|---|---|---|
| | | | | Group Symbol | Group Name[B] |
| Coarse-grained Soils (more than 50% retained on No. 200 sieve) | Gravels (More than 50% of coarse fraction retained on No. 4 sieve) | Clean Gravels (Less than 5% fines[C]) | $C_u \geq 4$ and $1 \leq C_c \leq 3$[D] | GW | Well-graded gravel[E] |
| | | | $C_u < 4$ and/or ($C_c < 1$ or $C_c > 3$)[D] | GP | Poorly graded gravel[E] |
| | | Gravels with Fines (More than 12% fines[C]) | Fines classify as ML or MH | GM | Silty gravel[E F G] |
| | | | Fines Classify as CL or CH | GC | Clayey gravel[E F G] |
| | Sands (50% or more coarse fraction passes No. 4 sieve) | Clean Sands (Less than 5% fines[H]) | $C_u \geq 6$ and $1 \leq C_c \leq 3$[D] | SW | Well-graded sand[I] |
| | | | $C_u < 6$ and/or ($C_c < 1$ or $C_c > 3$)[D] | SP | Poorly graded sand[I] |
| | | Sands with Fines (More than 12% fines[H]) | Fines classify as ML or MH | SM | Silty sand[F G I] |
| | | | Fines classify as CL or CH | SC | Clayey sand[F G I] |
| Fine-grained Soils (50% or more passes the No. 200 sieve) | Silts and Clays (Liquid limit less than 50) | Inorganic | PI > 7 and plots on or above "A" line[J] | CL | Lean clay[K L M] |
| | | | PI < 4 or plots below "A" line[J] | ML | Silt[K L M] |
| | | Organic | $\frac{\text{Liquid Limit – oven dried}}{\text{Liquid Limit – not dried}} < 0.75$ | OL | Organic clay[K L M N] / Organic silt[K L M O] |
| | Silts and Clays (Liquid limit 50 or more) | Inorganic | PI plots on or above "A" line | CH | Fat clay[K L M] |
| | | | PI plots below "A" line | MH | Elastic silt[K L M] |
| | | Organic | $\frac{\text{Liquid Limit – oven dried}}{\text{Liquid Limit – not dried}} < 0.75$ | OH | Organic clay[K L M P] / Organic silt[K L M Q] |
| Highly Organic Soils | | Primarily organic matter, dark in color, and organic odor | | PT | Peat |

A. Based on the material passing the 3-inch (75-mm) sieve.
B. If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
C. Gravels with 5 to 12% fines require dual symbols:
   GW-GM well-graded gravel with silt
   GW-GC well-graded gravel with clay
   GP-GM poorly graded gravel with silt
   GP-GC poorly graded gravel with clay
D. $C_u = D_{60} / D_{10}$ $\quad C_c = (D_{30})^2 / (D_{10} \, x \, D_{60})$
E. If soil contains ≥ 15% sand, add "with sand" to group name.
F. If fines classify as CL-ML, use dual symbol GC-GM or SC-SM.
G. If fines are organic, add "with organic fines" to group name.
H. Sands with 5 to 12% fines require dual symbols:
   SW-SM well-graded sand with silt
   SW-SC well-graded sand with clay
   SP-SM poorly graded sand with silt
   SP-SC poorly graded sand with clay
I. If soil contains ≥ 15% gravel, add "with gravel" to group name.
J. If Atterberg limits plot in hatched area, soil is CL-ML, silty clay.
K. If soil contains 15 to < 30% plus No. 200, add "with sand" or "with gravel", whichever is predominant.
L. If soil contains ≥ 30% plus No. 200, predominantly sand, add "sandy" to group name.
M. If soil contains ≥ 30% plus No. 200 predominantly gravel, add "gravelly" to group name.
N. PI ≥ 4 and plots on or above "A" line.
O. PI < 4 or plots below "A" line.
P. PI plots on or above "A" line.
Q. PI plots below "A" line.




### Particle Size Identification

Boulders............. over 12"
Cobbles................ 3" to 12"
Gravel
  Coarse............ 3/4" to 3" (19.00 mm to 75.00 mm)
  Fine................ No. 4 to 3/4" (4.75 mm to 19.00 mm)
Sand
  Coarse............. No. 10 to No. 4 (2.00 mm to 4.75 mm)
  Medium........... No. 40 to No. 10 (0.425 mm to 2.00 mm)
  Fine................. No. 200 to No. 40 (0.075 mm to 0.425 mm)
Silt........................ No. 200 (0.075 mm) to .005 mm
Clay...................... < .005 mm

### Relative Proportions[L, M]

trace............................ 0 to 5%
little............................. 6 to 14%
with............................. ≥ 15%

### Inclusion Thicknesses

lens............................... 0 to 1/8"
seam............................. 1/8" to 1"
layer............................. over 1"

### Apparent Relative Density of Cohesionless Soils

Very loose .................... 0 to 4 BPF
Loose ........................... 5 to 10 BPF
Medium dense............. 11 to 30 BPF
Dense........................... 31 to 50 BPF
Very dense................... over 50 BPF

| Consistency of Cohesive Soils | Blows Per Foot | Approximate Unconfined Compressive Strength |
|---|---|---|
| Very soft | 0 to 1 BPF | < 1/4 tsf |
| Soft | 2 to 4 BPF | 1/4 to 1/2 tsf |
| Medium | 5 to 8 BPF | 1/2 to 1 tsf |
| Stiff | 9 to 15 BPF | 1 to 2 tsf |
| Very Stiff | 16 to 30 BPF | 2 to 4 tsf |
| Hard | over 30 BPF | > 4 tsf |

### Moisture Content:

**Dry:** Absence of moisture, dusty, dry to the touch.
**Moist:** Damp but no visible water.
**Wet:** Visible free water, usually soil is below water table.

### Drilling Notes:

**BPF:** Numbers indicate blows per foot recorded in standard penetration test, also known as "N" value. The sampler was set 6 inches into undisturbed soil below the hollow-stem auger. Driving resistances were then counted for second and third 6-inch increments, and added to get BPF.

**Partial Penetration:** If the sampler cannot be driven the full 12 inches beyond the initial 6-inch set, the number of blows for that partial penetration is shown as "No./X" (i.e., 50/2"). If the sampler cannot be advanced beyond the initial 6-inch set, the depth of penetration will be recorded in the Notes column as "No. to set X" (i.e., 50 to set 4").

**WH:** WH indicates the sampler penetrated soil under weight of hammer and rods alone; driving not required.

**WR:** WR indicates the sampler penetrated soil under weight of rods alone; hammer weight and driving not required.

**WL:** WL indicates the water level measured by the drillers either while drilling or following drilling.

### Laboratory Tests

| | | | | | |
|---|---|---|---|---|---|
| **DD** | Dry Density, pcf | **OC** | Organic content, % | **PL** | Plastic limit |
| **WD** | Wet Density, pcf | **$q_p$** | Pocket penetrometer strength, tsf | **LL** | Liquid limit |
| **P200** | % Passing #200 sieve | **MC** | Moisture conent, % | **PI** | Plasticity Index |

# GRAIN SIZE ACCUMULATION CURVE (ASTM)


**Braun Project B1900400**
**Geotechnical Evaluation**
**Silver Lake Dam**
**135th Avenue Southeast & Klefstad Access Road**
**Sargent County, North Dakota**

BORING: SL-01 DEPTH: 9.0'-11.0'

| | |
|---|---|
| GRAVEL | 0.0% |
| SAND | 32.0% |
| SILT | 32.1% |
| CLAY | 35.9% |
| D60=0.049 | |
| D30=0.002 | Cu= |
| D10= | Cc= |

CLASSIFICATION:
SANDY LEAN CLAY (CL)

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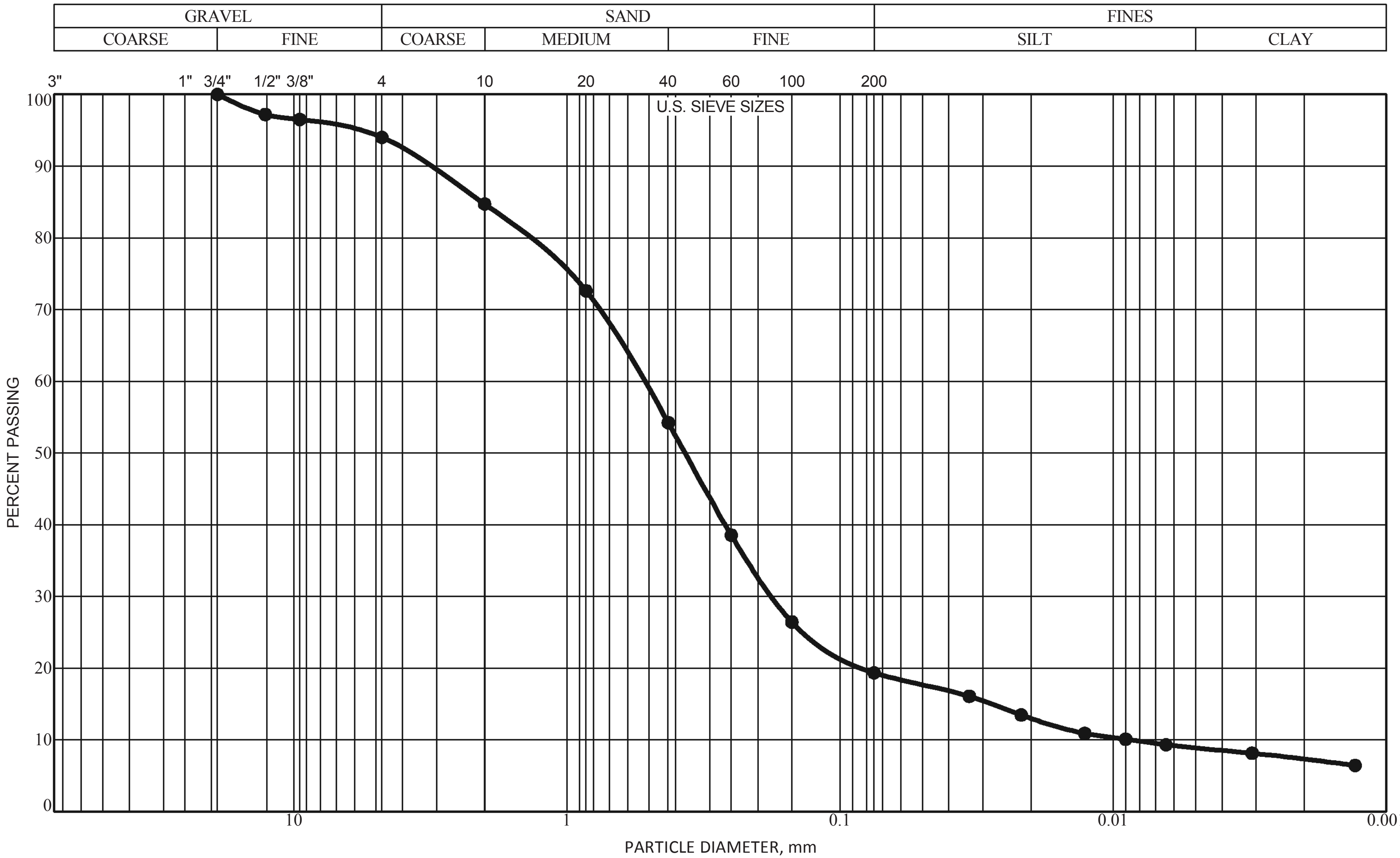
# GRAIN SIZE ACCUMULATION CURVE (ASTM)



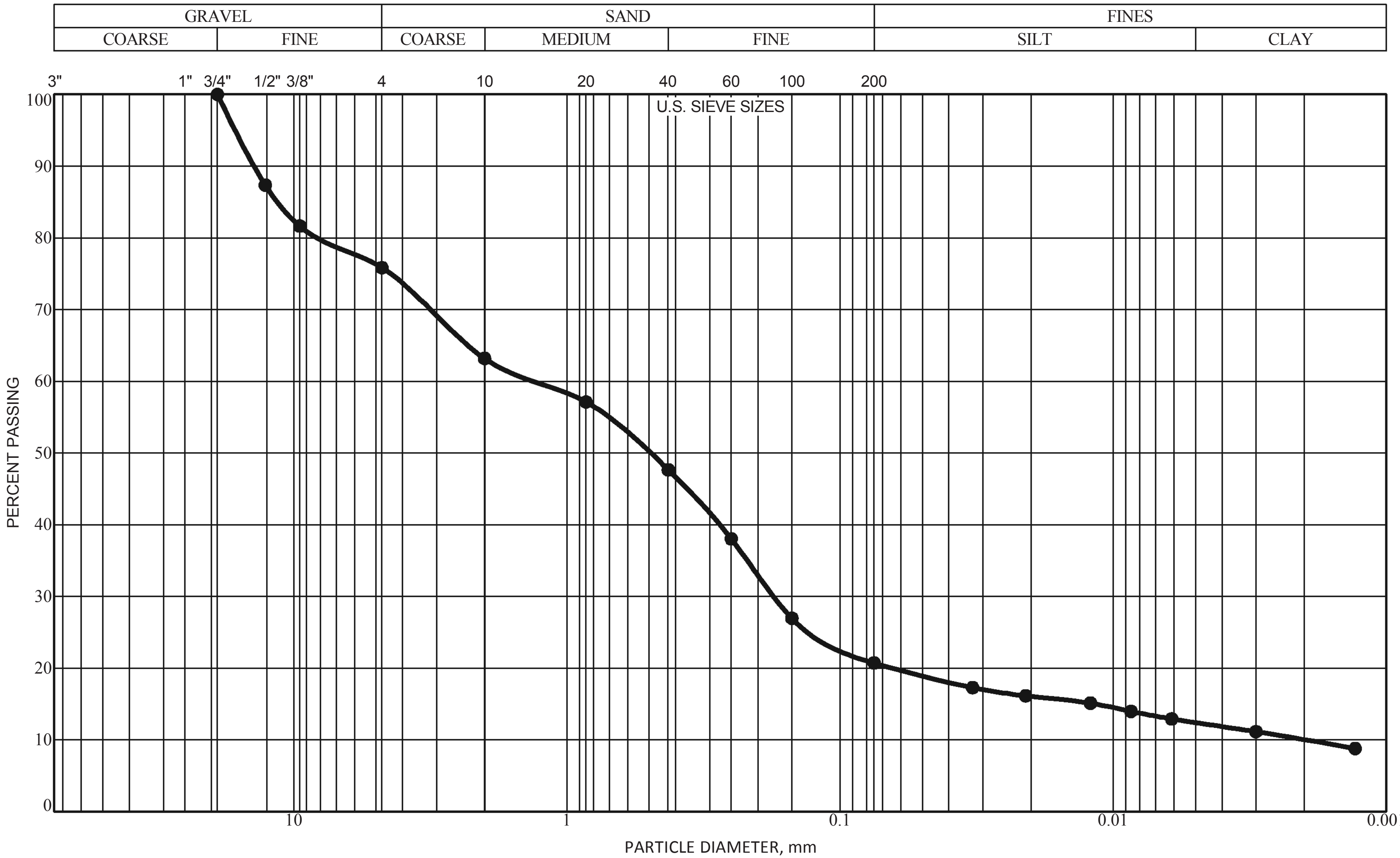

**Braun Project B1900400**
**Geotechnical Evaluation**
**Silver Lake Dam**
**135th Avenue Southeast & Klefstad Access Road**
**Sargent County, North Dakota**

BORING: SL-01 DEPTH: 15.0'-16.0'

| | |
|---|---|
| GRAVEL | 6.0% |
| SAND | 74.7% |
| SILT | 10.4% |
| CLAY | 8.9% |
| D60=0.529 | |
| D30=0.174 | Cu=60.8 |
| D10=0.009 | Cc=6.6 |

CLASSIFICATION:
SILTY SAND (SM)

# GRAIN SIZE ACCUMULATION CURVE (ASTM)




**Braun Project B1900400**
**Geotechnical Evaluation**
**Silver Lake Dam**
**135th Avenue Southeast & Klefstad Access Road**
**Sargent County, North Dakota**

BORING: SL-01 DEPTH: 25.0'-26.0'

| | |
|---|---|
| GRAVEL | 24.2% |
| SAND | 55.1% |
| SILT | 8.3% |
| CLAY | 12.4% |
| D60=1.278<br>D30=0.173<br>D10=0.002 | Cu=635.7<br>Cc=11.6 |

CLASSIFICATION:
SILTY SAND with GRAVEL (SM)

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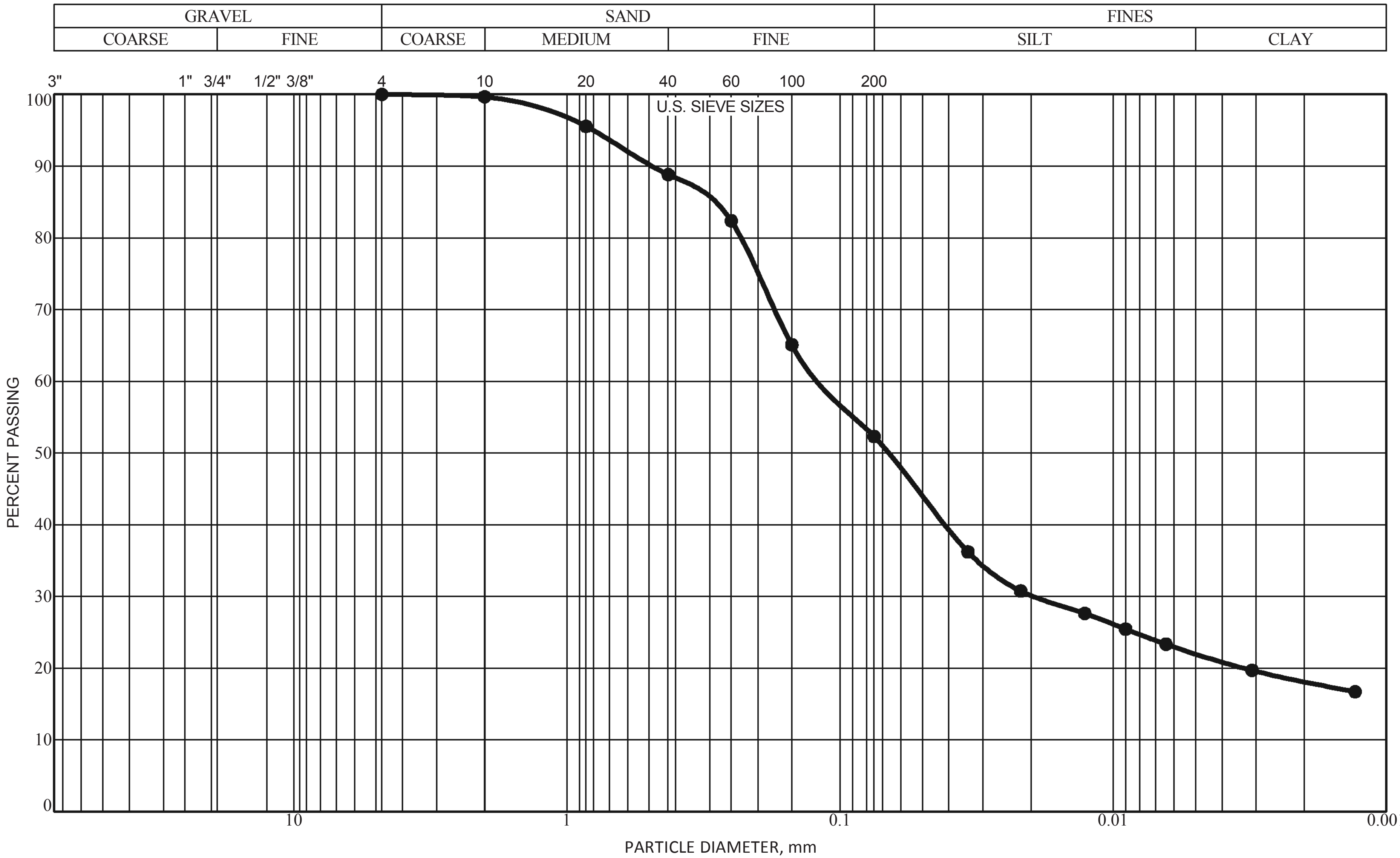
# GRAIN SIZE ACCUMULATION CURVE (ASTM)





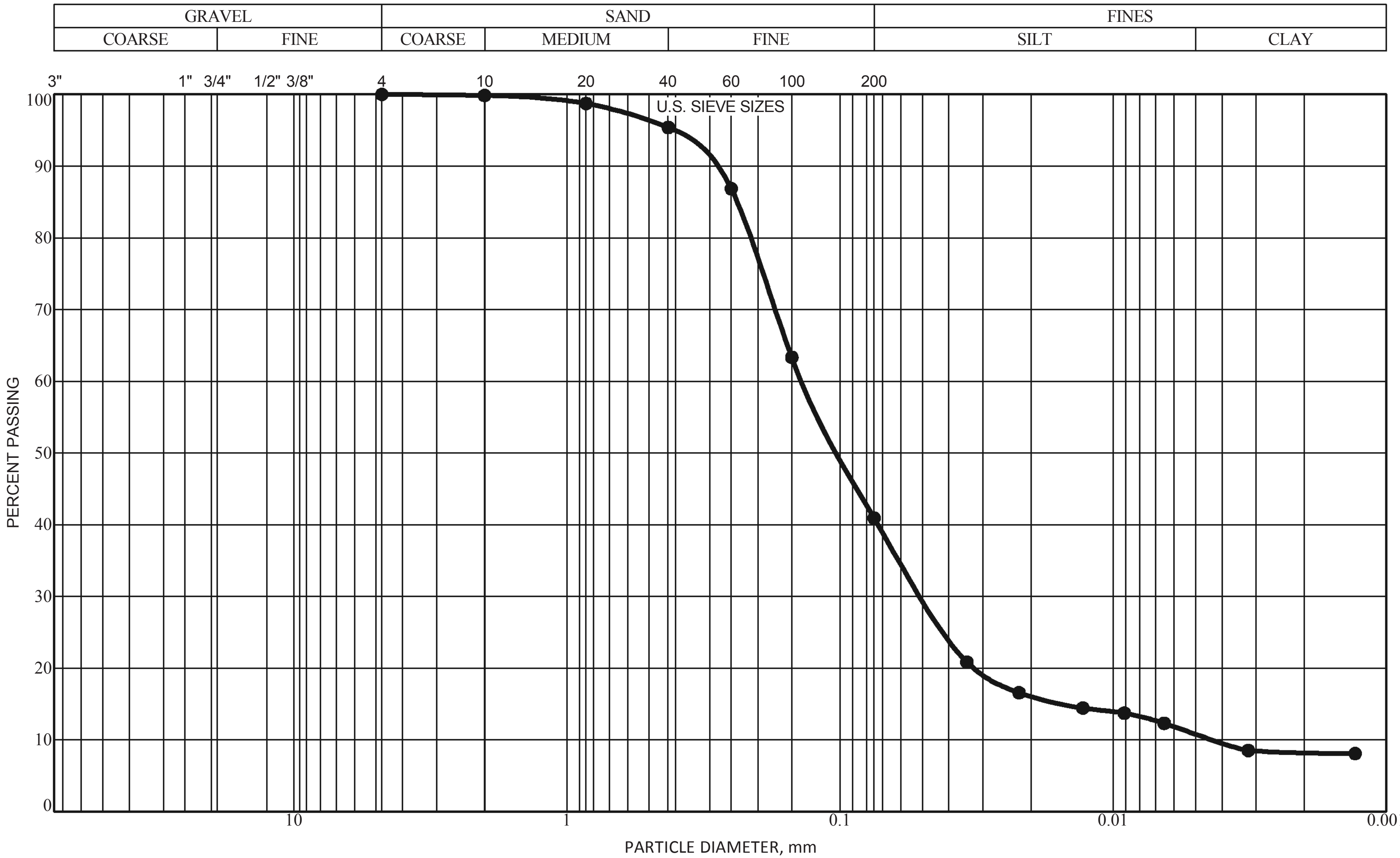

BRAUN[SM] INTERTEC

**Braun Project B1900400**
**Geotechnical Evaluation**
**Silver Lake Dam**
**135th Avenue Southeast & Klefstad Access Road**
**Sargent County, North Dakota**
BORING: SL-02 DEPTH: 4.0'-6.0'

| | |
|---|---|
| GRAVEL | 0.0% |
| SAND | 47.7% |
| SILT | 30.2% |
| CLAY | 22.1% |
| D60=0.114 | Cu= |
| D30=0.019 | Cc= |
| D10= | |

CLASSIFICATION:
SANDY LEAN CLAY (CL)

# GRAIN SIZE ACCUMULATION CURVE (ASTM)

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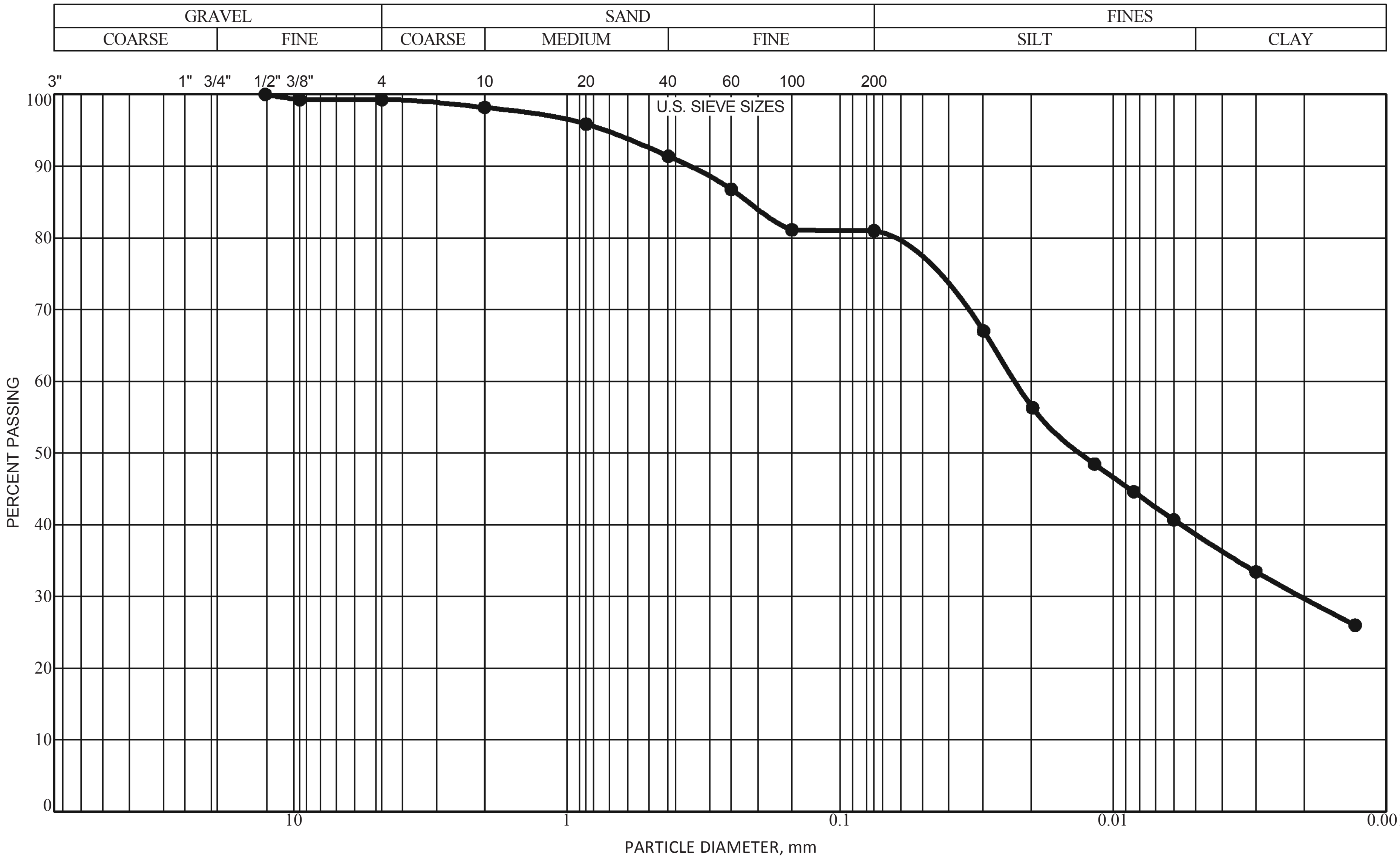
| | | | |
|---|---|---|---|
| BRAUN INTERTEC | **Braun Project B1900400**<br>**Geotechnical Evaluation**<br>**Silver Lake Dam**<br>**135th Avenue Southeast & Klefstad Access Road**<br>**Sargent County, North Dakota**<br>BORING: SL-02 DEPTH: 8.0'-10.0' | GRAVEL 0.0%<br>SAND 59.1%<br>SILT 30.0%<br>CLAY 10.9%<br>D60=0.135<br>D30=0.049 Cu=31.9<br>D10=0.004 Cc=4.2 | CLASSIFICATION:<br>SILTY SAND (SM) |

# GRAIN SIZE ACCUMULATION CURVE (ASTM)




BRAUN INTERTEC

**Braun Project B1900400**
**Geotechnical Evaluation**
**Silver Lake Dam**
**135th Avenue Southeast & Klefstad Access Road**
**Sargent County, North Dakota**

BORING: SL-02 DEPTH: 12.0'-14.0'

| | |
|---|---|
| GRAVEL | 0.7% |
| SAND | 18.3% |
| SILT | 42.2% |
| CLAY | 38.8% |
| D60=0.023 | |
| D30=0.002 | Cu= |
| D10= | Cc= |

CLASSIFICATION:
LEAN CLAY with SAND (CL)

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The Science You Build On.

# Hydrometer And Sieve Analysis

**ASTM D422**

6/4/2019

11001 Hampshire Avenue S
Minneapolis, MN 55438
Phone: 952-995-2000

**Client:**

Moore Engineering, Inc.
925 10th Avenue East
West Fargo, ND 58078

**Project:**

B1900400
Silver Lake Dam
135th Avenue Southeast & Klefstad Access Road
Sargent County, ND

## Sample Information

**Sample Number:** 242788

**Depth (ft):** 6-8

**Boring Number:** SL-03

**Sampled By:** Streier, Jim

**Sample Date:** 06/03/2019

**Received Date:** 06/03/2019

**Lab:** 11001 Hampshire Ave S, Bloomington, MN, 55438

**Tested Date:** 06/04/2019

**Tested By:** Streier, Jim

## Laboratory Data

### Sieve Analysis

| Sieve Size | Percent Passing | Specifications |
|---|---|---|
| 2 mm (No. 10) | 100.0 | - |
| 850 µm (No. 20) | 99.5 | - |
| 425 µm (No. 40) | 97.6 | - |
| 250 µm (No. 60) | 93.8 | - |
| 150 µm (No. 100) | 87.9 | - |
| 75 µm (No. 200) | 76.2 | - |

### Hydrometer Analysis

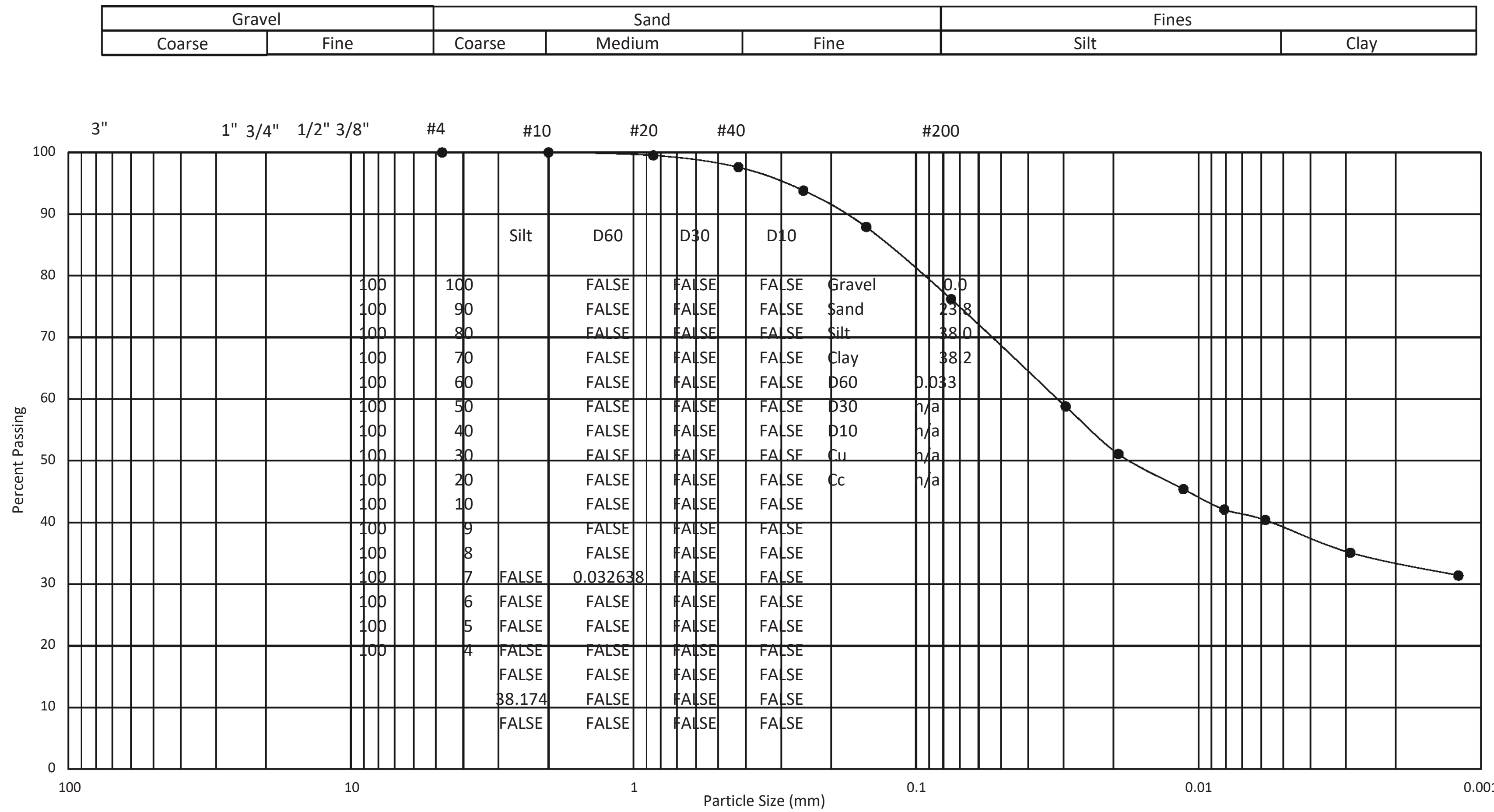
| Diameter Of Soil Particle (µm) | Percent Passing | Specifications |
|---|---|---|
| 29.5 | 58.8 | - |
| 19.2 | 51.1 | - |
| 11.3 | 45.4 | - |
| 8.1 | 42.1 | - |
| 5.8 | 40.4 | - |
| 2.9 | 35.1 | - |
| 1.2 | 31.4 | - |

**Soil Classification:** CL Lean clay with sand

## General

See 242788.pdf in the documents section at the end of this report.

## Grain Size Accumulation Curve (ASTM)

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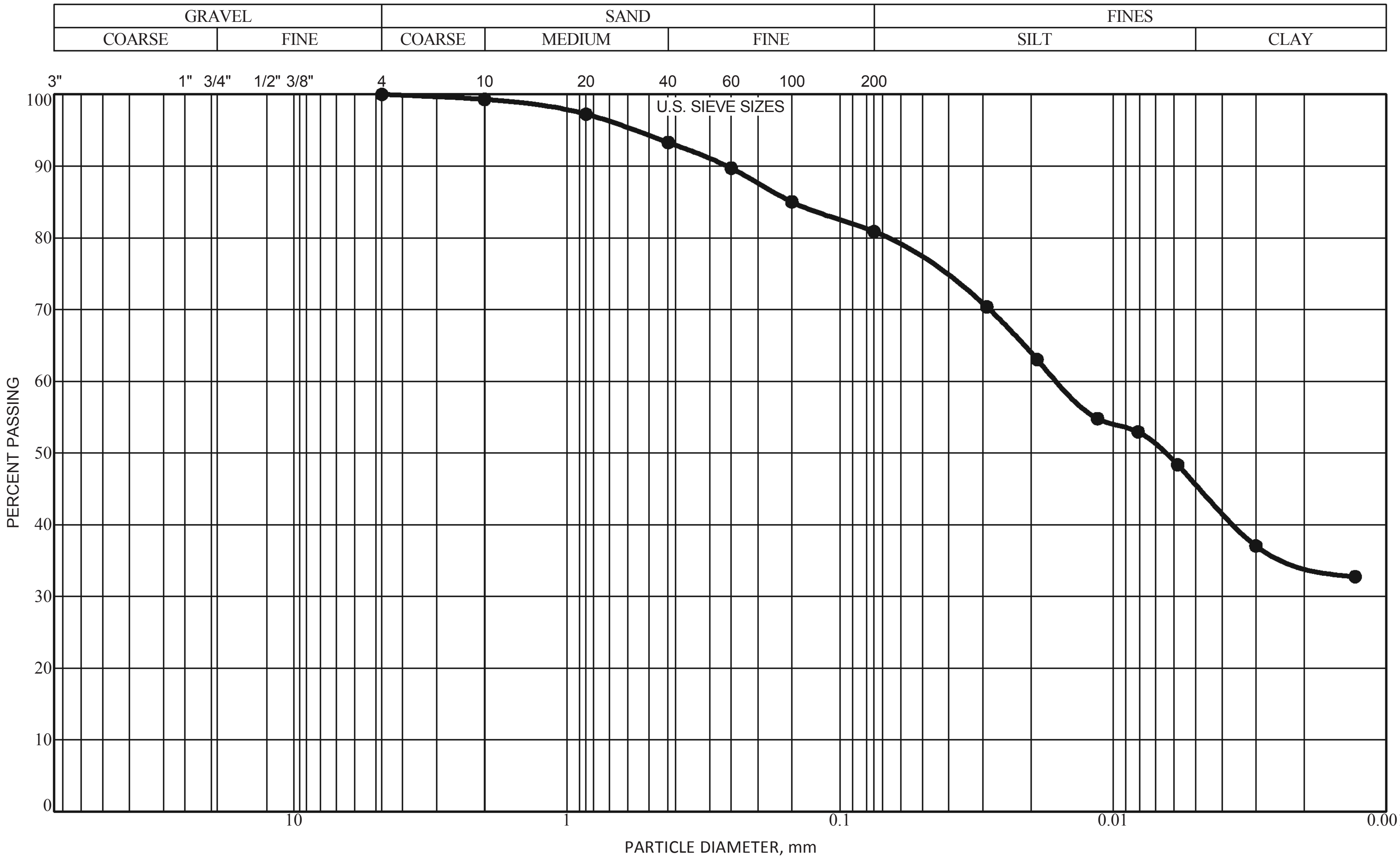
| | |
|---|---|
| Project Number | B1900400 |
| Sample Number | 242788 |
| Boring Number | SL-03 |
| Depth | 6-8' |

| | | |
|---|---|---|
| Gravel | 0.0 | |
| Sand | 23.8 | |
| Silt | 38.0 | |
| Clay | 38.2 | |
| D60= | 0.033 | Cu= n/a |
| D30= | n/a | Cc= n/a |
| D10= | n/a | |

Classification

LEAN CLAY with SAND(CL)

# GRAIN SIZE ACCUMULATION CURVE (ASTM)



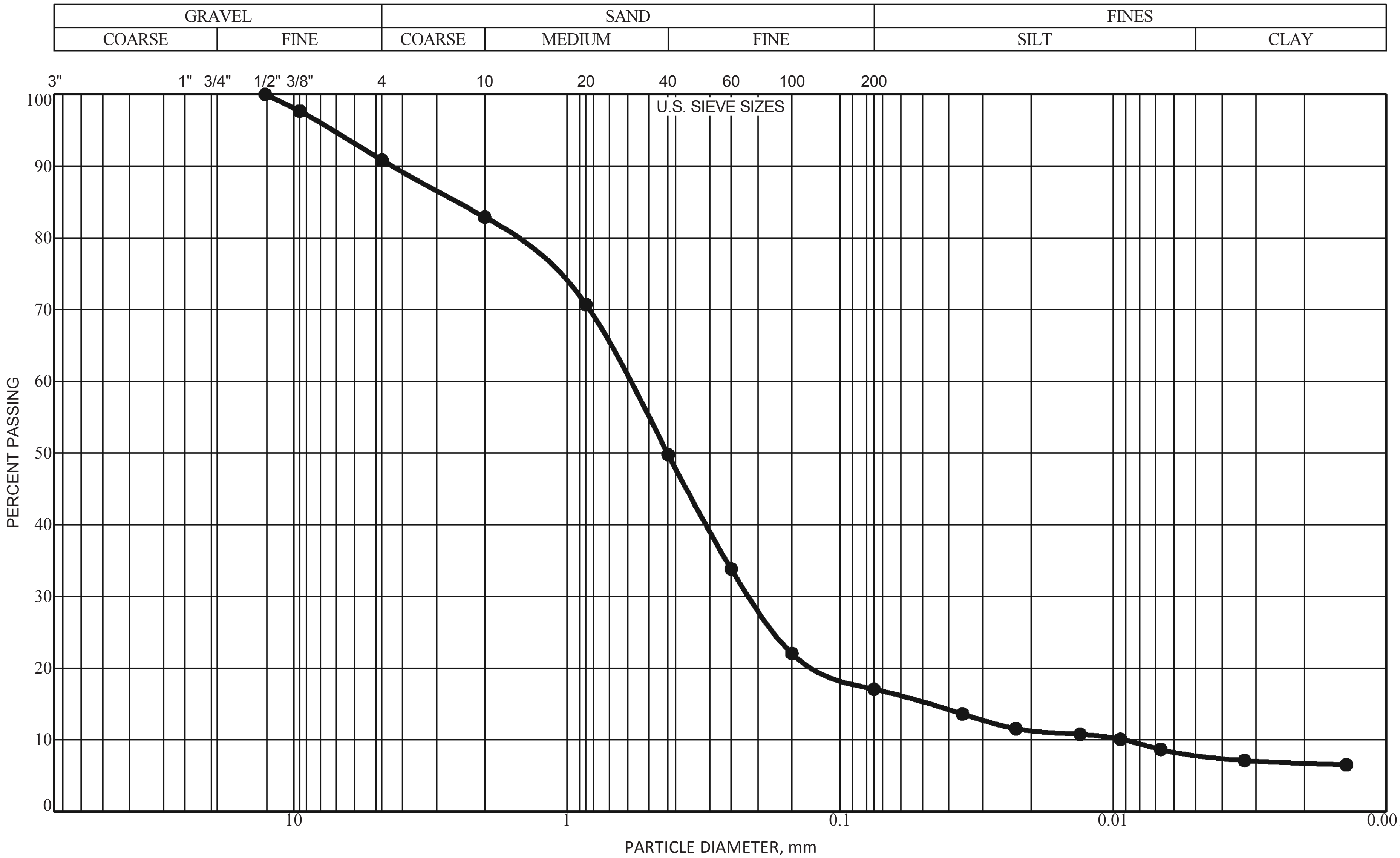

**Braun Project B1900400**
**Geotechnical Evaluation**
**Silver Lake Dam**
**135th Avenue Southeast & Klefstad Access Road**
**Sargent County, North Dakota**
BORING: SL-03 DEPTH: 17.5'-18.5'

| | |
|---|---|
| GRAVEL | 0.0% |
| SAND | 19.1% |
| SILT | 35.1% |
| CLAY | 45.8% |
| D60=0.016 | |
| D30= | Cu= |
| D10= | Cc= |

CLASSIFICATION:
FAT CLAY with SAND (CH)

BRAUN INTERTEC

# GRAIN SIZE ACCUMULATION CURVE (ASTM)




BRAUN[SM] INTERTEC

**Braun Project B1900400**
**Geotechnical Evaluation**
**Silver Lake Dam**
**135th Avenue Southeast & Klefstad Access Road**
**Sargent County, North Dakota**
BORING: SL-03 DEPTH: 45.0'-46.0'

| | |
|---|---|
| GRAVEL | 9.2% |
| SAND | 73.8% |
| SILT | 9.0% |
| CLAY | 8.0% |
| D60=0.596 | Cu=64.5 |
| D30=0.212 | Cc=8.1 |
| D10=0.009 | |

CLASSIFICATION:
SILTY SAND (SM)

Braun Intertec Corporation
11001 Hampshire Avenue South
Minneapolis, MN 55438
Phone: 952.995.2000

# Material Test Report

**Report No: MAT:W19-000402-S1**
**Issue No: 1**

| | |
|---|---|
| **Client:** | Chris Gross<br>Moore Engineering, Inc.<br>444 Sheyenne Street, Suite 301<br>West Fargo, ND, 58078 |
| **Project:** | B1900400<br>Silver Lake Dam<br>135th Avenue Southeast & Klefstad Access Road<br>Sargent County, ND, |
| **TR:** | Ezra Ballinger, eballinger@braunintertec.com |

**Laboratory Results Reviewed by:**

ISO/IEC 17025

Jim Streier
Geotechnical Laboratory
Date of Issue: 4/3/2019

## Sample Details

| | |
|---|---|
| **Sample ID:** | W19-000402-S1 |
| **Alternate Sample ID:** | |
| **Sampled By:** | Drill Crew |
| **Sampling Method:** | Soil Boring Shelby Tube |
| **Date Sampled:** | |
| **Date Submitted:** | |
| **Specification:** | ASTM D 422 |
| **Source:** | Native |
| **Material Type:** | Sandy Lean Clay |
| **Sample Location:** | SL-01, 9-11' |

## Other Test Results

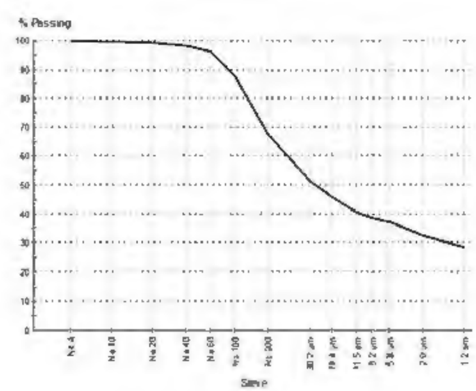
| Description | Method | Result | Limits |
|---|---|---|---|
| Dispersion device | ASTM D 422 - 07 | | |
| Dispersion time (min) | | | |
| Shape | | | |
| Hardness | | | |
| Liquid Limit | ASTM D 4318 - 05 | 37 | |
| Method | | Method B | |
| Plastic Limit | | 15 | |
| Plasticity Index | | 22 | |
| Sample history | | Air-dried | |
| Date Tested | | 4/3/2019 | |
| Temperature (°C) | ASTM D 5084 - 03 | 22.0 | |
| Cell Pressure (lb/in²) | | 99.0 | |
| Top Pressure (lb/in²) | | 91.0 | |
| Bottom Pressure (lb/in²) | | 94.0 | |
| Effective Pressure (lb/in²) | | 5.0 | |
| Pressure Differential (lb/in²) | | 3.0 | |
| Permeant | | De-aired tap water | |
| Assumed Specific Gravity | | 2.650 | |
| Initial Sample Height (in) | | 2.394 | |
| Final Sample Height (in) | | 2.358 | |
| Initial Sample Diameter (in) | | 1.410 | |
| Final Sample Diameter (in) | | 1.384 | |
| Initial Sample Cross-Section Area (in²) | | 1.561 | |
| Final Sample Cross-Section Area (in²) | | 1.504 | |
| Initial Sample Volume (in³) | | 3.738 | |
| Final Sample Volume (in³) | | 3.547 | |
| Initial Sample Mass (g) | | 90.20 | |
| Final Sample Mass (g) | | 91.14 | |
| Initial Dry Density (lb/ft³) | | 91.9 | |
| Final Dry Density (lb/ft³) | | 97.9 | |

## Particle Size Distribution

**Method:** ASTM D 422 - 07
**Drying by:**
**Date Tested:** 4/3/2019

| Sieve Size | % Passing | Limits |
|---|---|---|
| No.4 (4.75mm) | 100 | |
| No.10 (2.0mm) | 100 | |
| No.20 (850µm) | 99 | |
| No.40 (425µm) | 98 | |
| No.60 (250µm) | 96 | |
| No.100 (150µm) | 88 | |
| No.200 (75µm) | 68 | |
| 30.2 µm | 51.4 | |
| 19.4 µm | 46.0 | |
| 11.5 µm | 40.6 | |
| 8.2 µm | 38.5 | |
| 5.8 µm | 37.0 | |
| 2.9 µm | 32.5 | |
| 1.2 µm | 28.5 | |

## Chart




## Comments

N/A

BRAUN INTERTEC

Braun Intertec Corporation
11001 Hampshire Avenue South
Minneapolis, MN 55438
Phone: 952.995.2000

# Material Test Report

**Report No: MAT:W19-000402-S1**
**Issue No: 1**

**Client:** Chris Gross
Moore Engineering, Inc.
444 Sheyenne Street, Suite 301
West Fargo, ND, 58078
**Project:** B1900400
Silver Lake Dam
135th Avenue Southeast & Klefstad Access Road
Sargent County, ND,
**TR:** Ezra Ballinger, eballinger@braunintertec.com

**Laboratory Results Reviewed by:**

ISO/IEC 17025

Jim Streier
Geotechnical Laboratory
Date of Issue: 4/3/2019

## Sample Details

| | |
|---|---|
| **Sample ID:** | W19-000402-S1 |
| **Alternate Sample ID:** | |
| **Sampled By:** | Drill Crew |
| **Sampling Method:** | Soil Boring Shelby Tube |
| **Date Sampled:** | |
| **Date Submitted:** | |
| **Specification:** | ASTM D 422 |
| **Source:** | Native |
| **Material Type:** | Sandy Lean Clay |
| **Sample Location:** | SL-01, 9-11' |

## Other Test Results

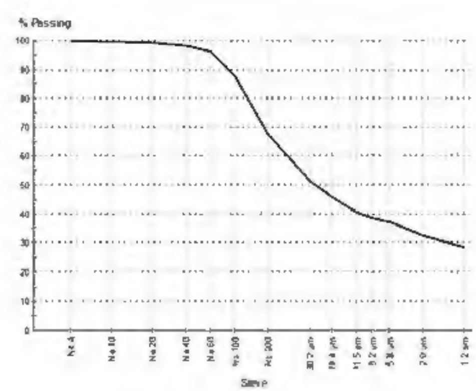
| Description | Method | Result | Limits |
|---|---|---|---|
| Initial Moisture Content (%) | | 29.3 | |
| Final Moisture Content (%) | | 26.0 | |
| Initial Saturation (%) | | 97 | |
| Final Saturation (%) | | 97 | |
| Initial Hydraulic Gradient | | 34.5 | |
| Ending Hydraulic Gradient | | 35.5 | |
| Hydraulic Conductivity (cm/s) | | 2.39E-06 | |
| Corrected Hydraulic Conductivity (cm/s) | | 2.28E-06 | |
| Date Tested | | 4/3/2019 | |

## Particle Size Distribution

**Method:** ASTM D 422 - 07
**Drying by:**
**Date Tested:** 4/3/2019

| Sieve Size | % Passing | Limits |
|---|---|---|
| No.4 (4.75mm) | 100 | |
| No.10 (2.0mm) | 100 | |
| No.20 (850µm) | 99 | |
| No.40 (425µm) | 98 | |
| No.60 (250µm) | 96 | |
| No.100 (150µm) | 88 | |
| No.200 (75µm) | 68 | |
| 30.2 µm | 51.4 | |
| 19.4 µm | 46.0 | |
| 11.5 µm | 40.6 | |
| 8.2 µm | 38.5 | |
| 5.8 µm | 37.0 | |
| 2.9 µm | 32.5 | |
| 1.2 µm | 28.5 | |

## Chart




## Comments

N/A

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# Hydraulic Conductivity

**ASTM D5084**

11001 Hampshire Avenue S
Minneapolis, MN 55438
Phone: 952-995-2000

| **Client:** | **Project:** |
|---|---|
| Moore Engineering, Inc.<br>925 10th Avenue East<br>West Fargo, ND 58078 | B1900400<br>Silver Lake Dam<br>135th Avenue Southeast & Klefstad Access Road<br>Sargent County, ND |

## Sample Information

**Sample Number:** 242788 **Depth (ft):** 6-8

**Boring Number:** SL-03

**Sample Date:** 06/03/2019

**Received Date:** 06/03/2019 **Lab:** 11001 Hampshire Ave S, Bloomington, MN, 55438

**Tested Date:** 06/03/2019 **Tested By:** Streier, Jim

## Laboratory Data

**Type Of Specimen:** **Back Pressure (psi):** 91.00

**Permeant Liquid:** Water **Specific Gravity:** 2.75 ( Assumed )

**Saturation B Coefficient:** 1.00 **Effective Pressure (psi):** 8.00

**Method:** Method C Falling Head Rising Tailwater

| Time Interval (sec) | Average Head Loss (cm) | Average Test Temperature (°C) | Quantity Of Flow (cm^3) | Hydraulic Gradient | K (cm/sec) At 20 °C |
|---|---|---|---|---|---|
| 51600 | 207.616 | 22.0 | 0.0000 | 29.25 | 1.6E-08 |
| 19380 | 208.166 | 22.0 | 0.0000 | 29.33 | 1.5E-08 |
| 54360 | 207.416 | 22.0 | 0.0000 | 29.22 | 2.6E-08 |
| 28140 | 206.316 | 22.0 | 0.0000 | 29.07 | 2.9E-08 |

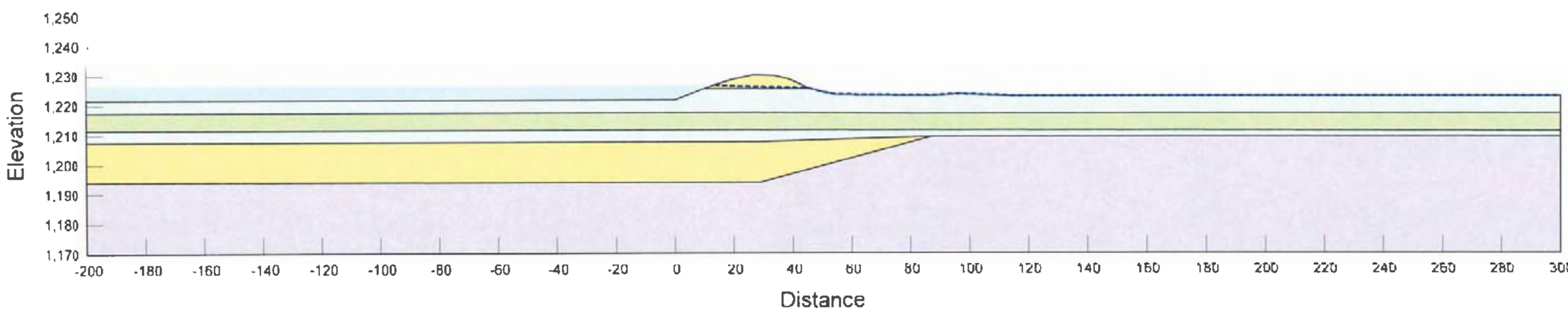
**Average Of Last Four Hydraulic Conductivity (cm/sec):** 2.1E-08

| | | | | |
|---|---|---|---|---|
| **Saturation (%)** | **Initial:** | 99 | **Final:** | 99 |
| **Moisture Content (%)** | **Initial:** | 27.2 | **Final:** | 26 |
| **Dry Density Of Specimen (pcf)** | **Initial:** | 97.6 | **Final:** | 99.6 |

## General

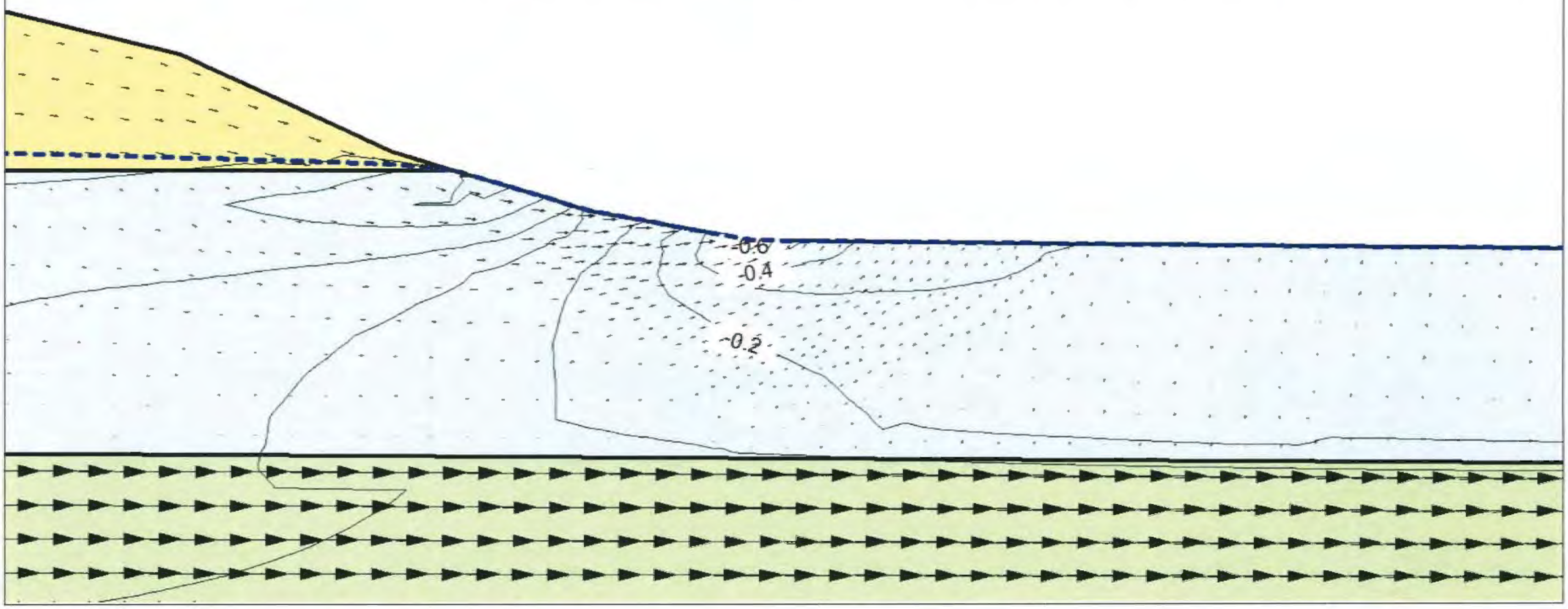
Project Name: Silver Lake Dam
Project Number: B1900400
Analysis: Steady State Seepage w/No Drain

| Color | Name | K-Function | Ky'/Kx' Ratio |
|---|---|---|---|
| | Alluvial Clays | Alluvial Clays | 0.1 |
| | Alluvial Sands | Alluvial Sands | 0.1 |
| | Glacial Clays | Glacial Clays | 1 |
| | Glacial Sands | Glacial Sands | 1 |
| | Levee Fill | Levee Fill | 1 |



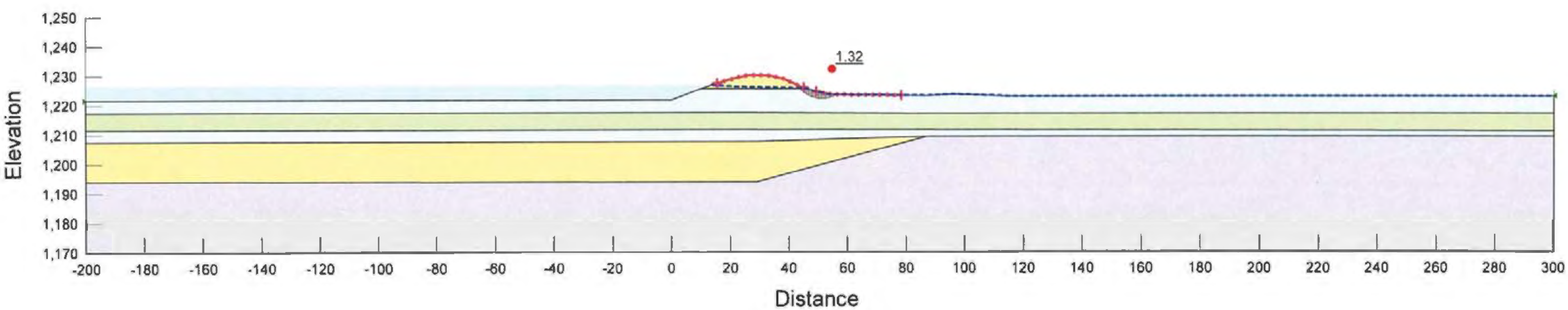
**B1900400: Silver Lake Dam**

# Y-Gradient and Flow Detail
# Steady State Seepage w/No Drain



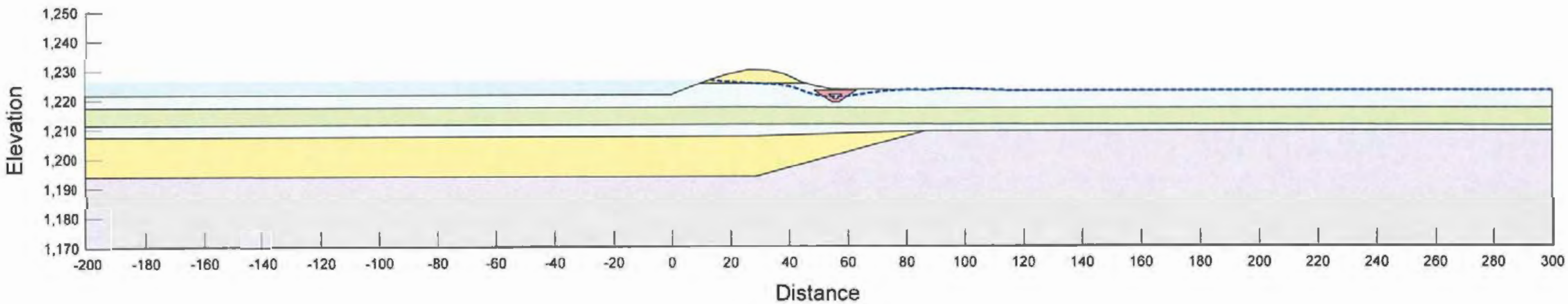
Project Name: Silver Lake Dam
Project Number: B1900400
Analysis: Effective Stress Slope Stability w/No Drain

| Color | Name | Unit Weight (pcf) | Cohesion' (psf) | Phi' (°) |
|---|---|---|---|---|
| | Alluvial Clays | 115 | 0 | 30 |
| | Alluvial Sands | 115 | 0 | 29 |
| | Glacial Clays | 130 | 0 | 32 |
| | Glacial Sands | 120 | 0 | 32 |
| | Levee Fill | 125 | 0 | 30 |

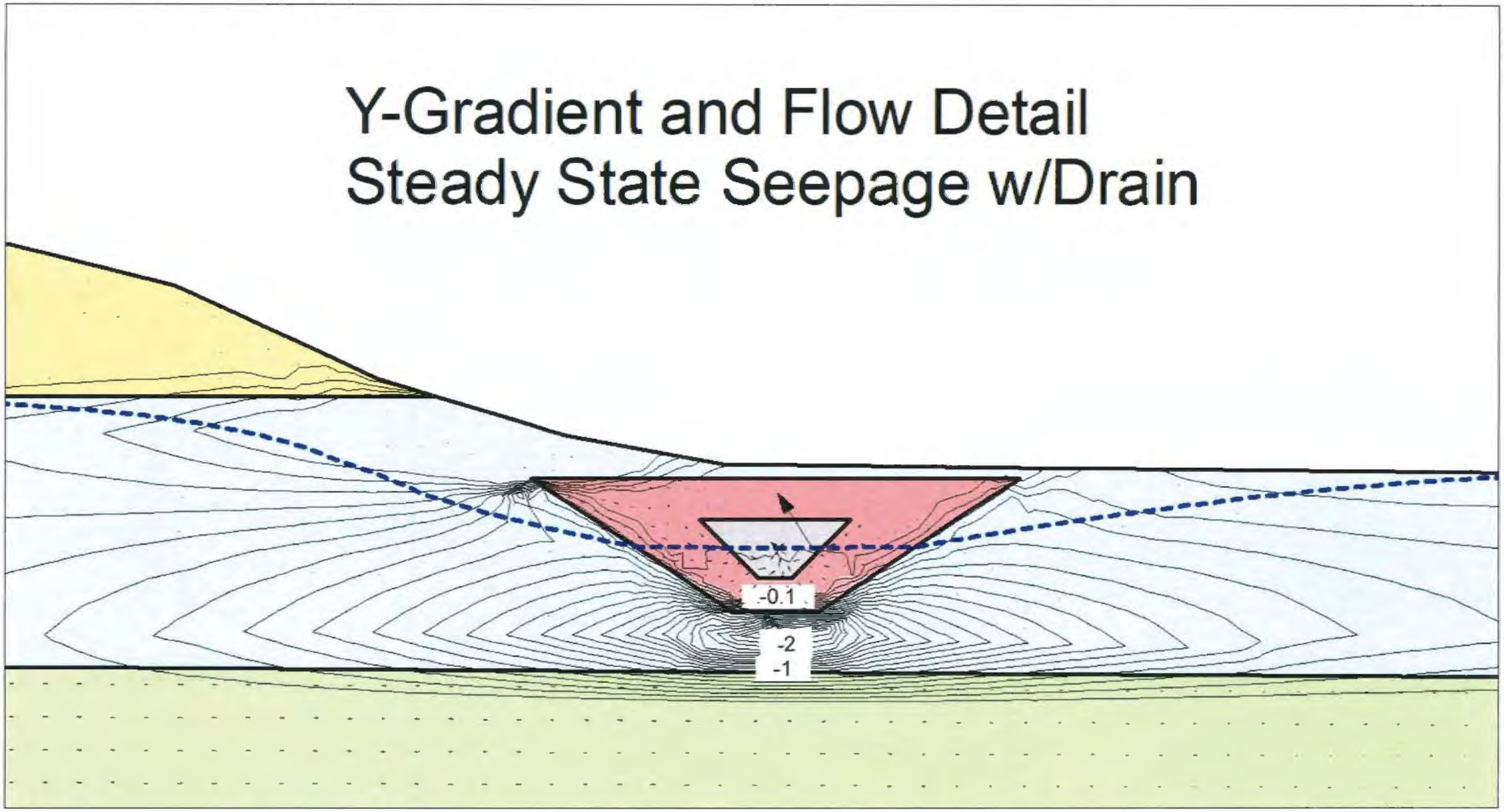


Project Name: Silver Lake Dam
Project Number: B1900400
Analysis: Steady State Seepage w/Drain

| Color | Name | K-Function | Ky'/Kx' Ratio |
|---|---|---|---|
| | Alluvial Clays | Alluvial Clays | 0.1 |
| | Alluvial Sands | Alluvial Sands | 0.1 |
| | Drainage Gravel | Drainage Gravel | 1 |
| | Drainage Sand | Glacial Sands | 1 |
| | Glacial Clays | Glacial Clays | 1 |
| | Glacial Sands | Glacial Sands | 1 |
| | Levee Fill | Levee Fill | 1 |

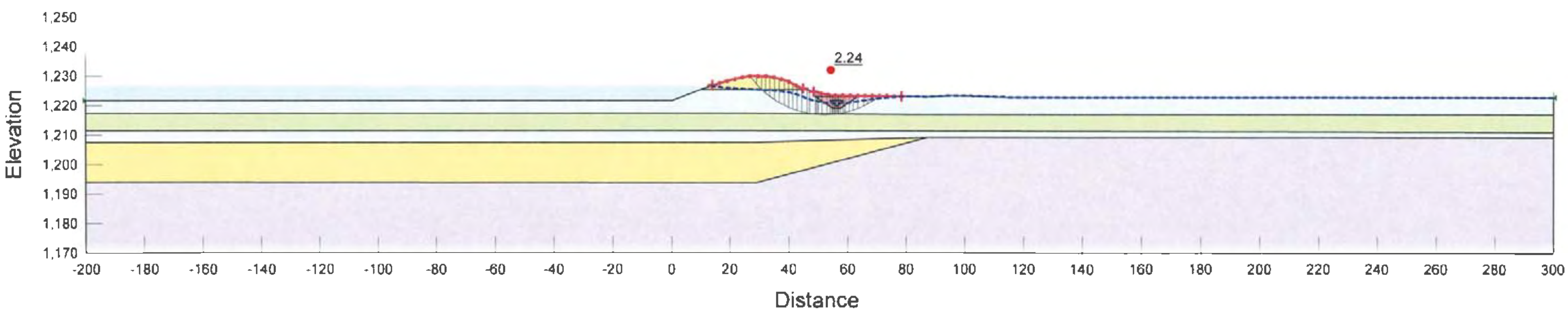


**B1900400: Silver Lake Dam**



Project Name: Silver Lake Dam
Project Number: B1900400
Analysis: Effective Stress Slope Stability w/Drain

| Color | Name | Unit Weight (pcf) | Cohesion' (psf) | Phi' (°) |
|---|---|---|---|---|
| | Alluvial Clays | 115 | 0 | 30 |
| | Alluvial Sands | 115 | 0 | 29 |
| | Drainage Gravel | 135 | 0 | 35 |
| | Drainage Sand | 120 | 0 | 32 |
| | Glacial Clays | 130 | 0 | 32 |
| | Glacial Sands | 120 | 0 | 32 |
| | Levee Fill | 125 | 0 | 30 |



# B1900400: Silver Lake Dam

## SEEP/W Exit Gradient Evaluation

| Section or Condition | Exit Elev. | Conf. Layer Bottom Elev. | Max. Total Head | Min. Total Head | ΔH | ΔL | Est. Act. Gradient | Est. Critical Gradient | Estimated FOS | **Required FOS** |
|---|---|---|---|---|---|---|---|---|---|---|
| Existing condition - no toe drain | 1223.4 | 1217.2 | 1225.0 | 1223.4 | 1.5 | 6.2 | 0.25 | 0.85 | 3.41 | **1.60** |
| Proposed condition - with toe drain | 1223.4 | 1217.2 | 1224.5 | 1223.4 | 1.0 | 6.2 | 0.17 | 0.85 | 5.03 | **1.60** |

## SEEP/W Boundary Force Evaluation

| Section or Condition | Surface Elev. | Conf. Layer Bottom Elev. | Min. Total Head | Total Stress Down, psf | Pore Pressure Down, psf | Eff. Stress Down, psf | Total Pore Press. Up, psf | Diff. Pore Press. Up, psf | Estimated FOS | **Required FOS** | Pipe Flux, $ft^3$/day/ft | Pipe Flux, PD, $ft^3$/day/ft |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Existing condition - no toe drain | 1223.4 | 1217.2 | 1223.4 | 711.9 | 385.6 | 326.2 | 482.9 | 97.2 | 3.36 | **1.60** | | |
| Proposed condition - with toe drain | 1223.4 | 1217.2 | 1223.4 | 711.9 | 385.6 | 326.2 | 451.3 | 65.7 | 4.96 | **1.60** | 0.003 | |

# Appendix C – Current North Dakota State Water Commission Cost Share Policy

NORTH Dakota | Water Commission

Be Legendary.™

# PROJECT FUNDING POLICY, PROCEDURE, AND GENERAL REQUIREMENTS

The State Water Commission has adopted this policy to support local sponsors in development of sustainable water related projects in North Dakota. This policy reflects the State Water Commission's cost-share priorities and provides basic requirements for all projects considered for prioritization during the agency's budgeting process. Projects and studies that receive funding from the agency's appropriated funds are consistent with the public interest. The State Water Commission values and relies on local sponsors and their participation to assure on-the-ground support for projects and prudent expenditure of funding for evaluations and project construction. It is the policy of the State Water Commission that only the items described in this document will be eligible for cost-share upon approval by the State Water Commission, unless specifically authorized by State Water Commission action.

900 East Boulevard Ave | Bismarck, ND 58505 | 701.328.4862 | SWC.nd.gov

I. DEFINITIONS

A. CAPITAL IMPROVEMENT FUND is money set aside using a portion of user fees for future asset replacement and a cost-share application shall include documentation of the following:

1. Current capital improvement fund balance
2. Existing and new assets
3. Replacement cost of assets
4. Average life of assets
5. Current and future monthly reserve per user

B. CONSTRUCTION COSTS include earthwork, concrete, mobilization and demobilization, dewatering, materials, seeding, rip-rap, crop damages, re-routing electrical transmission lines, moving storm and sanitary sewer system and other underground utilities and conveyance systems affected by construction, mitigation required by law related to the construction contract, water supply works, irrigation supply works, and other items and services provided by the contractor. Construction costs are only eligible for cost-share if incurred after State Water Commission approval and if the local sponsor has complied with North Dakota Century Code (N.D.C.C.) in soliciting and awarding bids and contracts, and complied with all applicable federal, state, and local laws.

C. COST-SHARE means funds appropriated by the legislative assembly or otherwise transferred by the Commission to a local entity under Commission policy as reimbursement for a percentage of the total approved cost of a project approved by the Commission.

D. ECONOMIC ANALYSIS means an estimate of the economic benefits and direct costs that result from the development of a project.

E. ENGINEERING SERVICES include pre-construction and construction engineering. Pre-construction engineering is the engineering necessary to develop plans and specifications for permitting and construction of a project including preliminary and final design, material testing, flood insurance studies, hydraulic models, and geotechnical investigations. Construction engineering is the engineering necessary to build the project designed in the pre-construction phase including construction contract management, and construction observation. Administrative and support services not specific to the approved project are not engineering services. Engineering services are eligible costs if incurred after State Water Commission approval. If the total anticipated engineering costs are greater than the threshold stipulated in NDCC 54-44.7-04, then the local sponsor must follow the engineering selection process provided in NDCC 54-44.7 and provide a copy of the selection committee report to the Chief Engineer. The local sponsor will be considered to have complied with this requirement if they have completed a selection process for a general engineering services agreement at least once every three years and have formally assigned work to a firm or firms under an agreement. The local sponsor must inform the Chief Engineer of any change in the provider of general engineering services.

F. EXPANSIONS are construction related projects that increase the project area or users served. Expansions do not include maintenance, replacement, or reconstruction activities.

G. EXTRAORDINARY MAINTENANCE COSTS include the repair or replacement of portions of facilities or components that extends the overall life of the system or components that are above and beyond regular or normal maintenance. Extraordinary maintenance activities extend the asset's useful life beyond its originally predicted useful life.

H. GRANT means a one-time sum of money appropriated by the legislative assembly and transferred by the Commission to a local entity for a particular purpose. A grant is not dependent on the local entity providing a particular percentage of the cost of the project.

I. IMPROVEMENTS are construction related projects that upgrade a facility to provide increased efficiency, capacity, or redundancy. Improvements do not include any activities that are maintenance, replacement, or reconstruction.

J. LIFE CYCLE COST ANALYSIS means the summation of all costs associated with the anticipated useful life of a project, including project development, land, construction, operation, maintenance, and disposal or decommissioning.

K. LOAN means an amount of money lent to a sponsor of a project approved by the Commission to assist with funding approved project components. A loan may be stand-alone financial assistance.

L. LOCAL SPONSOR is the entity submitting a cost-share application and must be a political subdivision, state entity, or commission legislatively granted North Dakota recognition that applies the necessary local share of funding to match State Water Commission cost-share. They provide direction for studies and projects, public point of contact for communication on public benefits and local concerns, and acquire necessary permits and rights-of-way.

M. REGULAR MAINTENANCE COSTS include normal repairs and general upkeep of facilities to allow facilities to continue proper operation and function. These maintenance items occur on a regular or annual basis. Regular maintenance activities simply help ensure the asset will remain serviceable throughout its originally predicted useful life.

N. SUSTAINABLE OPERATION, MAINTENANCE, AND REPLACEMENT PLAN is a description of the anticipated operation, maintenance, and replacement costs with a statement that the operation, maintenance, and replacement of the project will be sustainable by the local sponsor. For water supply projects, a summary of the project sponsor's Capital Improvement Fund must also be included.

O. WATER CONVEYANCE PROJECT means any surface or subsurface drainage works, bank stabilization, or snagging and clearing of water bodies.

II. INELIGIBLE ITEMS excluded from cost-share include:

1 Administrative costs, including salaries for local sponsor members and employees as well as consultant services that are not project specific and other incidental costs incurred by the sponsor;

2 Property and easement acquisition costs paid to the landowner unless specifically identified as eligible within the Flood Recovery Property Acquisition Program, the Flood Protection Program, or Water Retention Projects;

3 Work and costs incurred prior to a cost-share approval date, except for emergencies as determined by the Chief Engineer;

4 Project related operation and regular maintenance costs;

5 Funding contributions provided by federal, other state, or other North Dakota state entities that supplant costs;

6 Work incurred outside the scope of the approved study or project; or

7 Local requirements imposed beyond State and Federal requirements for the project may be ineligible.

III. COST-SHARE APPLICATION AND APPROVAL PROCEDURES
The State Water Commission will not consider any cost-share applications unless the local sponsor first makes an application to the Chief Engineer. No funds will be used in violation of Article X, § 18 of the North Dakota Constitution (Anti-Gift Clause).

A. APPLICATION REQUIRED. An application for cost-share is required in all cases and must be submitted by the local sponsor on the State Water Commission Cost-Share Application form. Applications for cost-share are accepted at any time. Applications received less than 45 days before a State Water Commission meeting will not be considered at that meeting and will be held for consideration at a future meeting unless specifically exempted by the Chief Engineer. The application form is maintained and updated by the Chief Engineer. A completed application must include the following:

1 Category of cost-share activity

2 Location of the proposed project or study area shown on a map

3 Description, purpose, goal, objective, narrative of the proposed activities

4 Delineation of costs

5 Anticipated timeline of project from preliminary study through final closeout

6 Potential federal, other state, or other North Dakota state entity participation

7 Documentation of an engineering selection process if engineering costs are anticipated to be greater than the threshold provided in NDCC 54-44.7-04

8 Engineering plans, if applicable

9 Status of required permitting

10 Potential territorial service area conflicts or service area agreements, if applicable

11 Sustainable operation, maintenance, and replacement plan for projects

12 Completed economic analysis worksheet for water conveyance and flood-related projects expected to cost more than one million dollars. (Required at the time applications include a request for construction cost-share.)

13 Completed life cycle cost analysis worksheet for municipal water supply construction projects

14 Additional information as deemed appropriate by the Chief Engineer

Applications for cost-share are separate and distinct from the State Water Commission biennial project information collection effort that is part of the budgeting process and published as the State Water Plan. All local sponsors are encouraged to submit project financial needs for the State Water Plan. Projects not submitted as part of the State Water Plan development process may be held until action can be taken on those that were included during budgeting, unless determined to be an emergency that directly impacts human health and safety or that are a direct result of a natural disaster.

B. PRE-APPLICATION. A pre-application process is allowed for cost-share of assessment projects. This process will require the local sponsor to submit a brief narrative of the project, and a delineation of costs. The Chief Engineer will then review the material presented, make a determination of project eligibility, and estimate the cost-share funding the project may anticipate receiving. A project eligibility letter will then be sent to the local sponsor noting the percent of cost-share assistance that may be expected on eligible items as well as listing those items that are not considered to be eligible costs. In addition, the project eligibility letter will state that the Chief Engineer will recommend approval when all cost-share requirements are addressed. The local sponsor may use the project eligibility letter to develop a project budget for use in the assessment voting process. Upon completion of the assessment vote and all other requirements an application for cost-share can be submitted.

C. REVIEW. Upon receiving an application for cost-share, the Chief Engineer will review the application and accompanying information. If the Chief Engineer is satisfied that the proposal meets all requirements, the local sponsor will be asked to present the application, and the Chief Engineer will provide a recommendation to the State Water Commission for its action. The Chief Engineer's review of the application will include the following items and any other considerations that the Chief Engineer deems necessary and appropriate.

1 Applicable engineering plans;

2 Field inspection, if deemed necessary by the Chief Engineer;

3 The percent and limit of proposed cost-share determined by category of cost-share activity and eligible expenses;

4 Assurance of sustainable operation, maintenance, and replacement of project facilities by the local sponsor;

5 Status of permitting and service area agreements;

6 Available funding in the State Water Commission budget, if in the State Water Plan, and a priority ranking when appropriate;

7 Results of economic analysis of water conveyance or flood-related projects, when applicable; and

8 Results of life cycle cost analysis for municipal water supply projects, when applicable.

For cost-share applications over $100 million, additional information requested by the State Water Commission will be used to determine cost-share.

The Chief Engineer is authorized to approve cost-share up to $75,000 and also approve cost overruns up to $75,000 without State Water Commission action. The Chief Engineer will respond to such requests within 60 days of receipt of the request. A final decision may be deferred if warranted by funding or regulatory consideration.

D. NOTICE. The Chief Engineer will give a 10-day notice to local sponsors when their application for cost-share is placed on the tentative agenda of the State Water Commission's next meeting.

E. AGREEMENT AND DISTRIBUTION OF FUNDS. No funds will be disbursed until the State Water Commission and local sponsor have entered into an agreement for cost-share participation. No agreement for construction funding will be entered into until all required State Engineer permits have been acquired.

For construction projects, the agreement will address indemnification and vicarious liability language. The local sponsor must require that the local sponsor and the state be made an additional insured on the contractor's commercial general liability policy including any excess policies, to the extent applicable. The levels and types of insurance required in any contract must be reviewed and agreed to by the Chief Engineer. The local sponsor may not agree to any provision that indemnifies or limits the liability of a contractor.

For any property acquisition, the agreement will specify that if the property is later sold, the local sponsor is required to reimburse the Commission the percent of sale price equal to the percent of original cost-share.

The Chief Engineer may make partial payment of cost-sharing funds as deemed appropriate. Upon notice by the local sponsor that all work or construction has been completed, the Chief Engineer may conduct a final field inspection. If the Chief Engineer is satisfied that the work has been completed in accordance with the agreement, the final payment will be disbursed to the local sponsor, less any partial payment previously made.

The project sponsor must provide a progress report to the Commission at least once every four years if the term of the project exceeds four years. If a progress report is not received in a timely fashion, or if after a review of the progress report the Commission determines the project has not made sufficient progress, the Commission may terminate the agreement for project funding. The project sponsor may submit a new application to the Commission for funding for a project for which the Commission previously terminated funding.

F. LITIGATION. If a project submitted for cost-share is the subject of litigation, the application may be deferred until the litigation is resolved. If a project approved for cost-share becomes the subject of litigation before all funds have been disbursed, the Chief Engineer may withhold funds until the litigation is resolved. Litigation for this policy is defined as legal action that would materially affect the ability of the local sponsor to construct the project; that would delay construction such that the authorized funds could not be spent; or is between political subdivisions related to the project.

G. ECONOMIC ANALYSIS. Project sponsors seeking cost-share for construction of flood control or water conveyance projects with a total cost of one million dollars or more must complete the Water Commission's economic analysis worksheet. The results of the economic analysis must be provided with the sponsor's application for cost-share assistance for agency review. When the results of the economic analysis are determined by the agency to be accurate, the results will then be presented to the State Water Commission for their consideration as part of the cost-share request.

H. LIFE CYCLE COST ANALYSIS. Project sponsors seeking cost-share for construction of municipal water supply projects must complete the Water Commission's life cycle cost analysis worksheet. The results of the life cycle cost analysis must be provided with the sponsor's application for cost-share assistance for agency review. When the results of the life cycle cost analysis are determined by the agency to be accurate, the results will then be presented to the State Water Commission for their consideration as part of the cost-share request.

IV. COST-SHARE CATEGORIES

The State Water Commission supports the following categories of projects for cost-share. Engineering expenses related to construction are cost-shared at the same percent as the construction costs when approved by the State Water Commission.

A. PRE-CONSTRUCTION EXPENSES. The State Water Commission supports local sponsor development of feasibility studies, engineering designs, and mapping as part of pre-construction activities to develop support for projects within this cost-share policy. The following projects and studies are eligible.

1 Feasibility studies to identify water related problems, evaluate options to solve or alleviate the problems based on technical and financial feasibility, and provide a recommendation and cost estimate of the best option to pursue.

2 Engineering design to develop plans and specifications for permitting and construction of a project, including associated cultural resource and archeological studies.

3 Mapping and surveying to gather data for a specific task such as flood insurance studies and flood plain mapping, LiDAR acquisition, and flood imagery attainment, which are valuable to managing water resources.

Copies of the deliverables must be provided to the Chief Engineer upon completion. The Chief Engineer will determine the payment schedule and interim progress report requirements.

B. WATER SUPPLY

1 RURAL AND MUNICIPAL WATER SUPPLY PROJECTS. The State Water Commission supports water supply efforts. The local sponsor may apply for funding, and the application will be reviewed to determine project priority. Debt per capita, water rates and financial need may be considered by the Commission when determining an appropriate cost-share percentage. The Commission reserves flexibility to adjust percentages on a case by case basis, but generally:

Up to 75% cost-share may be provided for:

- Rural Water System Expansions and Improvements
- Connection of communities to a regional system
- Improvements required to meet primary drinking water standards

Up to 60% cost-share may be provided for:

- Municipal Water Supply Expansions and Improvements
- Connection of new rural water customers located within extraterritorial areas of a municipality

Water Depots for industrial use receiving water from facilities constructed using State Water Commission funding or loans have the following additional requirements:

a) Domestic water supply has priority over industrial water supply in times of shortage. This must be explicit in the water service contracts with industrial users.

b) If industrial water service will be contracted, public notice of availability of water service contracts is required when the depot becomes operational.

c) Public access to water on a non-contracted basis must be provided at all depots.

2 FEDERAL MUNICIPAL, RURAL, AND INDUSTRIAL WATER SUPPLY PROGRAM. The Municipal, Rural, and Industrial Water Supply Program, which uses federal funds, is administered according to North Dakota Administrative Code Article 89-12.

3 DROUGHT DISASTER LIVESTOCK WATER ASSISTANCE PROGRAM. This program is to provide assistance with water supply for livestock impacted during drought declarations and is administered according to North Dakota Administrative Code Article 89-11.

C. FLOOD CONTROL. The State Water Commission may provide cost-share for eligible items of flood control projects protecting communities from flooding and may include the repair of dams that provide a flood control benefit.

1 FLOOD RECOVERY PROPERTY ACQUISITION PROGRAM. This program is used to assist local sponsors with flood recovery expenses that provide long term flood damage reduction benefits through purchase and removal of structures in areas where flood damage has occurred. All contracted costs directly associated with the acquisition will be considered eligible for cost-share. Contracted costs may include: appraisals, legal fees (title and abstract search or update, etc.), property survey, closing costs, hazardous materials abatement needs (asbestos, lead paint, etc.), and site restoration.

The State Water Commission may provide cost-share of the eligible costs of approved flood recovery expenses that provide long term flood reduction benefits based on the following criteria and priority order:

a) Local sponsor has flood damage and property may be needed for construction of temporary or long-term flood control projects, may be cost-shared up to 75 percent.

b) Local sponsor has flood damage and property would increase conveyance or provide other flood control benefits, may be cost-shared up to 60 percent.

Prior to applying for assistance, the local sponsor must adopt and provide to the Chief Engineer an acquisition plan (similar to plans required by Hazard Mitigation Grant Program (HMGP)) that includes the description and map of properties to be acquired, the estimated cost of property acquisition including contract costs, removal of structures, the benefit of acquiring the properties, and information regarding the ineligibility for HMGP funding. Property eligible for HMGP funding is not eligible for this program. The acquisition plan must also include a description of how the local sponsor will insure there is not a duplication of benefits.

Over the long-term development of a flood control project following a voluntary acquisition program, the local sponsor's governing body must officially adopt a flood risk reduction plan or proposal including the flow to be mitigated. The flow used to develop the flood risk reduction plan must be included in zoning discussions to limit new development on other flood-prone property. An excerpt of the meeting minutes documenting the local sponsor's official action must be provided to the Chief Engineer.

The local sponsor must fund the local share for acquisitions. This requirement will not be waived. Federal funds are considered "local" for this program if they are entirely under the authority and control of the local sponsor.

The local sponsor must include a perpetual restrictive covenant similar to the restrictions required by the federal HMGP funding with the additional exceptions being that the property may be utilized for flood control structures and related infrastructure, paved surfaces, and bridges. These covenants must be recorded either in the deed or in a restrictive covenant that would apply to multiple deeds.

The local sponsor must provide justification, acceptable to the Chief Engineer, describing the property's ineligibility to receive federal HMGP funding. This is not meant to require submission and rejection by the federal government, but rather an explanation of why the property would not be eligible for federal funding. Example explanations include: permanent flood control structures may be built on the property; project will not achieve required benefit-cost analysis to support HMGP eligibility; or lack of available HMGP funding. If inability to receive federal funding is not shown to the satisfaction of the Chief Engineer, following consultation with the North Dakota Department of Emergency Services, the cost-share application will be returned to the local sponsor for submittal for federal funding prior to use of these funds.

2 FLOOD PROTECTION PROGRAM. This program supports local sponsor efforts to prevent future property damage due to flood events. The State Water Commission may provide cost-share up to 60 percent of eligible costs. For projects with federal participation, the cost-share may be up to 50 percent of eligible non-federal costs. The State Water Commission may consider a greater level of cost participation for projects involving a total cost greater than $100 million and having a basin wide or regional benefit.

Local share must be provided on a timely basis. The State Water Commission may lend a portion of the local share based on demonstrated financial need.

Property acquisition costs limited to the purchase price of the property that is not eligible for HMGP funding and within the footprint of a project may be eligible under this program. The local sponsor must include a perpetual restrictive covenant on any properties purchased under this program similar to the restrictions required by the federal HMGP funding with the additional exceptions being that the property may be utilized for flood control structures and related infrastructure, paved surfaces, and bridges. These covenants must be recorded either in the deed or in a restrictive covenant that would apply to multiple deeds.

Costs for property acquired, by easement or fee title, to preserve the existing conveyance of a breakout corridor recognized as essential to FEMA system accreditation may be eligible under this program.

The cost-share application must include the return interval or design flow for which the structure will provide protection. The Commission will calculate the amount of its financial assistance, based on the needs for protection against:

1. One-hundred year flood event as determined by a federal agency;
2. The national economic development alternative; or
3. The local sponsor's preferred alternative if the Commission first determines the historical flood prevention costs and flood damages and the risk of future flood prevention costs and flood damages, warrant protection to the level of the local sponsor's preferred alternative.

Storm water management is not an eligible cost-share category. In order to differentiate between a flood control project and storm water management, the Commission may reduce the cost-share provided by the percentage of the contributing watershed that is located within the community's corporate limits as calculated on an acreage basis.

3 FEMA LEVEE SYSTEM ACCREDITATION PROGRAM. The State Water Commission may provide cost-share up to 60 percent for eligible services for FEMA 44 CFR 65.10 flood control or reduction levee system certification analysis. The analysis is required for FEMA to accredit the levee system for flood insurance mapping purposes. Typical eligible costs include site visits and field surveys to include travel expenses, hydraulic evaluations, closure evaluations, geotechnical evaluations, embankment protection, soils investigations, interior drainage evaluations, internal drainage hydrology and hydraulic reports, system modifications, break-out flows, and all other engineering services required by FEMA. The analysis will result in a comprehensive report to be submitted to FEMA and the Chief Engineer.

Administrative costs to gather existing information or to recreate required documents, maintenance and operations plans and updates, and emergency warning systems implementation are not eligible.

4 DAM SAFETY AND EMERGENCY ACTION PLANS. The State Water Commission supports dam safety including repairs and removals, as well as emergency action plans. The State Water Commission may provide cost-share for up to 75 percent of the eligible items for dam safety repair projects and dam breach or removal projects. Dam safety repair projects that are funded with federal or other agency funds may be cost-shared up to 75 percent of the eligible non-federal costs. The intent of these projects is to return the dam to a state of being safe from the condition of failure, damage, error, accidents, harm or other events that are considered a threat to public safety. The State Water Commission may lend a portion of the local share based on demonstrated financial need.

The State Water Commission may provide cost-share up to 80 percent, for emergency action plans (EAPs) of each dam classified as high or medium/significant hazard. The cost of a dam break model is only eligible for reimbursement for dams classified as a high hazard.

5 WATER RETENTION PROJECTS. The goal of water retention projects is to reduce flood damages by storing floodwater upstream of areas prone to flood damage. The State Water

Commission may provide cost-share up to 60 percent of eligible costs for water retention projects including purchase price of the property. For projects with federal participation, the cost-share may be up to 50 percent. Water retention structures constructed with State Water Commission cost-share must meet state dam safety requirements, including the potential of cascade failure. A hydrologic analysis including an operation plan and a quantification of the flood reduction benefits for 25, 50, and 100-year events must be submitted with the cost-share application.

6 INDIVIDUAL RURAL AND FARMSTEAD RING DIKE PROGRAM. This program is intended to protect individual rural homes and farmsteads through ring dike programs established by water resource districts. All ring dikes within the program are subject to the Commission's Individual Rural and Farmstead Ring Dike Criteria provided in Attachment A. Protection of a city, community or development area does not fall under this program but may be eligible for the flood control program. The State Water Commission may provide up to 60 percent cost-share of eligible items for ring dikes up to a limit of $55,000 per ring dike.

Landowners enrolled in the Natural Resource Conservation Service's (NRCS) Environmental Quality Incentive Program (EQIP) who intend to construct rural or farmstead ring dikes that meet the State Water Commission's elevation design criteria are eligible for a cost-share reimbursement of 20 percent of the NRCS construction payment, limited to a combined NRCS and State Water Commission contribution of 80 percent of project costs.

D. WATER CONVEYANCE.

1 RURAL FLOOD CONTROL. These projects are intended to improve the drainage and management of runoff from agricultural sources. The State Water Commission may provide cost-share up to 45 percent of the eligible items for the construction of drains, channels, or diversion ditches. Construction costs for public road crossings that are integral to the project are eligible for cost-share as defined in N.D.C.C. § 61-21-31 and 61-21-32. If an assessment-based rural flood control project involves multiple districts, each district involved must join in the cost-share application.

Cost-share applications for rural assessment drains will only be processed after the assessment vote has passed, and a drain permit has been obtained. If the local sponsor wishes to submit a cost-share application prior to completion of the aforementioned steps, a pre-application process will be followed.

A sediment analysis must be provided with any application for cost-share assistance for reconstruction of an existing drain. The analysis must be completed by a qualified professional engineer and must clearly indicate the percentage volume of sediment removal involved in the project. The cost of that removal must be deducted from the total for which cost-share assistance is being requested.

2 BANK STABILIZATION. The State Water Commission may provide cost-share up to 50 percent of eligible items for bank stabilization projects on public lands or those lands under easement by federal, state, or political subdivisions. Bank stabilization projects are intended to stabilize the banks of lakes or watercourses, as defined in N.D.C.C § 61-01-06, with the purpose of protecting public facilities. Drop structures and outlets are not considered for funding as bank stabilization projects, but may be eligible under other cost-share program categories. Bank stabilization projects typically consist of a rock or vegetative design and

are intended to prevent damage to public facilities including utilities, roads, or buildings adjacent to a lake or watercourse.

3 SNAGGING AND CLEARING. Snagging and clearing projects consist of the removal and disposal of fallen trees and associated debris encountered within or along the channel of a natural watercourse. Snagging and clearing projects are intended to prevent damage to structures such as bridges, and maintain the hydraulic capacity of the channel during flood flows. The Water Commission may provide cost-share for up to 50 percent of the eligible items for snagging and clearing as well as any sediment that has accumulated in the immediate vicinity of snags and any trees in imminent danger of falling in the channel or watercourses as defined in N.D.C.C § 61-01-06. Items that are not eligible include snagging and clearing of man-made channels; the dredging of watercourses for sediment removal; the clearing and grubbing of cattails and other plant vegetation; or the removal of any other unwanted materials.

E. RECREATION. The State Water Commission may provide cost-share up to 40 percent for projects intended to provide water-based recreation. Typical projects provide or complement water-based recreation associated with dams.

F. IRRIGATION. The State Water Commission may provide cost-share for up to 50 percent of the eligible items for irrigation projects. The items eligible for cost-share are those associated with the off-farm portion of new central supply works, including water storage facilities, intake structures, wells, pumps, power units, primary water conveyance facilities, and electrical transmission and control facilities. The Commission will only enter into cost-share agreements with political subdivisions, including irrigation districts, and not with individual producers.

## ATTACHMENT A
## INDIVIDUAL RURAL AND FARMSTEAD RING DIKE CRITERIA

### MINIMUM DESIGN CRITERIA

- Height: The dike must be built to an elevation 2 ft above either the 100-year flood or the documented high water mark of a flood event of greater magnitude, whichever is greater.
- Top Width:

| | |
|---|---|
| If dike height is 5 ft or less: | 4 ft top width |
| If dike height is between 5 ft and 14 ft: | 6 ft top width |
| If dike height is greater than 14 ft: | 8 ft top width |

- Side Slopes: 3 horizontal to 1 vertical
- Strip topsoil and vegetation: 1 ft
- Adequate embankment compaction: Fill in 6-8 inch layers, compact with passes of equipment
- Spread topsoil and seed on ring dike

### LANDOWNER RESPONSIBILITY

Landowners are responsible to address internal drainage on ring dikes. If culverts and flap gates are installed, these costs are eligible for cost-share. The landowner has the option of completing the work or hiring a contractor to complete the work.

IF CONTRACTOR DOES THE WORK, payment is for actual costs with documented receipts.

IF LANDOWNER DOES THE WORK, payment is based on the following unit prices:

- Stripping, spreading topsoil, and embankment fill: Chief Engineer will determine rate schedule based on current local rates.
- Seeding: Cost of seed times 200%
- Culverts: Cost of culverts times 150%
- Flap gates: Cost of flap gates times 150%

### OTHER FACTS AND CRITERIA

- The topsoil and embankment quantities will be estimated based on dike dimensions. Construction costs in excess of the 3:1 side slope standard will be the responsibility of the landowner. Invoices will be used for the cost of seed, culverts, and flap gates.
- Height can be determined by existing FIRM data or known elevations available at county floodplain management offices. Engineers or surveyors may also assist in establishing height elevations.

- The projects will not require extensive engineering design or extensive cross sections.
- A dike permit is required if the interior volume of the dike consists of 50 acre-feet, or more.