Saddle Lake
Lake Level Control Structure
Preliminary Engineering Study

Prepared for:

Van Buren County Drain Commissioner

219 E Paw Paw St. #301
Paw Paw, MI 49079

DRAFT

Prepared by:

Land & Resource Engineering (LRE)

May 10, 2024
Project No. 23-169

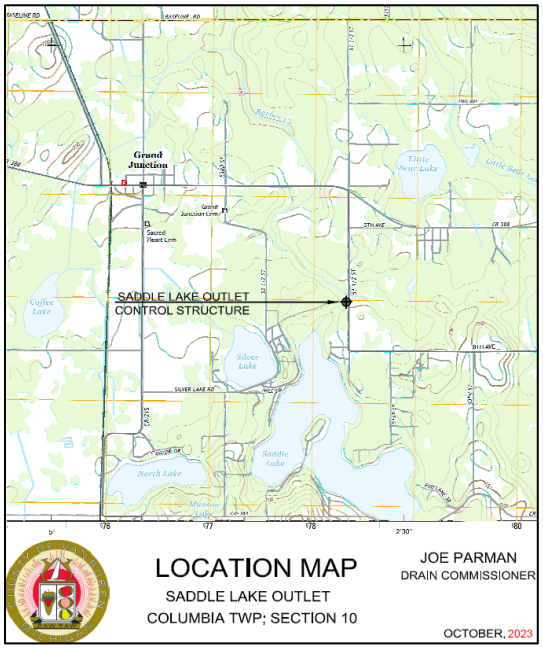
LRE
ENGINEERS & SURVEYORS

2121 3 Mile Rd. NW
Walker, MI 49544
Ph: 616-301-7888
www.LREMI.com

TABLE OF CONTENTS

INTRODUCTION

Saddle Lake (Lake) encompasses roughly 298 acres in the central part of Columbia Township, Van Buren County, Michigan. There are over 200 parcels that border the Lake. The lake level control structure for Saddle Lake is owned by the Saddle Lake property owners and the Van Buren County Drain Commissioner (VBCDC) acts as the delegated authority.



The Saddle Lake Intercounty Drain (Barber Creek) serves as the primary outlet for the Lake. Water levels in the Lake are regulated by the Saddle Lake Level Control Structure (Dam), located north of the Lake at the southwest corner of the intersection between Silver Lake Road and 51 1/2 Street. The sheeting on the Dam between the two spillways has corroded to the point of leaking and must be repaired/replaced. The Dam is regulated under Part 307, Inland Lake Levels, of the Natural Resources and Environmental Protection Act, (P.A. 451 of 1994, as amended).

Purpose of Study

The VBCDC was seeking qualifications for engineering services pertaining to the Saddle Lake Level Control Structure in December 2023. LRE was selected by the VBCDC in January 2024 to conduct an engineering study of the Dam. Our project team includes Material Testing Consultants (MTC) to provide geotechnical analysis and provide structural engineering recommendations.

The primary purpose of the study is to analyze the condition of the existing Dam, evaluate potential improvement alternatives, provide recommendations, obtain an EGLE permit under Part 301, Inland Lakes and Streams, of NREPA and prepare drawings and specifications for bidding. A dam inspection report conducted on November 15, 2023 by the VBCDC noted several deficiencies in the Dam warranting repair or replacement.

DAM OVERVIEW

Dam History

On July 6, 1931, the Van Buren County Circuit Court (Court) established the legal level of the Lake, which is set at 668.00-feet USGS Datum. The initial Saddle Lake Dam, constructed in 1931 was a 24-foot, concrete spillway set at a height of 667.91-feet and 6-foot-long return walls. Drawings for the first dam can be found in **Appendix 3.**

The Dam was replaced in spring of 1983 by a steel sheet pile dam placed approximately 14-feet upstream from the original concrete dam. The replacement was warranted

because the original dam settled and could no longer maintain the legal lake level of 668-feet. Alpha Engineering of South Haven, MI provided the engineering analysis and design of the proposed sheet pile structure. The Dam was constructed with 8-foot tall sheets along the outer 4.5-feet and 6-foot tall sheets for the 24-foot spillway. The outer sections have a top elevation of 669.5, whereas the spillway elevation is 667.91. The resulting embedment elevation would be approximately 661.5-feet. A permit from the Department of Natural Resources was issued on September 8, 1982, to *"construct 32-feet of interlocking sheet piling to maintain a lake level. Remove existing concrete control structure and deepen existing channel at the outlet of Saddle Lake."*

On August 19, 1987 the Court (Order #:20-445) amended the Lake Level *"to authorize the Drain Commissioner of Van Buren County to modify the control structure outlet by permanently lowering the fixed height of the control structure six (6) inches. Provided however, such modification shall include an adjustable section of the control structure capable of raising the level of the control structure from its fixed height up to 668 feet USGS Datum."*

Merritt Engineering of Niles, MI designed and bid out the modifications to the existing sheet pile dam. Bids for the modifications on the Dam were received on August 28, 1987. The design consisted of lowering two (2) 6-foot sections from the original spillway elevation of 667.91 to 667.41 feet. Treated timbers were used within the newly constructed spillways for seasonal lake level adjustment.

On April 12, 2012, Manning Enterprises replaced the angles on the existing frame work with stainless steel channels and repaired the stop log locking mechanism.

ANALYSIS OF EXISTING CONDITIONS

The VBCDC performed the required inspection of the Dam in October 2023 under Part 307 of NREPA. Holes in the sheeting and leaks from the stop log were observed during this inspection. This prompted the VBCDC to pursue improvements to the Dam.

Topographic Survey

LRE conducted a topographic survey of the Saddle Lake Drain approximately 200-feet upstream and downstream of the Dam on February 9, 2024. A plan and profile of the topographic survey is provided in the enclosed **Sheet C1.** The crest of the Dam is 667.35-feet (NAVD-88) for the summer level and 667.05-feet for the winter level.

The historic Dam drawings and court order are established using the NGVD-29 datum. The recent elevation data collected was converted from NAVD-88 to NGVD-29 using the NGS Coordinate Conversion and Transformation Tool (NCAT). There is a difference of negative 0.447-feet between NGVD-29 and NAVD-88. Converting the survey data yields a dam crest elevation of 667.81 at the summer level and 667.49 at the winter level. The summer elevation is approximately 0.10-feet lower than the historic as built elevations and 0.08-feet higher than the winter crest elevation.

Geotechnical Investigation

LRE subcontracted MTC to perform a geotechnical investigation for the Saddle Lake Level Control Structure. Soil borings were conducted by MTC on February 19, 2024. A copy of the Geotechnical Report prepared by MTC is included in **Appendix 2** and is summarized below.

The Saddle Lake Level Control Structure is located in an area of outwash and glacial channels associated with Barber Creek and Saddle Lake. Soil conditions are primarily granular in glacial outwash deposits with sorting of particle sizes with depth based on historic flow rates. The bedrock layer in this area is approximately 400-feet (NAVD-88), roughly 260-feet deeper than the existing grade.

Two soil borings were conducted, one on the west (B-1) and one on the east (B-2) of the Saddle Lake Drain (Barber Creek). Both bores were taken to a depth of approximately 20-feet below the ground surface. Soils consisted of 12-20 inches of topsoil at the ground surface over granular soil to the explored depth. Poorly graded sand with silt was encountered between 3-6-feet from the surface, grading to a medium dense to dense relative density that increased with depth. Poor sample recovery was noted at the ground surface in boring B-2, indicating the presence of coarse gravel or cobble. Groundwater was encountered during drilling activities between 4-4.5-feet from the surface, elevations 665.8-666.4-feet (NAVD-88).

MTC performed an overturning analysis for the existing and proposed sheet pile structures to evaluate the stability of the structure and anticipated later deflection at the top of sheeting. The overturning stability analysis confirmed the minimum sheet pile embedment depth and evaluated the minimum section modulus for the sheet pile to limit deflection and stresses.

MTC performed a steady state seepage analysis of the existing Dam based on the observed soil conditions and water surface elevations. The purpose of the analysis was to evaluate the existing structure to evaluate downstream boiling and heaving resistance. Conditions for piping of in—situ soil develop when the hydraulic gradient occurring in the field exceeds the critical hydraulic gradient of soil to equal the ratio of the soil's effective unit weight to the unit weight of water.

MTC's overturning and seepage analysis indicates that the existing structure is *"borderline stable regarding the overturing stability with an estimated Factor of Safety of 1.0 and exit gradient in excess of 0.5."* MTC recommends the sheeting be driven to a minimum elevation of 659.4-feet and have a section modulus of 15.3 cu.in/ft to provide suitable Factors of Safety.

EVALUATION OF ALTERNATIVES

LRE evaluated the following alternatives for Van Buren County to consider regarding the Dam.

Do Nothing

The existing sheet pile Dam has severe corrosion of the steel sheet pile above stream bed resulting in leaks developing through the Dam. The condition of sheeting below the bed of Barber Creek is unknown. The geotechnical analysis results indicate that the existing structure is borderline stable based on the overturning and seepage analysis performed. Additional corrosion of the steel sheeting will develop along the length of the Dam.

Dam Replacement – Steel Sheet Pile (In-Kind)

This alternative evaluates replacement of the dam with an "In-Kind" structure. The new structure would have sheeting driven to the recommended minimum embedment elevation of 659.4-feet (NAVD-88) to prevent overturning or seepage. This alternative will utilize a single timber stop log to maintain the summer and winter legal levels as ordered by the Court. The crest of the Dam will be set to match the existing structure elevations. This structure would otherwise appear and operate as the existing structure does.

Dam Replacement – Steel Sheet Pile (Variations)

Replacement of the Dam with a steel sheet pile structure similar to the in-kind structure was evaluated for this alternative. The 1987 Court Order states "t*o modify the control structure at the outlet of Saddle Lake by permanently lowering the fixed height of the control structure six (6) inches. Provided, however, such modification shall include an adjustable section of the control structure capable of raising the level of the control structure from its fixed height up to 668 feet USGS Datum."* The current Dam does not have a fixed elevation 6-inches lower than crest at the summer level. This alternative would provide an opening 6-inches lower than the fixed height of the structure and a combination of stop logs varying in height to effectively maintain the legal lake levels.

RECOMMENDATION & IMPLEMENTATION

LRE recommends replacing the control structure with a steel sheet pile weir with channel cap in-kind to the existing structure. After discussion with the VBCDC, there have been no complaints regarding the water level elevations in the Lake. Therefore, the in-kind replacement structure was selected.

The estimated cost to implement the recommended Dam replacement is **$146,000.** An itemized estimate of project cost is provided in **Appendix 1.** The estimate does not include legal, court cost, administrative or finance costs.

Permitting

The proposed Dam replacement will require a permit from the Michigan Department of Environment, Great Lakes and Energy pertaining to Part 301, Inland Lakes and Streams.

Final Design and Construction

Upon approval by the Van Buren County Drain Commissioner, LRE will establish a project schedule.

Project Schedule

A preliminary project timeline is provided in **Table 1.** The critical path will be obtaining an EGLE permit for construction; therefore, the actual project may vary.

Table 1 – Project Timeline

Task	2024				2025
	Spring	Summer	Fall	Winter	Spring
Engineering Report					
Engineering Design					
Permitting					
Bidding					
Construction					

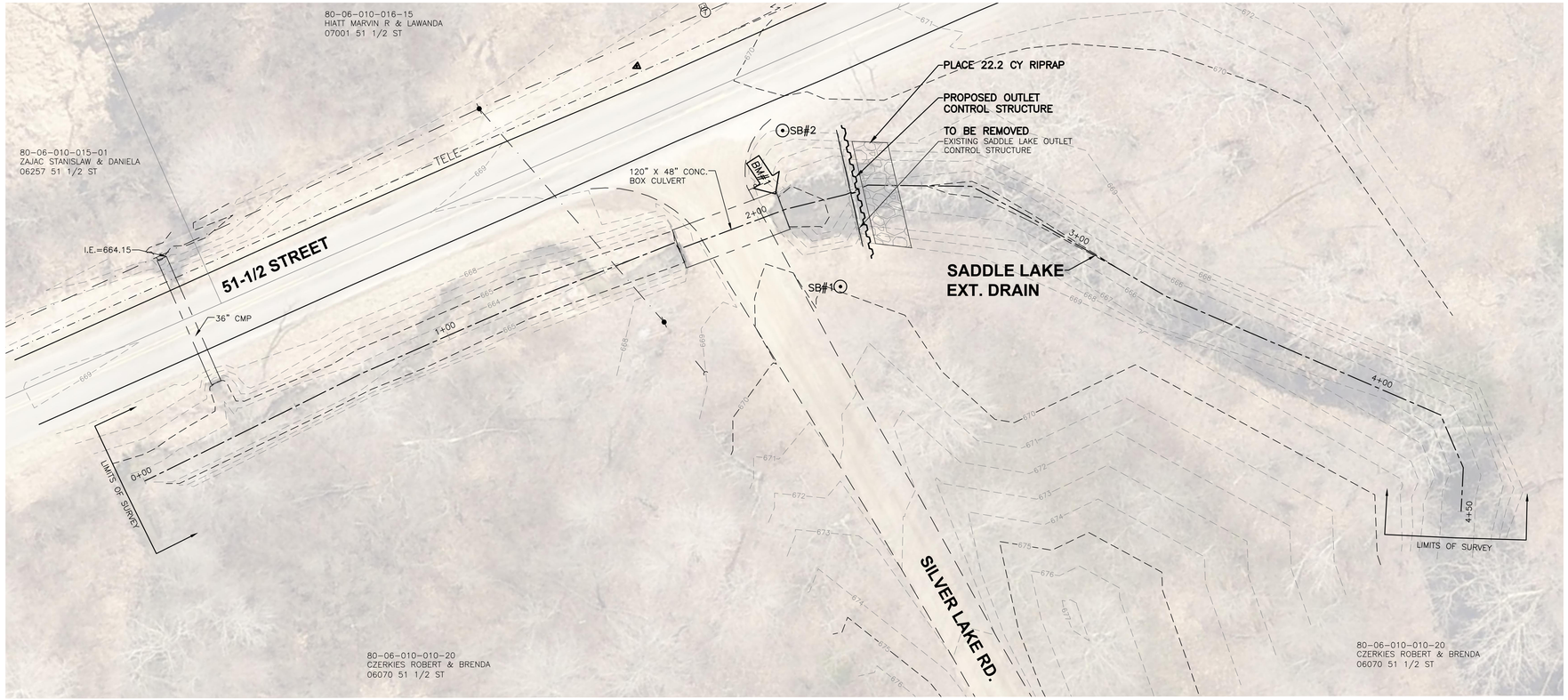
**Note – dark blue represents target schedule.*

Current Structure - Holes in Metal

BENCHMARK INFORMATION

BM#1) ELEVATION: 668.38
CHISELED BOX IN CONCRETE ON SOUTH END OF BOX CULVERT

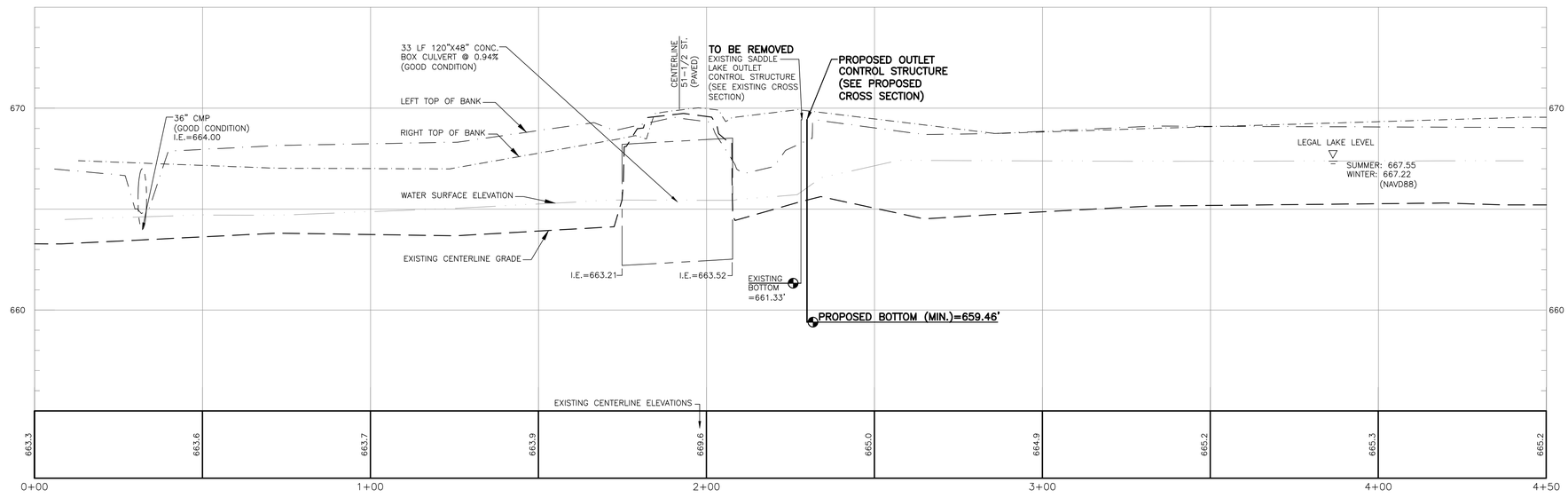
THE ELEVATIONS ARE BASED ON NAVD 88



PLAN VIEW

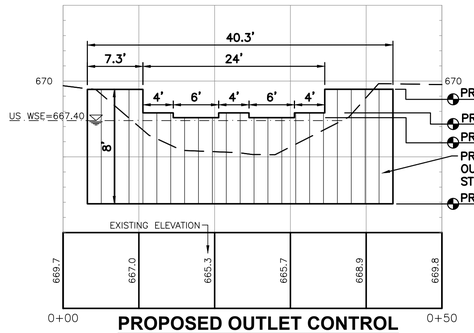
0 20 40
Horizontal Scale in Feet

NORTH



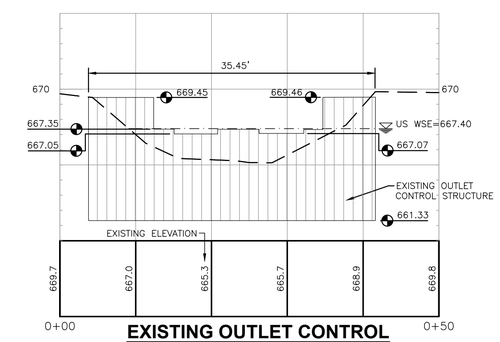
CENTERLINE PROFILE

SCALE: HORIZONTAL: 1" = 20'
VERTICAL: 1" = 5'



PROPOSED OUTLET CONTROL STRUCTURE CROSS SECTION

SCALE: HORIZONTAL: 1" = 10'
VERTICAL: 1" = 1'



EXISTING OUTLET CONTROL STRUCTURE CROSS SECTION

SCALE: HORIZONTAL: 1" = 10'
VERTICAL: 1" = 1'

FIGURE 1 - RECOMMENDATIONS

NOTE: AT 11"X17" DRAWING IS HALF-SCALE

CLIENT: VAN BUREN COUNTY DRAIN COMMISSIONER
PROJECT NUMBER: 23-169 DATE: 5/9/2024
DESIGNED BY: AWS
DRAFTED BY: NDJ

LRE ENGINEERS & SURVEYORS
2121 3 Mile Rd. NW
Walker, MI 49544
Ph: 616-301-7888
www.LREMI.com

APPENDIX 1 – Preliminary Cost Estimate

PRELIMINARY ESTIMATE OF PROJECT COST
SADDLE LAKE DAM - SHEET PILE IN-KIND

Date: May 7, 2024

ENGINEERS & SURVEYORS

No.	Item Description	Quantity		Unit Cost	Total Cost
1	Mobilization	1	LS	$ 20,000.00	$ 20,000.00
2	Utility Coordination	1	LS	$ 2,500.00	$ 2,500.00
3	Soil Erosion & Sedimentation Control	1	LS	$ 2,500.00	$ 2,500.00
4	Demolition of Existing Dam	1	LS	$ 2,500.00	$ 2,500.00
5	Steel Sheeting (Dam)	400	SF	$ 100.00	$ 40,000.00
6	Channel Cap	40	LF	$ 200.00	$ 8,000.00
7	Stop Logs and Locking Device	1	LS	$ 4,000.00	$ 4,000.00
8	Rock Riprap	50	SY	$ 100.00	$ 5,000.00
9	Final Site Restoration	1	LS	$ 2,500.00	$ 2,500.00
				Estimated Construction Total	**$ 87,000.00**

Estimated Construction Cost	$ 87,000.00
Estimated Engineering *(Study though Construction)*	$ 40,000.00
Contingency to Cover Unanticipated Costs *(~15%)*	$ 19,000.00
*** Preliminary Estimate of Probable Project Cost**	**$ 146,000.00**

** Does not include Legal, Court Costs, Administrative, Wetland Mitigation, Floodplain Mitigation, Environmental Remediation, Land Acquisition, Easement Acquisition, or Financing Costs.*

APPENDIX 2 – Geotechnical Investigation Report

March 18, 2024
Project No. 241064

Land & Resource Engineering
2121 3 Mile Road NW
Walker, Michigan 49544

Attention: Andrew Stoffel, P.E.
Senior Engineer

Reference: Report of Geotechnical Investigation
Saddle Lake Level Control Structure
Columbia Township, Michigan

Dear Mr. Stoffel:

MATERIALS TESTING CONSULTANTS, INC. has completed a geotechnical investigation for the above-referenced project. The findings of the study along with recommendations for the design of a replacement steel sheet pile dam structure are presented in the attached report.

Please contact our office should you have any questions or require further assistance.

Sincerely,

MATERIALS TESTING CONSULTANTS, INC.

Adam L. DePoy, P.E.
Project Manager

Todd D. Munger, P.E.
Vice President, Senior Project Manager

att: Report

MATERIALS TESTING CONSULTANTS

GEOTECHNICAL REPORT

SADDLE LAKE LEVEL CONTROL STRUCTURE
COLUMBIA TOWNSHIP, MICHIGAN

Prepared For:

LAND & RESOURCE ENGINEERING
Walker, Michigan

Prepared By:

MATERIALS TESTING CONSULTANTS, INC.

March 2024
MTC Project No. 241064

TABLE OF CONTENTS

REPORT OF GEOTECHNICAL INVESTIGATION
SADDLE LAKE LEVEL CONTROL STRUCTURE

1.0 INTRODUCTION

MATERIALS TESTING CONSULTANTS, INC. (MTC) has completed a geotechnical investigation for the planned replacement steel sheet pile dam structure, located within Barber Creek, southwest of the intersection of Silver Lake Road and 51 ½ Street in Columbia Township, Michigan, approximately ¼ mile north of Saddle Lake. This work has been performed as described in our proposal, number 17889 and dated January 4, 2024. Authorization to proceed was received from Land & Resource Engineering (LRE) through email on January 31, 2024.

The scope of this study in general includes the following:

- performance of a field investigation including soil test borings and field engineering reconnaissance;
- review of recovered samples by one of our engineers and assignment of technical soil classifications;
- performance of laboratory testing on selected soil samples;
- engineering evaluation of encountered conditions with respect to the proposed construction; and
- preparation of this report.

Presented herein are descriptions of our understanding of the design considerations, the investigation program, encountered conditions and engineering recommendations. The Appendix contains the report limitations, boring log terminology, soil classification chart, boring logs and laboratory test data.

2.0 DESIGN CONSIDERATIONS

2.1 Available Information

We have been provided the following documents and information for use in this investigation:

- Pictures of the existing sheet pile dam structure, received from Andrew Stoffel, P.E. of Land and Resource Engineering as part of a Request for Proposal email received on December 29, 2023.
- Plan and section drawings of the existing sheet pile dam structure, 3 sheets, prepared by Alpha Engineering, which we understand was prepared in 1980, received from Land and Resource Engineering through email on February 8, 2024.
- A plan and profile sheet of the existing sheet pile dam structure, Sheet C1, prepared by Land and Resource Engineering, dated February 2024 and received through email on February 21, 2024.
- Telephone and email correspondence with Mr. Andrew Stoffel, P.E. of Land and Resource Engineering regarding the type of construction, upstream lake/water levels for Saddle Lake, scour information, design elevations for the proposed replacement sheet pile dam structure, and project authorization.
- AASHTO LRFD Bridge Design Specifications, Ninth Edition, 2020.

2.2 Location and Type of Structure

The proposed construction will be located in plan as shown on the attached Boring Location Plan, Figure No. 1. The site is located immediately west of 51 ½ Street and immediately south of Silver Lake Road in Columbia Township. The existing dam structure is located within Barber Creek, approximately ¼ mile north of Saddle Lake. Barber Creek is approximately 10 to 12 ft wide in this area and flows from south to north within the project limits.

The proposed project will involve replacement of the existing Saddle Lake Level Control Structure. The existing structure is a steel sheet pile dam with wooden stop logs located within Barber Creek, with rip rap placed approximately 10 ft upstream and 10 ft downstream of the structure. As-built drawings indicate the existing dam consists of a 6 to 8-ft long sheet pile with approximately 4 ft of embedment and 2 to 4 ft of stickup above the bottom of the creek. The far east and west ends of the sheet pile were 8 ft long and were embedded into the

creekbank, while the spillway portion of the dam was 6 ft long (2 ft of stickup relative to creek bottom) to allow for water to flow over this portion of the dam. The plan and profile sheet received from LRE indicates the existing top of sheet is at el 667.35 (spillway portion) to 669.43 (far east and west ends), with the existing tip of sheeting at approximately el 661.4. We have not been informed of any past performance issues with the existing dam structure, and the dam appeared to be functioning adequately at the time of our field study.

We understand the proposed replacement dam structure will also consist of steel sheet piling and will be constructed in the same general location as the existing dam structure with the same approximate top of sheeting elevations (667.4 for spillway portion, 669.4 for far ends). We understand the court ordered Saddle Lake summer water level is el 668.0 and that no design scour is anticipated at the proposed structure. MTC has been contracted to evaluate the soil conditions in the area of the proposed construction and provide minimum design parameters for the replacement steel sheet pile dam structure.

We should be informed of any changes between the actual design conditions and those described herein as this information may affect our recommendations.

3.0 INVESTIGATION METHODOLOGY

3.1 Field Investigation

Subsurface conditions were investigated by two conventional soil test borings, one on each side of Barber Creek, to a depth of 20 ft. Boring locations are shown on the attached plan, Figure No. 1.

One of our geologists staked the approximate boring locations in the field. Boring elevations were approximated using a survey grade GPS unit. The elevations used in this report are given in feet and are based on NAVD 88 datum. If more precise location and elevation data are desired, a registered professional land surveyor should be retained to locate the borings and determine their ground elevations. As an additional safety precaution, Ground Penetrating Radar (GPR) scanning was performed near proposed boring locations to explore for potentially unmarked underground utilities.

A right-of-way permit was obtained through the Van Buren County Road Commission in order to perform Boring B-2 within the 51 ½ Street right-of-way. Traffic control consisted of a temporary shoulder closure with warning signs and cones along southbound 51 ½ Street. The drilling was performed using conventional hollow-stem auger methods to advance the boreholes. The boreholes were backfilled to the original ground surface after drilling completion using cement-bentonite grout.

Soil samples were recovered on 2.5-ft intervals by means of the Standard Penetration Test (SPT), ASTM D1586. The SPT test involves the use of a 140-lb hammer with a 30-inch drop to drive a standard 2.0-inch O.D. split spoon sampler. The number of hammer blows required to drive the sampler 12 inches, after seating 6 inches, is termed the soil N-value and provides an indication of the soil's relative density and strength parameters at the sample location. SPT blow counts in 6-inch increments are recorded on the boring logs. The drill rig was equipped with an automatic hammer system which delivers a more consistent driving energy to the sampler compared to the rope and cathead system.

Recovered samples were sealed, labeled and transported to our laboratory. All soil samples will be discarded after sixty days unless a longer hold time is specifically requested.

The recovered soil samples were reviewed by an engineer and technically classified according to the methods of ASTM D2488 "Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)". A copy of the test boring logs along with a description of the terminology used on the logs and a chart of the ASTM D2488 group symbol names are provided in the Appendix.

Borings were drilled and other sampling was conducted solely to obtain indications of subsurface conditions as part of a geotechnical exploration program. No services were performed to evaluate subsurface environmental conditions.

3.2 Laboratory

A representative composite granular sample from both borings was subjected to the following laboratory tests:

- ASTM D1140 "Test Methods for Determining the Amount of Material Finer than 75-μm (No. 200) Sieve in Soils by Washing"
- ASTM D2434 "Test Methods for Measurement of Hydraulic Conductivity of Coarse-Grained Soils"
- ASTM D6913 "Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis"

The samples subjected to grain-size testing were reclassified according to ASTM D2487 procedures "Standard Test Method for Classifications of Soils for Engineering Purposes". The ASTM D2487 and D2488 classifications are included on the boring logs. Results of the laboratory tests have been summarized in a table provided in the Appendix.

4.0 INVESTIGATION RESULTS

4.1 Regional Geology

The *Map of the Surface Formations of the Southern Peninsula of Michigan*, published by the State of Michigan, indicates the site is in an area of outwash and glacial channels associated with Barber Creek and Saddle Lake. Soil conditions typically are found to be primarily granular in glacial outwash deposits with sorting of particle sizes with depth based on historic outwash flow rates, consistent with the conditions encountered during our field study.

The *Map of Bedrock Topography of the Southern Peninsula of Michigan* indicates bedrock to be at approximately el 400, approximately 260 ft or deeper below existing site grades.

4.2 Site Conditions

At the time of our field work, the area west of Barber Creek (near Boring B-1) was covered with grass and fallen leaves while the area east of the creek (near Boring B-2) consisted of the 51 ½ Street gravel shoulder and grass west of the shoulder. Trees and brush were observed along the shoreline of Barber Creek, while cobble and boulder were observed along the creekbank and creek bed downslope of the dam structure. Site grades appeared to be

relatively flat in areas outside of the creek and creekbank, while grades appeared to drop approximately 5 ft from the top of creekbank to the bottom of the creek.

The existing steel sheet pile dam structure appeared to be in fair condition with no obvious signs of structural distress, deflection, cracking or settlement. Water was observed to be flowing overtop of the dam structure (south to north) as designed. No obvious signs of heaving or boiling were observed on the downslope side of the dam structure. A concrete box culvert was also observed north of the dam structure, below the Silver Lake Road roadway, and appeared to be in good condition with no obvious signs of structural distress or settlement.

Existing Dam Structure – Looking Southeast

Existing Box Culvert – Looking Northeast

4.3 Subsurface Conditions

The investigation, in general, encountered 12 to 20 inches of topsoil at the ground surface over granular soil to the explored depths of 20 ft. The soil borings encountered loose poorly graded sand with silt (SP-SM) to depths of approximately 3 to 6 ft, grading to a medium dense to dense relative density and generally increasing in relative density with depth. The relative density of granular soil is based on recorded SPT N-values.

Poor sampler recovery was noted at the ground surface sample in Boring B-2, possibly indicating the presence of coarse gravel or cobble obstructions. Boulder should be anticipated whenever cobble is noted.

Groundwater was encountered during the drilling activities at depths of 4 to 4.5 ft, corresponding to els 665.8 to 666.4. Groundwater levels will fluctuate due to seasonal

variations such as precipitation, snowmelt, the Barber Creek and Saddle Lake water level and other factors that may not be evident at the time of measurement. Groundwater levels may be different at the time of construction.

This section has provided a generalized description of the encountered subsurface soil conditions. The boring logs located in the Appendix should be reviewed for detailed soil descriptions. Some variation between boring locations may be expected.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Analysis Basis of Design

5.1.1 Overturning Analysis

MTC performed an overturning analysis for the existing and proposed sheet pile dam structures to evaluate the overturning stability of the structures and the anticipated lateral deflection at the top of sheeting. For our analysis, we considered a minimum factor of safety of 2.0 for bottom stability (piping/heaving) and 1.5 for overturning stability. NAVFAC 7.01 states that exit gradients exceeding 0.5 to 0.75 have the potential to cause unstable conditions. MTC evaluated a minimum sheet pile section and embedment depth as part of a sheet pile design which satisfies the requirements for bottom stability (piping/heaving) and overturning stability and produces a sufficiently low exit gradient per NAVFAC 7.01. The Contractor will be responsible for the appropriate installation of sheeting.

MTC performed an overturning stability analysis of the sheet pile design using SupportIT software, estimates of soil internal friction angle and unit weight based on recorded SPT N-values, resistance factors taken from Section 11 (Walls, Abutments and Piers) of the 2020 AASHTO LRFD Bridge Design Specifications, with creek bottom and top of sheeting elevations provided by LRE (top of spillway at el 667.4, creek bottom at el 665.4). The differential hydrostatic head between the upstream and downstream sides of the sheeting was assumed to be approximately 2.5 ft (el 668.0 upstream, el 665.5 downstream). The overturning stability analysis was performed to verify the minimum sheet pile embedment depth, as well

as to evaluate a minimum section modulus for the steel sheeting required to limit sheet pile deflection and stresses.

5.1.2 Seepage Analysis

MTC performed a steady-state seepage analysis of the existing and proposed sheet pile dam structures to evaluate flow rates and hydraulic gradients below and downstream of the structure and determine a minimum sheet pile tip elevation to adequately resist heaving or boiling downstream of the structure. An upstream creek water level at elevation 668.0 was considered in our analysis which corresponds to the court ordered summer lake level for Saddle Lake with top of sheeting elevations provided by LRE. Laboratory and empirical estimates of soil permeability were utilized in conjunction with the software program SLIDE 7.0 to perform a two-dimensional groundwater flow analysis to evaluate flow rates and hydraulic gradients.

Estimated Permeability:

Laboratory permeability testing was performed to approximate the in-situ permeability of the native granular soil. Soil gradation testing was also performed on a composite sample of granular soil to evaluate the material's particle size distribution, and empirical correlations relating gradation to permeability were utilized in our seepage analysis.

Per Hazen (1892, 1900), the approximate coefficient of permeability can be empirically estimated per the following equation:

$$k = C(D_{10})^2$$

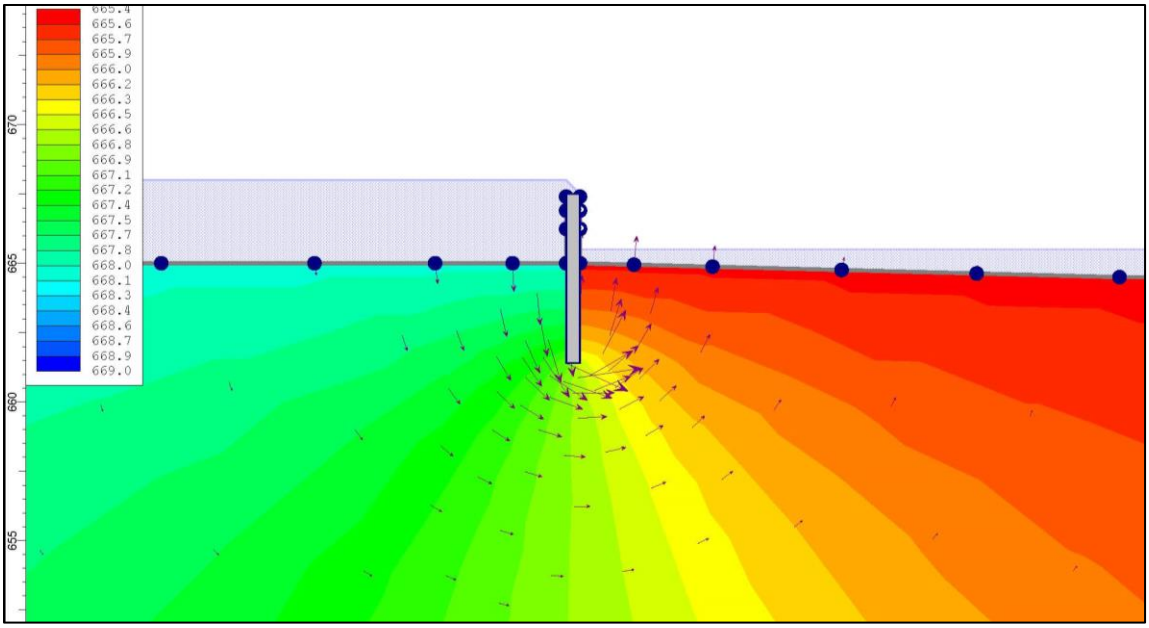
where:

- k = Approximate Coefficient of Permeability (cm/sec)
- C = Calibration coefficient (typically assumed to be 100)
- D_{10} = Particle size at which 10 percent of material is finer (cm), determined from soil gradation testing

An average soil permeability of 0.005 cm/second was considered for the poorly graded sand with silt (SP-SM) based on laboratory permeability testing, empirical correlations from gradation testing, and on correlations from visual classification per the NAVFAC Dewatering Manual.

SLIDE Seepage Analysis:

A two-dimensional groundwater flow net model was constructed using the seepage module of SLIDE 7.0 and utilizing estimated coefficients of permeability for the native poorly graded sand with silt (SP-SM) and considering an upstream creek water level at elevation 668.0 and a downslope end boundary condition at elevation 665.0. A visual of the SLIDE seepage model is provided below.



SLIDE Seepage Model – Looking West

Soil piping, also known as internal erosion, is the erosion and migration of soil particles beneath a dam structure caused by a difference in hydraulic head between the upstream and downstream sides of the dam. Conditions for piping of in-situ soil develop when the hydraulic gradient occurring in the field exceeds the critical hydraulic gradient of the in-situ soil. We have considered the critical hydraulic gradient of soil to equal the ratio of the soil's effective

unit weight to the unit weight of water. Assuming a total unit weight of 120 pcf for soil, the critical hydraulic gradient of the soil would approximately equal 0.9.

5.2 Analysis Results

The results of our analysis for overturning and bottom stability (piping/heaving), as well as minimum design parameters for the proposed sheet pile dam, are presented in Table 5.2.1.

Table 5.2.1 – Sheet Pile Dam Design– Overturning and Bottom Stability Results

Design Parameter	Existing Sheet Pile Dam	Proposed Sheet Pile Dam
Approximate Upstream Groundwater Elevation (ft)	668.0	
Assumed Top of Sheeting Elevation (ft)	667.4 (Spillway), 669.4 (Ends)	
Assumed Bottom of Creek Elevation (ft)	665.4	
Sheeting Stickup Considered (ft)	2 (Spillway), 4 (Ends)	
Assumed Differential Head (ft)	2.5	
Sheeting Embedment Depth Considered (ft)	4	6
Estimated Sheeting Length (ft)	6 (Spillway), 8 (Ends)	8 (Spillway), 10 (Ends)
Sheeting Tip Elevation Considered (ft)	661.4	659.4
Approximate Factor of Safety Against Bottom Instability	1.5	≥ 2.0
Exit Gradient	0.2 to 0.6	0.1 to 0.4
Factor of Safety Against Overturning Stability	1.0	≥ 1.5
Sheeting Section Modulus Considered (in^3/ft)	15.3	
Estimated Steel Sheeting Type	PZ22 or approved equivalent	
Anticipated Deflection at Top of Sheeting (in)	≤ ¼	≤ ¼

Our overturning and seepage analysis results indicate that the existing sheet pile dam structure is borderline stable in regards to overturning stability with an estimated Factor of Safety of 1.0 and an exit gradient in excess of 0.5. A steel sheet pile dam structure with a minimum sheeting section modulus of 15.3 in^3/ft and a minimum sheeting embedment depth of 6 ft (maximum sheeting tip elevation of 659.4) is anticipated to provide suitable Factors of

Safety against bottom stability and overturning stability failure while resulting in ¼ inch or less lateral deflection at the top of sheeting. Our analysis considered sheeting section loss for a PZ22 sheet pile per the MDOT Bridge Design Manual Appendix 7.03.08D (nominal section modulus of 18.1 in^3/ft, effective section modulus of 15.3 in^3/ft).

5.3 Sheetpile Wall Construction Considerations

Steel sheeting for the new dam structure should avoid being driven within the alignment of existing sheets to avoid potential complications driving sheeting in disturbed/loosened ground or potentially encountering sheeting left in place from the original dam structure.

Boring B-2 encountered poor sampler recovery at the ground surface sample, possibly indicating the presence of coarse gravel or cobble obstructions. The Contractor should be prepared to remove obstructions as encountered to ensure sheets are appropriately embedded.

The selected Contractor should have appropriate equipment to drive sheets to the required depths. The selected Contractor should have at least 5 years of acceptable experience installing similar types of sheeting in similar subsurface conditions to this project, and should have worked on at least 5 past projects involving similar steel sheeting installation. The Contractor should thoroughly review the test boring data performed as part of this investigation prior to mobilization.

6.0 CLOSURE

In this report, descriptions of the geotechnical investigation, encountered conditions and recommendations for the design of a replacement steel sheet pile dam structure have been provided. The limitations of this study are described in the Appendix.

The recommendations presented in this report are based upon a limited number of subsurface samples obtained from various sampling locations. The samples may not fully indicate the nature and extent of the variations that actually exist between sampling locations. For that reason, among others, we strongly recommend that a qualified geotechnical firm be

retained to observe earthwork construction. If variations or other latent conditions become evident during construction, it will be necessary for us to review these conditions and our recommendations as appropriate.

TITLE: BORING LOCATION PLAN		PROJECT: SADDLE LAKE LEVEL CONTROL STRUCTURE, COLUMBIA TOWNSHIP	
SCALE: AS SHOWN	DATE: 02/20/2024	PROJECT NO.: 241064	MTC MATERIALS TESTING CONSULTANTS
FIG. NO.: 1	DR. BY: AD	REV. BY: AD	

APPENDIX

- Limitations
- Test Drilling and Sampling Procedures
- Boring Log Terminology and Classification Outline
- Boring Logs
- Laboratory Test Results

LIMITATIONS

Soil Variations

The recommendations in this report are based upon the data obtained from the soil borings. This report does not reflect variations which may occur between these borings, and which would not become evident until construction. If variations then become evident, it would be necessary for a re-evaluation of recommendations of this report, after performing on-site observations.

Warranties

We have prepared this report in accordance with generally accepted soil and foundation engineering practices. We make no other warranties, either expressed or implied, as to the professional advice provided under the terms of our agreement and included in this report. This report is prepared exclusively for our client and may not be relied upon by other parties without written consent from our office.

Boring Logs

In the process of obtaining and testing samples and preparing this report, we follow reasonable and accepted practice in the field of soil engineering. Field logs maintained during drilling describe field occurrences, sampling locations, and other information. The samples obtained in the field are subjected to additional testing in the laboratory and differences may exist between the field logs and the final logs. The engineer reviews the field logs and laboratory test data, and then prepares the final boring logs. Our recommendations are based on the contents of the final logs.

Review of Design Plans and Specifications

In the event that any changes in the design of the building or the location, however slight, are planned, our recommendations shall not be considered valid unless modified or approved in writing by our office. We recommend that we be provided the opportunity to review the final design and specifications in order to determine whether changes in the original concept may have affected the validity of our recommendations, and whether our recommendations have, in fact, been implemented in the design and specifications.

TEST DRILLING AND SAMPLING PROCEDURES

Test Drilling Methods:

- [X] Hollow stem auger, ASTM D6151
- [ ] Mud rotary, ASTM D5783
- [ ] Casing advancer, ASTM D5872
- [ ] Rock coring, ASTM D2113
- [ ] Core/Hand Auger

Note: Cone penetration test data can be used to interpret subsurface stratigraphy and can provide data on engineering properties of soils. The ASTM procedure does not include a procedure for determining soil classification from CPT testing. Soil classifications shown on CPT logs are based on published procedures and are not based on physical ASTM soil classification tests.

Sampling Methods:

- [X] SPT, ASTM D1586, Auto hammer (140 lb., 30" drop, 2" OD split spoon sampler)
- [ ] Thin-walled tube sampler (Shelby), ASTM D1587

Note: The number of hammer blows required to drive the SPT sampler 12 inches, after seating 6 inches, is termed the soil N-value and provides an indication of the soil's relative density and strength parameters at the sample location. SPT blow counts in 6 inch increments are recorded on the boring logs.

Drill Rig:

- [X] CME 55 (ATV)
- [ ] Acker Renegade (ATV)
- [ ] CME 45 Truck
- [ ] Geoprobe 7822 (ATV)
- [ ] Geoprobe Rotary Sonic

Boreholes Backfilled With:

- [ ] Excavated soil
- [X] Cement bentonite grout
- [ ] Piezometer or Monitoring Well (see notes on logs)
- [ ] Concrete or asphalt patch where appropriate

Sample Handling and Disposition:

- [X] Samples labeled, placed in jars, returned to MTC Laboratory
- [X] Discard after 60 days

BORING LOG TERMINOLOGY AND ASTM D 2488 CLASSIFICATION OUTLINE

TERMS DESCRIBING CONSISTENCY OR CONDITION

COARSE-GRAINED SOILS (major portions retained on No. 200 sieve): includes (1) clean gravel and sands and (2) silty or clayey gravels and sands. Condition is rated according to relative density as determined by laboratory tests or standard penetration resistance tests.

Descriptive Terms	Relative Density	SPT Blow Count
Very loose	0 to 15 %	< 5
Loose	15 to 35 %	5 to 10
Medium dense	35 to 65 %	10 to 30
Dense	65 to 85 %	30 to 50
Very dense	85 to 100 %	> 50

Per ASTM D2487, the following conditions must be met based on laboratory testing to justify the label 'well graded' in a soil description.

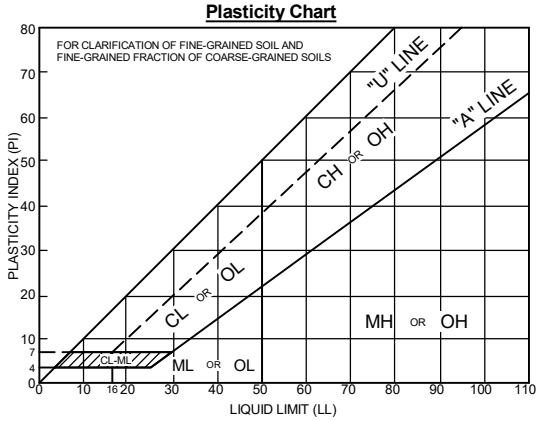
Gravel: $C_U = \frac{D_{60}}{D_{10}}$ greater than 4; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3

Sand: $C_U = \frac{D_{60}}{D_{10}}$ greater than 6; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3

FINE-GRAINED SOILS (major portions passing on No. 200 sieve): includes (1) inorganic and organic silts and clays, (2) gravelly, sandy, or silty clays, and (3) clayey silts. Consistency is rated according to shearing strength, as indicated by penetrometer readings, SPT blow count, or unconfined compression tests.

Descriptive Terms	Unconfined Compressive Strength TSF	SPT Blow Count
Very soft	< 0.25	< 2
Soft	0.25 to 0.5	2 to 4
Medium stiff	0.5 to 1.0	4 to 8
Stiff	1.0 to 2.0	8 to 15
Very stiff	2.0 to 4.0	15 to 30
Hard	> 4.0	> 30

Plasticity Chart



MAJOR DIVISIONS					TYPICAL NAMES
COARSE-GRAINED SOILS MORE THAN HALF IS COARSER THAN NO. 200 SIEVE	GRAVELS MORE THAN HALF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE	CLEAN GRAVELS WITH LESS THAN 15% FINES	GW		WELL-GRADED GRAVELS WITH OR WITHOUT SAND
			GP		POORLY-GRADED GRAVELS WITH OR WITHOUT SAND
		GRAVELS WITH 15% OR MORE FINES	GM		SILTY GRAVELS WITH OR WITHOUT SAND
			GC		CLAYEY GRAVELS WITH OR WITHOUT SAND
	SANDS MORE THAN HALF COARSE FRACTION IS FINER THAN NO. 4 SIEVE SIZE	CLEAN SANDS WITH LESS THAN 15% FINES	SW		WELL-GRADED SANDS WITH OR WITHOUT GRAVEL
			SP		POORLY-GRADED SANDS WITH OR WITHOUT GRAVEL
			SP-SM		POORLY-GRADED SANDS WITH SILT WITH OR WITHOUT GRAVEL
		SANDS WITH 15% OR MORE FINES	SM		SILTY SANDS WITH OR WITHOUT GRAVEL
			SC		CLAYEY SANDS WITH OR WITHOUT GRAVEL
FINE-GRAINED SOILS MORE THAN HALF IS FINER THAN NO. 200 SIEVE	SILTS AND CLAYS LIQUID LIMIT 50% OR LESS		ML		INORGANIC SILTS OF LOW TO MEDIUM PLASTICITY WITH OR WITHOUT SAND OR GRAVEL
			CL		INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY WITH OR WITHOUT SAND OR GRAVEL
			OL		ORGANIC SILTS OR CLAYS OF LOW TO MEDIUM PLASTICITY WITH OR WITHOUT SAND OR GRAVEL
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50%		MH		INORGANIC SILTS OF HIGH PLASTICITY WITH OR WITHOUT SAND OR GRAVEL
			CH		INORGANIC CLAYS OF HIGH PLASTICITY WITH OR WITHOUT SAND OR GRAVEL
			OH		ORGANIC SILTS OR CLAYS OF HIGH PLASTICITY WITH OR WITHOUT SAND OR GRAVEL
HIGHLY ORGANIC SOILS			PT/OL		PEAT AND OTHER HIGHLY ORGANIC SOILS

GENERAL NOTES

1. Classifications are based on the United Soil Classification System and include consistency, moisture, and color. Field descriptions have been modified to reflect results of laboratory tests where deemed appropriate.

2. "Grades with" or "Grades without" may be used to describe soil when characteristics vary within a stratum.

3. Preserved soil samples will be discarded after 60 days unless alternate arrangements have been made.

GROUNDWATER OBSERVATIONS:

During - indicates water level encountered during the boring
End- indicates water level immediately after drilling
Date and Depth - Measurements at indicated date

SAMPLE TYPES AND NUMBERING

S	SPT, split barrel sample, ASTM D1586
U	Shelby tube sample, ASTM D1587
R	Rock core run
*S	Other than 2" split barrel sample
L	SPT with liner, ASTM D1586
A	Auger cuttings
G	Geoprobe liner

MINOR COMPONENT QUANTIFYING TERMS

Less than 5%	TRACE
5 to 10%	FEW
15 to 25%	LITTLE
30 to 40%	SOME
50 to 100%	MOSTLY

GRAIN SIZE

BOULDER	>12"
COBBLE	12" to 3"
COARSE GRAVEL	3" to 0.75"
FINE GRAVEL	0.75" to No. 4
COARSE SAND	No. 4 to No. 10
MEDIUM SAND	No. 10 to No.40
FINE SAND	No. 40 to No. 200

LOG OF BORING

Project No.: 241064
Boring No.: B-1
Sheet: 1 of 1

Project: Saddle Lake Level Control Structure
Client: Land & Resource Engineering
Location: Columbia Township, Michigan
Drill Type: CME 55 / 300
Crew Chief: JC Field Eng.: MS Rev. By: AD
Coordinates: N=330452.4 E=12669129 (MI South ift)
Elevation: 670.9 ft Datum: NAVD 88 (GPS Observation)
Notes: Performed approximately 20' South of Silver Lake Road Centerline.
Plugging Record: Grouted borehole with cement bentonite slurry.

Date Begin: 02/19/2024 Date End: 02/19/2024

Tooling	Type	Dia.	Groundwater, ft.	
Casing	HSA	4 1/4"	During	4.5
Sampler	SPT	2"	End	NA
Core			Seepage	
Tube			Date	Depth, ft.
SPT Hammer	Auto			

Depth Drilled: 20.0 ft.

Component Percentages: Trace < 5%, Few 5-10%, Little 15-25%, Some 30-45%, Mostly 50-100%
QP = Calibrated Penetrometer (tons/sq. ft.)

Elev. FT.	Depth FT.	Sample Number	Recov. FT.	Penetration (Blows Per 6") ASTM D 1586	*USCS Group Symbol	*DESCRIPTION	QP tsf	MST %	DD pcf	REMARKS
669.9	1	S-1	1.5	3-3-3 N=6		12" Black Silty Topsoil 1.0				
668.9	2				SP-SM	Brown poorly graded SAND with silt; mostly fine sand, few silty fines, trace coarse to medium sand, trace fine gravel, moist				
667.9	3									
666.9	4	S-2	1.5	3-3-3 N=6						
665.9	5									
664.9	6					Grades wet, without gravel				Charged augers with water from 5'
663.9	7	S-3	1.5	6-8-11 N=19						
662.9	8					Grades gray				
661.9	9	S-4	1.5	6-8-11 N=19						
660.9	10									
659.9	11									
658.9	12	S-5	1.5	4-8-11 N=19		Grades brown				
657.9	13									
656.9	14	S-6	1.5	6-10-17 N=27						
655.9	15									
654.9	16									
653.9	17	S-7	1.5	5-8-12 N=20		Grades gray				
652.9	18									
651.9	19	S-8	1.5	6-12-18 N=30						
650.9	20					20.0				
						End of Boring				

* Visual estimate following ASTM D 2488 unless laboratory testing has been performed. Stratification changes are approximated between samples.

LOG OF BORING

Project No.: 241064
Boring No.: B-2
Sheet: 1 of 1

Project: Saddle Lake Level Control Structure
Client: Land & Resource Engineering
Location: Columbia Township, Michigan
Drill Type: CME 55 / 300
Crew Chief: JC Field Eng.: MS Rev. By: AD
Coordinates: N=330448.4 E=12669178.2 (MI South ift)
Elevation: 669.8 ft Datum: NAVD 88 (GPS Observation)
Notes: Performed approximately 21' West of 51 1/2 Street Centerline

Plugging Record: Grouted borehole with cement bentonite slurry.

Date Begin: 02/19/2024 Date End: 02/19/2024

Tooling	Type	Dia.	Groundwater, ft.	
Casing	HSA	4 1/4"	During	4
Sampler	SPT	2"	End	NA
Core			Seepage	
Tube			Date	Depth, ft.
SPT Hammer	Auto			

Depth Drilled: 20.0 ft.

Component Percentages: Trace < 5%, Few 5-10%, Little 15-25%, Some 30-45%, Mostly 50-100%

QP = Calibrated Penetrometer (tons/sq. ft.)

Elev. FT.	Depth FT.	Sample Number	Recov. FT.	Penetration (Blows Per 6") ASTM D 1586	*USCS Group Symbol	*DESCRIPTION	QP tsf	MST %	DD pcf	REMARKS
668.8	1	S-1	1.5	2-3-3-3 N=6		20" Black Silty Topsoil				S-1: Poor recovery; possible coarse gravel / COBBLE
667.8	2					1.7				
666.8	3				SP-SM	Brown poorly graded SAND with silt; mostly fine sand, few silty fines, trace coarse to medium sand, moist				
665.8	4	S-2	1.5	4-7-8 N=15						
664.8	5					Grades gray and wet				Charged augers with water from 5'
663.8	6									
662.8	7	S-3	1.5	6-7-14 N=21						
661.8	8									
660.8	9	S-4	1.5	5-10-12 N=22						
659.8	10									
658.8	11									
657.8	12	S-5	1.5	6-7-11 N=18						
656.8	13									
655.8	14	S-6	1.3	9-10-11 N=21						
654.8	15									
653.8	16									
652.8	17	S-7	1.5	12-13-18 N=31						
651.8	18									
650.8	19	S-8	1.5	14-17-25 N=42						
649.8	20					20.0				
						End of Boring				

* Visual estimate following ASTM D 2488 unless laboratory testing has been performed. Stratification changes are approximated between samples.

mtc-test.com 800.968.8378

PROJECT NO.: 241064
DATE: 2/29/2024
SHEET: 1 OF 1

PROJECT Saddle Lake Level Control Structure, Columbia Township
CLIENT Land and Resource Engineering
CONTRACTOR
ENGINEER/ARCHITECT

PERMEABILITY TEST ON GRANULAR SOIL ASTM D 2434

MTC SAMPLE NO.:	164125	TEST DATE:	2/29/2024
SAMPLE LOCATION:	B1 & B2 S-2 to S-8	SAMPLE DATE:	
DESCRIPTION OF SOIL:	Grayish-Brown	USCS CLASSIFICATION:	SP-SM
SAMPLE CONDITION:	Moderate Compaction	PERMEANT:	Tap Water
SAMPLE DIAMETER (cm):	7.62	SOIL WEIGHT (g):	1313.72
SAMPLE AREA (cm^2):	45.756	SOIL HEIGHT (cm):	14.88
DRY UNIT WEIGHT (PCF):	95.1	VOID RATIO:	0.74
OVERSIZE PARTICLES (%):	NA	SPECIFIC GRAVITY (D854):	2.65 (Assumed)

TEST DATA

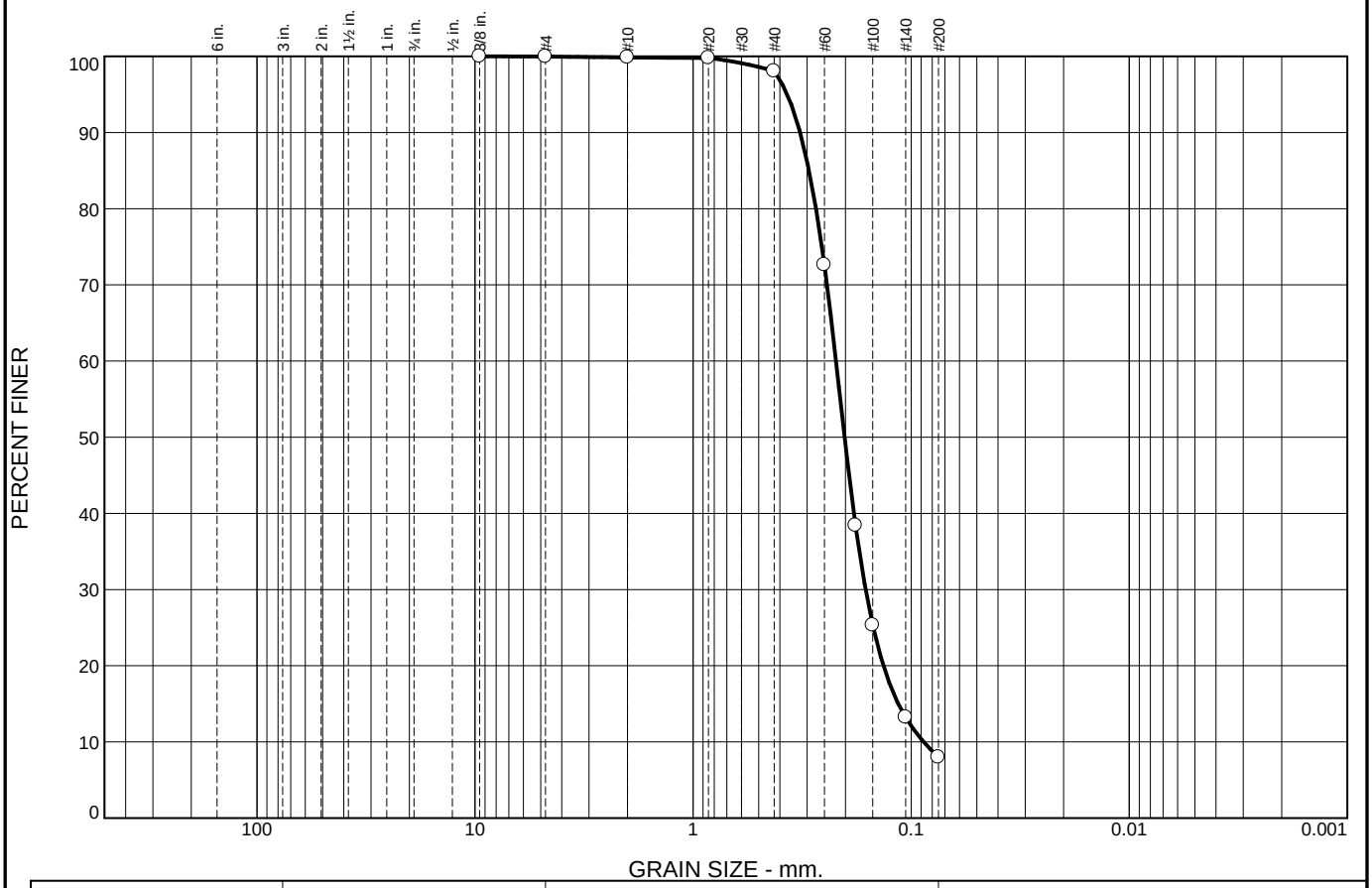
TEST NUMBER	MANOMETERS, mm		HEAD H, (CM)	QUANTITY Q, (CM^3)	TIME T, (SEC)	VELOCITY Q/At	HYDRAULIC GRADIENT H/L	TEMP (^oC)	COEFFICIENT OF PERMEABILITY (CM/SEC)
	H_1	H_2							
1	960	860	10.0	6.4	120	0.0012	1.31	14.4	1.03×10^{-3}
2	950	845	10.5	6.9	120	0.0013	1.38	14.4	1.06×10^{-3}
3	950	830	12.0	8.0	120	0.0015	1.57	14.4	1.07×10^{-3}
4	940	800	14.0	9.4	120	0.0017	1.84	14.4	1.08×10^{-3}
5	935	780	15.5	9.6	110	0.0019	2.03	14.4	1.09×10^{-3}
6	920	750	17.0	11.6	120	0.0021	2.23	14.4	1.10×10^{-3}

AVERAGE: 1.07×10^{-3} cm/sec

REMARKS: Average Coefficient of Permeability (Hydraulic Conductivity) is taken from tests 1 thru 6 selected by charting the Velocity vs. Hydraulic Gradient data.

REPORT BY: **REVIEWED BY:** Timothy J. Lautenbach

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.1	1.8	90.1	8.0	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.2941	0.2211	0.2019	0.1618	0.1146	0.0876	1.35	2.52

Material Description	USCS	AASHTO
○ Brown Poorly Graded Sand with Silt	SP-SM	

Project No. 241064 **Client:** Land & Resource Engineering

Project: Saddle Lake Level Control Structure, Columbia Township

○ **Location:** B-1 & B-2 S-2 to S-8 **Depth:** 0.0-20.0 ft **Sample Number:** 164125

Remarks:

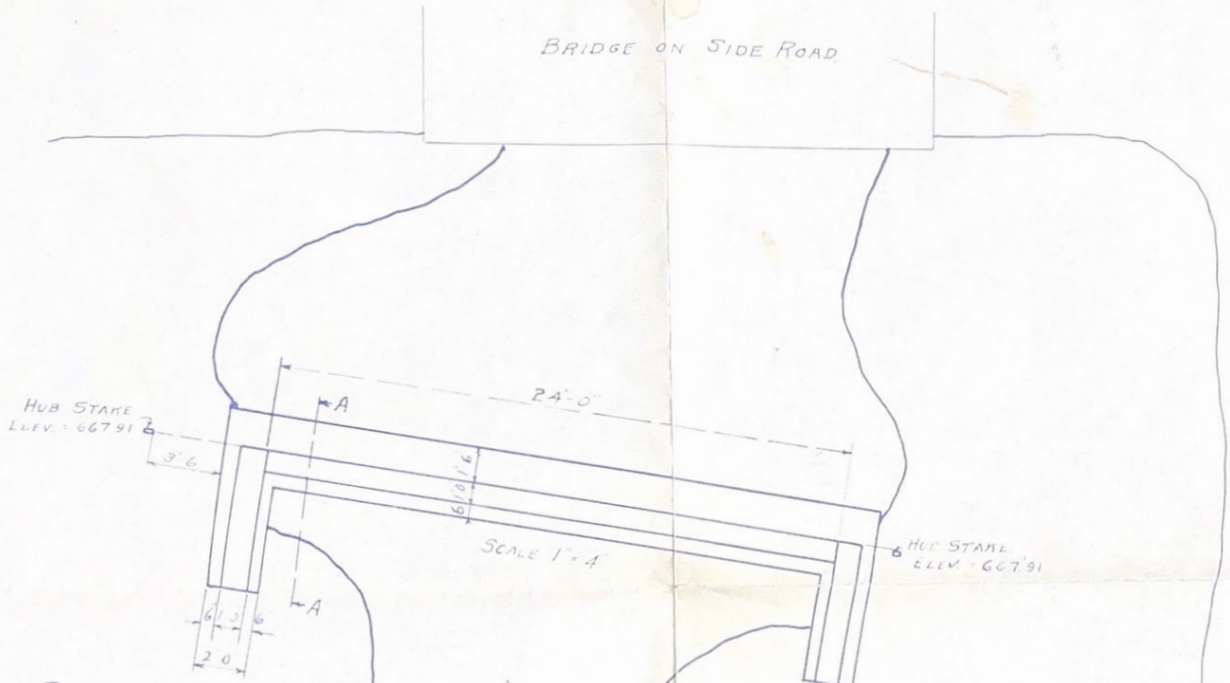
MATERIALS TESTING CONSULTANTS, INC.

Grand Rapids, MI

Figure

Tested By: R. Davis **Checked By:** K. VanStrate

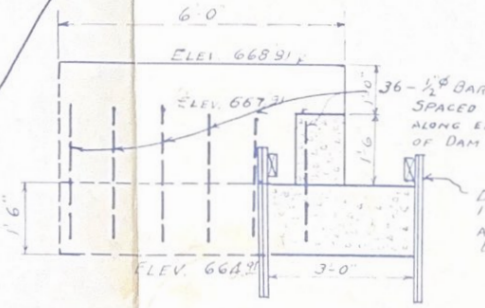
APPENDIX 3 – Historical Dam Drawings



MATERIAL REQUIRED

9 C. YDS. OF GRAVEL.
11 BARRELS CEMENT
30 - 3/4" ϕ BARS 1'2" LONG
70 - 1"x8"x14' SHIPLAP (SHEET PILING)
30 - 1"x8"x12' } (FORMS)
30 - 2"x4"x12' }
10 LBS. NO. 8 NAILS.

CONCRETE TO BE MIXED IN PROPORTION OF 1 OF CEMENT TO 5 OF CLEAN BANK RUN GRAVEL.



CROSS SECTION A-A.
SCALE 1" = 2'

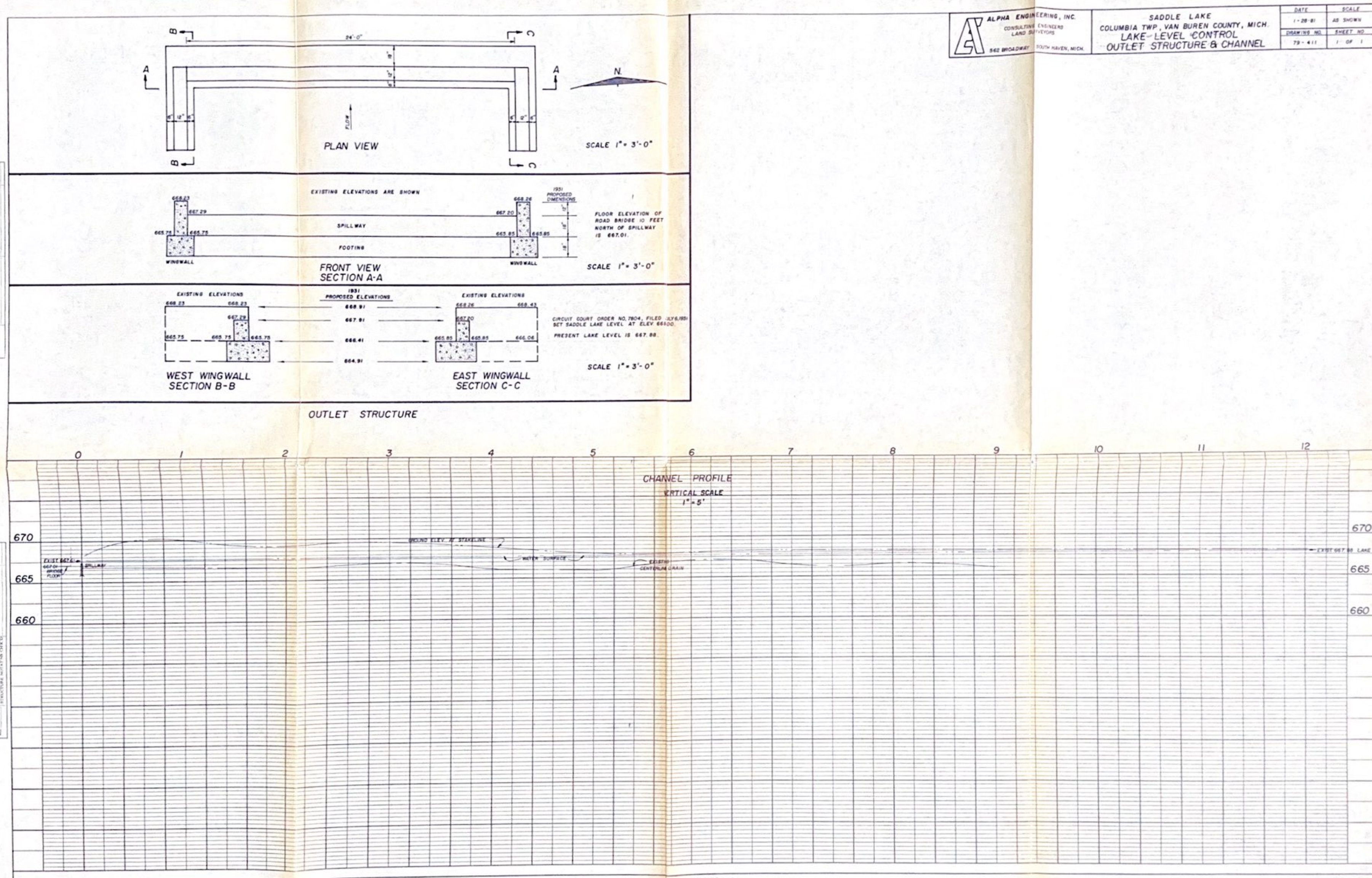
PLAN OF DAM IN SADDLE LAKE DRAIN NEAR CENTER OF SW 1/4 OF SECTION 10. COLUMBIA TOWNSHIP.

AUG. 14. 1931.

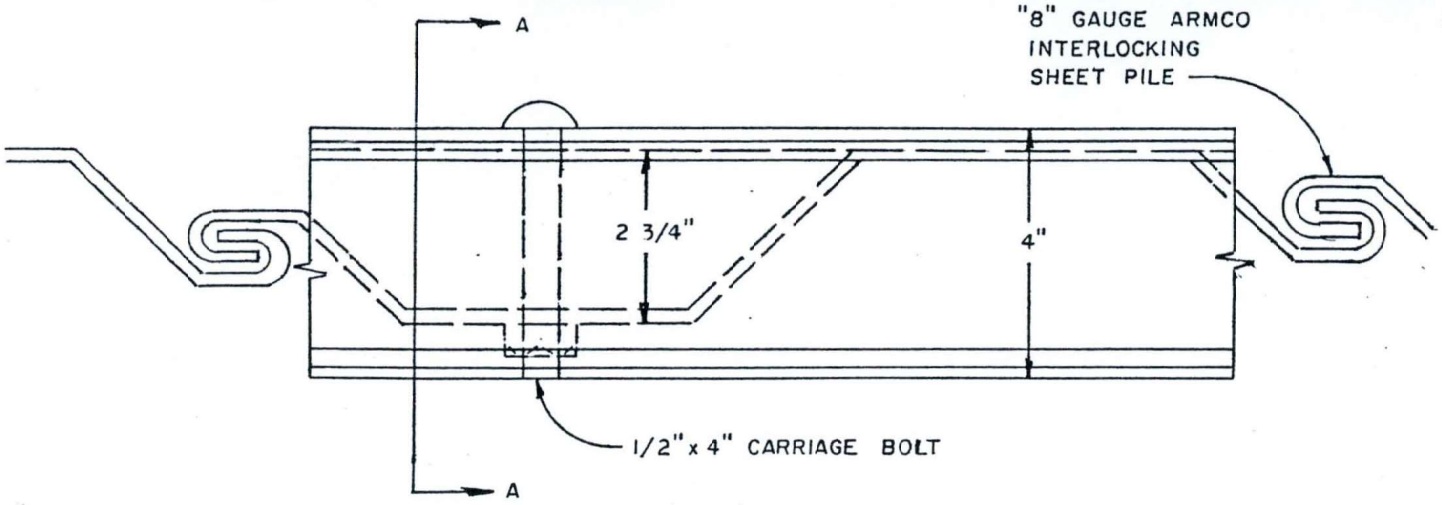
T. A. SMITH, REGISTERED CIVIL ENGINEER

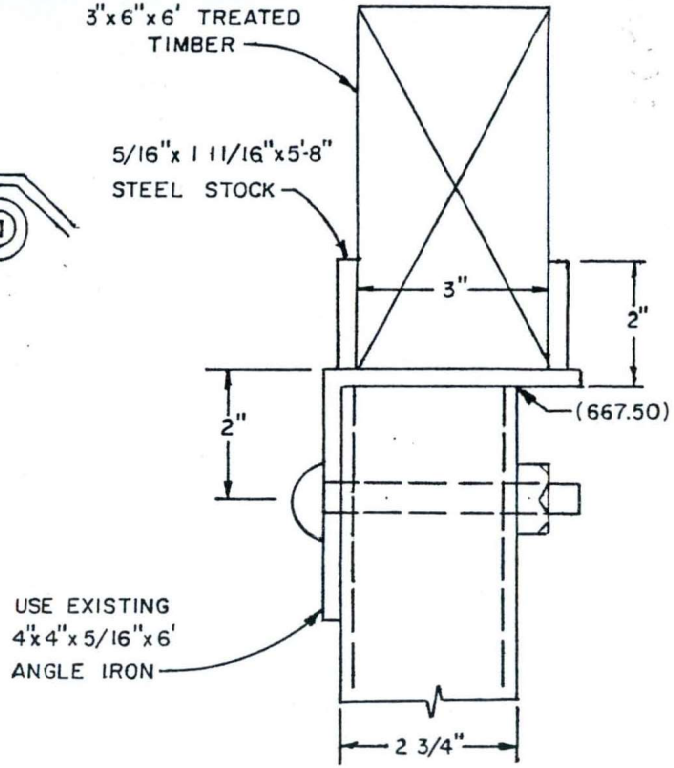
CIRCUIT COURT ORDER #1707
July 6, 1931
668'

B.M.= SPIKE IN SO. SIDE OF SILL
NO. OF BRIDGE, ELEV. = 670.40



PLAN VIEW
SCALE 1" = 3'-0"
EXISTING ELEVATIONS ARE SHOWN
SPILLWAY
FOOTING
WINGWALL
1931 PROPOSED DIMENSIONS
FLOOR ELEVATION OF ROAD BRIDGE 10 FEET NORTH OF SPILLWAY IS 667.01.
FRONT VIEW
SECTION A-A
SCALE 1" = 3'-0"
EXISTING ELEVATIONS
1931 PROPOSED ELEVATIONS
668.91
667.91
666.41
664.91
CIRCUIT COURT ORDER NO. 7804, FILED JULY 6, 1951
PRESENT LAKE LEVEL IS 667.88.
WEST WINGWALL
SECTION B-B
EAST WINGWALL
SECTION C-C
SCALE 1" = 3'-0"
OUTLET STRUCTURE
CHANNEL PROFILE
VERTICAL SCALE 1" = 5'
GROUND ELEV. AT STAKELINE
WATER SURFACE
EXISTING CENTERLINE DRAIN
SPILLWAY
LAKE LEVEL
ALPHA ENGINEERING, INC.
CONSULTING ENGINEERS
LAND SURVEYORS
562 BROADWAY SOUTH HAVEN, MICH.
SADDLE LAKE
COLUMBIA TWP., VAN BUREN COUNTY, MICH.
LAKE-LEVEL CONTROL
OUTLET STRUCTURE & CHANNEL
DATE 1-28-81
SCALE AS SHOWN
DRAWING NO. 79-411
SHEET NO. 1 OF 1



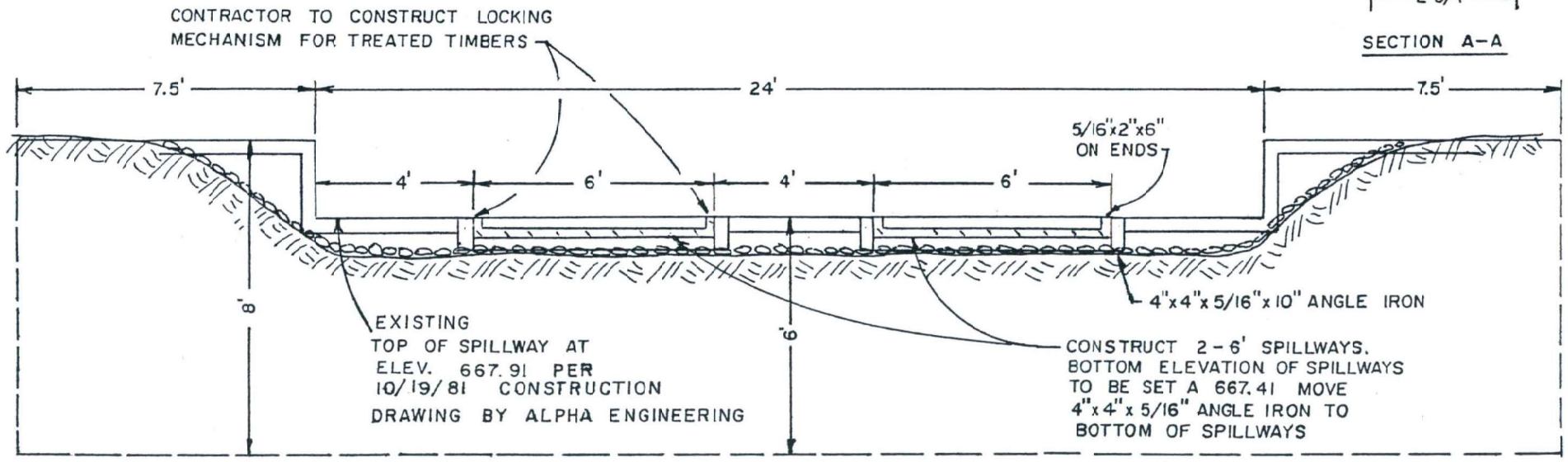


SECTION A-A

NOTE: ANGLE IRON TO BOLTED TO SHEET PILE - DO NOT WELD

1" = 3'

SCALE ~~1" = 30'~~



1" = 4'

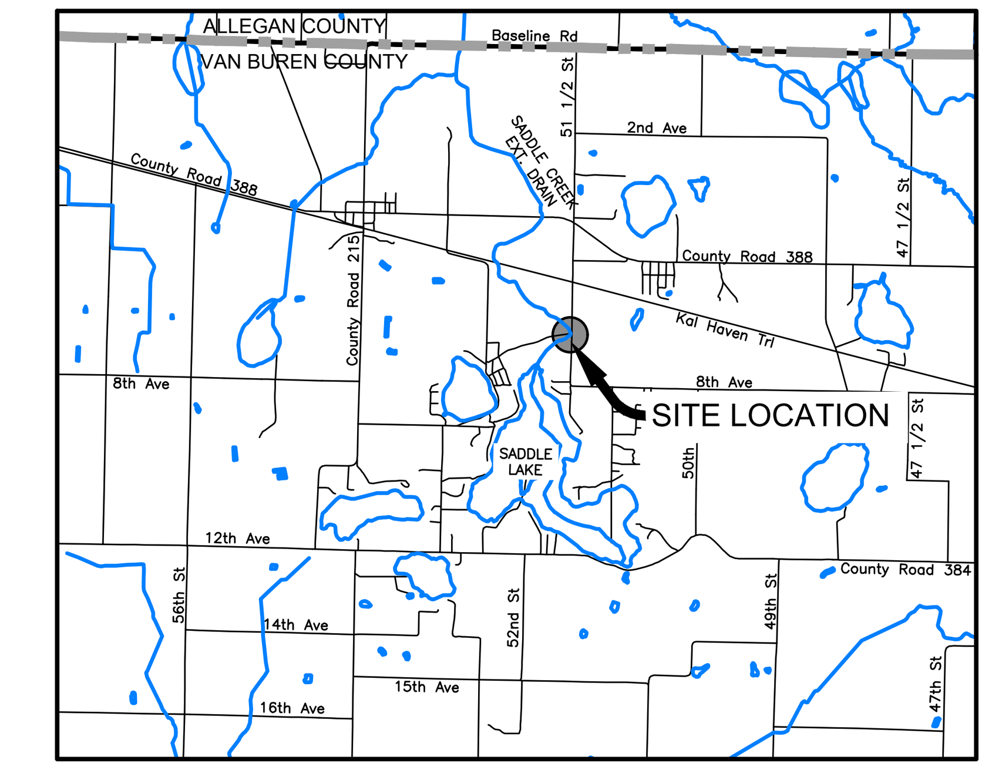
SCALE ~~1" = 40'~~

PROPOSED CROSS SECTION VIEW OF CONTROL STRUCTURE

MERRITT ENGINEERING, INC
NO. 8382 7-7-87

SADDLE LAKE OUTLET CONTROL STRUCTURE

Van Buren County Drain Commissioner - Joe Parman
Sections 10, Columbia Township (T01S, R15W)
Van Buren County, Michigan



VICINITY MAP
NOT TO SCALE

INDEX OF SHEETS

CS - COVER SHEET
C1 - PLAN & PROFILE
(STA. 0+00 - 4+50)

LEGEND

- ENCLOSED CHANNEL DRAIN
- OPEN CHANNEL DRAIN
- DRAINAGE DISTRICT BOUNDARY
- MUNICIPAL BOUNDARY
- SECTION LINE
- TOWNSHIP LINE
- ROADS
- PROPERTY LINES
- SECTION NUMBERS
- SHEET NUMBERS

SOILS LEGEND

3B	Coloma loamy sand, 0 to 6 percent slopes
7	Glendora sandy loam
8A	Morocco loamy sand, lake plain, 0 to 2 percent slopes
9B	Plainfield sand, lake plain, 0 to 6 percent slopes
9C	Plainfield sand, lake plain, 6 to 12 percent slopes
10	Aquents and Histosols, ponded
17A	Brems sand, 0 to 2 percent slopes
61B	Udipsamments and Udorthents, 0 to 4 percent slopes
AdraeA	Adrian muck, lake moderated, 0 to 1 percent slopes
HgtacA	Houghton muck, lake moderated, 0 to 1 percent slopes1
W	Water

NORTH

0 1000 2000
Horizontal Scale in Feet

MISS DIG 811
CALL 3 WORKING DAYS BEFORE YOU DIG

ALL UTILITIES AS SHOWN ARE APPROXIMATE LOCATIONS DERIVED FROM ACTUAL MEASUREMENTS AND AVAILABLE RECORDS. THEY SHOULD NOT BE INTERPRETED TO BE EXACT LOCATION NOR SHOULD IT BE ASSUMED THAT THEY ARE THE ONLY UTILITIES IN THE AREA.

LRE ENGINEERS & SURVEYORS
2121 3 Mile Rd. NW
Walker, MI 49544
Ph: 616-301-7888
www.LREMI.com

REVISIONS: NO.	ISSUED FOR	DATE

CLIENT: VAN BUREN COUNTY DRAIN COMMISSIONER
219 E PAW PAW STREET, PAW PAW, MICHIGAN

PROJECT: SADDLE LAKE OUTLET STRUCTURE
COLUMBIA TOWNSHIP, VAN BUREN COUNTY, MICHIGAN

PROJECT NUMBER: 23-169	DATE
SURVEYED BY: CVF	02/2024
DESIGNED BY:	MONTH/YEAR
DRAFTED BY: LGG	02/2024
QAQC:	MONTH/YEAR

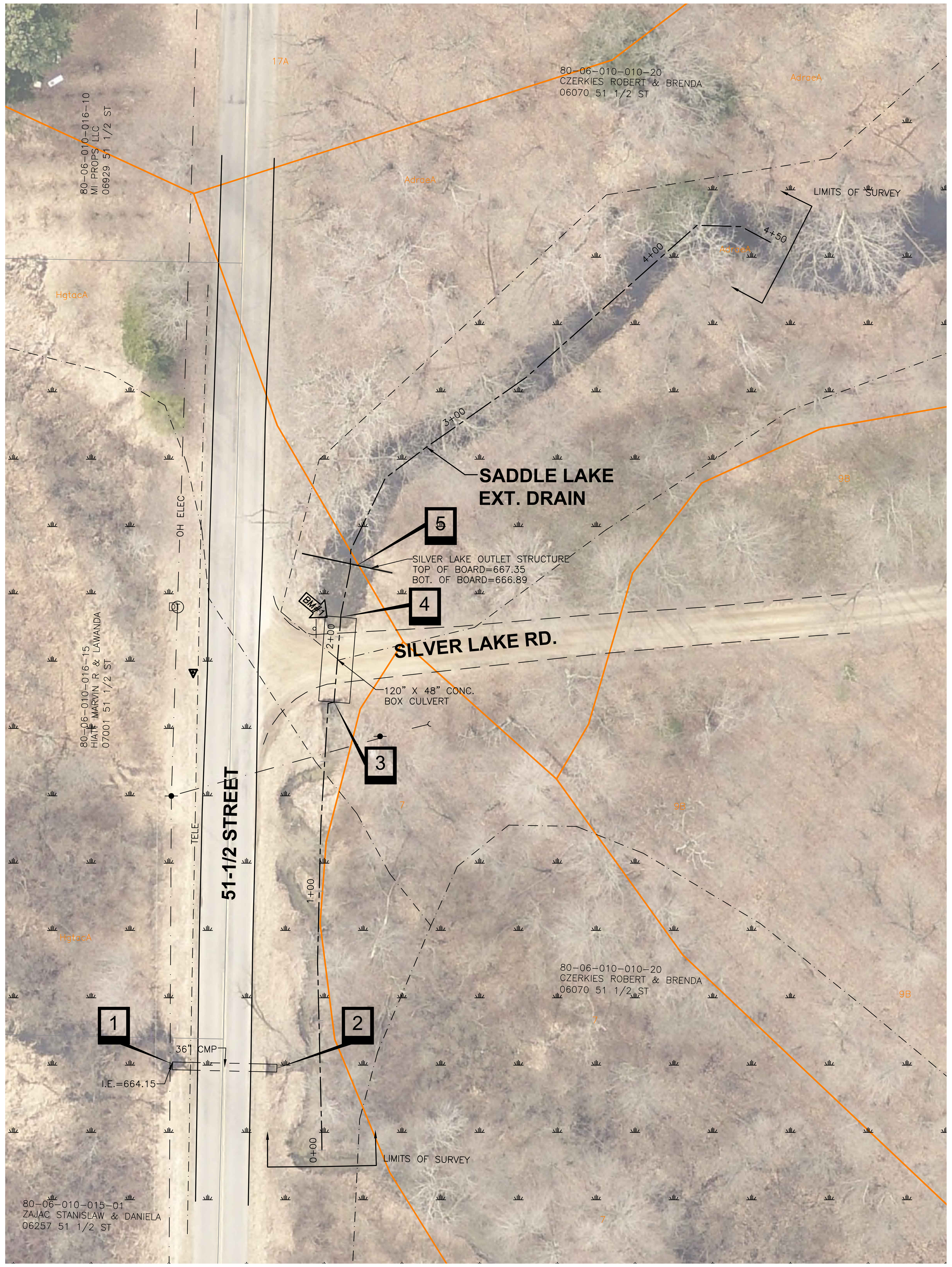
SHEET NAME: COVER SHEET

SHEET NUMBER
CS

BENCHMARK INFORMATION

BM#1) ELEVATION: 668.38
CHISELED BOX IN CONCRETE ON SOUTH END OF BOX CULVERT

THE ELEVATIONS ARE BASED ON NAVD 88



PLAN VIEW

0 30 60
Horizontal Scale in Feet

LEGEND

WETLAND (USFWS NATIONAL WETLAND INVENTORY)

SOIL TYPE (USDA NRCS WEBSOIL SURVEY)

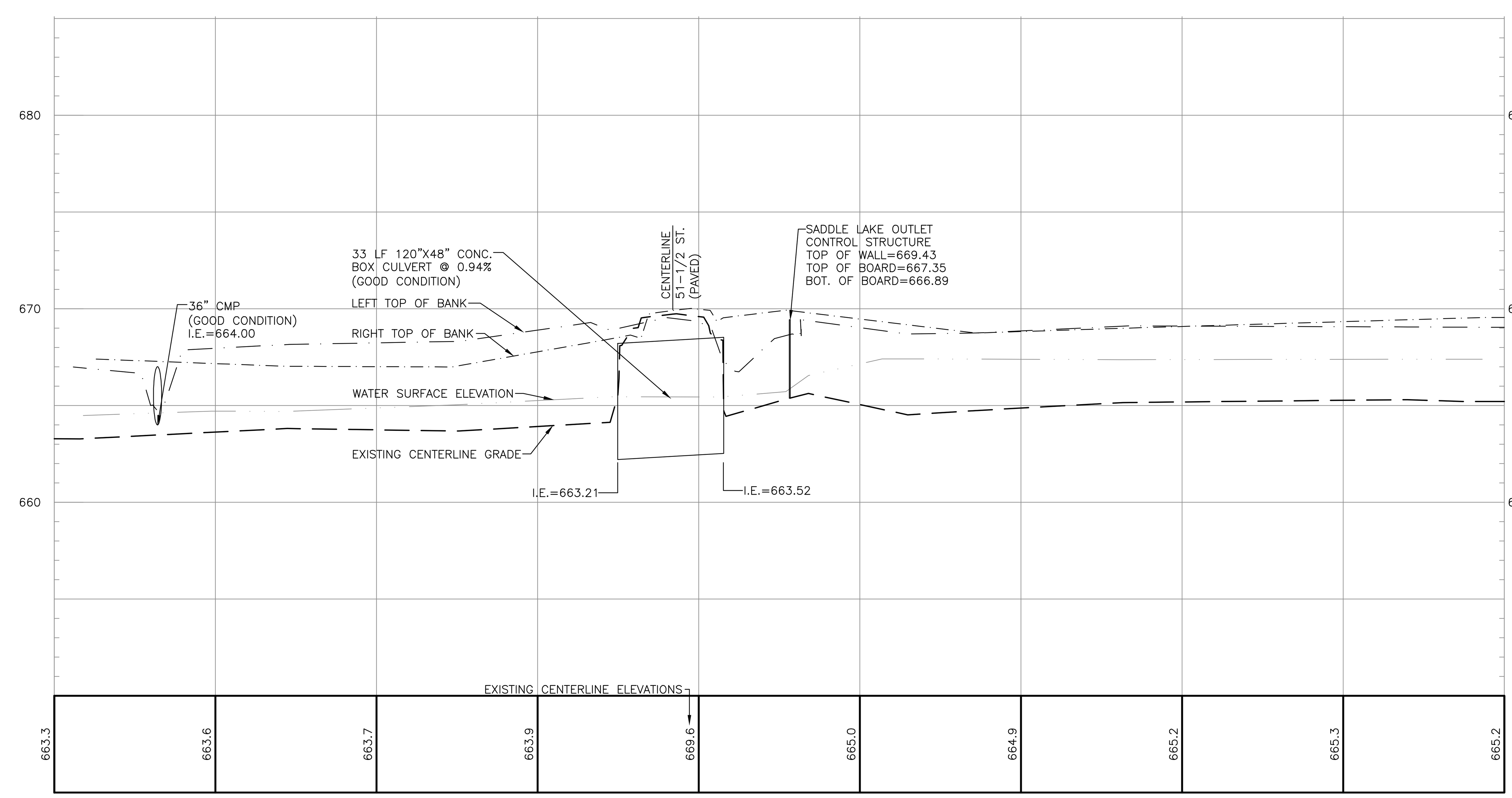
1


2


3


4


5

CENTERLINE PROFILE

SCALE: HORIZONTAL: 1" = 30'
VERTICAL: 1" = 5'

MISS DIG 811
CALL 3 WORKING DAYS BEFORE YOU DIG

ALL UTILITIES AS SHOWN ARE APPROXIMATE LOCATIONS DERIVED FROM ACTUAL MEASUREMENTS AND AVAILABLE RECORDS. THEY SHOULD NOT BE INTERPRETED TO BE EXACT LOCATION NOR SHOULD IT BE ASSUMED THAT THEY ARE THE ONLY UTILITIES IN THE AREA.

2121 3 Mile Rd. NW
Walker, MI 49544
Ph: 616-301-7888
www.LREMI.com

LRE ENGINEERS & SURVEYORS

REVISIONS: NO.	ISSUED FOR	DATE

CLIENT: VAN BUREN COUNTY DRAIN COMMISSIONER
219 E PAW PAW STREET, PAW PAW, MICHIGAN

PROJECT: SADDLE LAKE OUTLET STRUCTURE
COLUMBIA TOWNSHIP, VAN BUREN COUNTY, MICHIGAN

PROJECT NUMBER: 23-169

	DATE
SURVEYED BY: CVF	02/2024
DESIGNED BY:	MONTH/YEAR
DRAFTED BY: LGG	02/2024
QAQC:	MONTH/YEAR

SHEET NAME: PLAN & PROFILE
STA: 0+00 - 4+50

SHEET NUMBER
C1