PICTURED ROCKS NATIONAL LAKESHORE
MUNISING, MICHIGAN

TRAIL REHABILITATION
PMIS 226930

PROJECT SPECIFICATIONS

NATIONAL PARK SERVICE
June 23, 2025

Final Sealed Construction Documents

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DIVISION 01

General Requirements

SECTION 01 10 00
DIVISION 1 SHORT FORM GENERAL REQUIREMENTS

PART 1 – GENERAL

ITEM 1 - DESCRIPTION OF WORK

1.1 Background: The Munising Falls Day Use Trail is a popular destination at Pictured Rocks National Lakeshore, located within the community of Munising, which routes tens of thousands visitors annually along an 800-foot constructed trail to view the picturesque 50-foot Munising Waterfall. The trail is routed adjacent to Munising Creek. A portion of the trail traverses a steep forested hillside and is supported by a wood crib wall. The trail surface is a combination of asphalt, compacted aggregate, wooden plank boardwalk and short span wood decked bridges. Portions of the trail are lined with wood guardrails. The goal of this project is to replace aging paved surfaces and the failing wood crib wall along the main trail. The proposed trail includes a combination of cast in place concrete paving and prefabricated elevated walkways. The project includes miscellaneous drainage improvements and landscape restoration along the trail. Two existing spur trails with wood stairways are not included in the project area.

1.2 Work Covered by the Contract Documents:

A. Project Location: 1505 Sand Point Rd, Munising, MI 49862, Alger County.

B. Work consists of: Renovating an approximately 650 foot long paved trial. The existing trail is asphalt pavement with three wood bridges. The trail traverses a variety of steep and gradual terrain and follows Munising creek terminating at an overlook deck at the base of Munising Falls. The existing trail is approximately 5 ft wide typical and the proposed trail is 6’ wide typical. Existing bridges and portions of the existing on-grade trail will be replaced with elevated boardwalks. The quantities below further describe the work. Quantities below are approximate and provided as a courtesy only. Contractor is responsible for verifying all quantities and work elements prior to submitting their bid.

Contract Line Item No. 1 – Western Work Area includes the following approximate quantities of work:

1. *Install and maintain temporary cconstruction fencing*
2. *Install and maintain temporary traffic, safety and site protection measures*
3. *Install and maintain temporary accessible parking stalls, ramp, and signage*
4. *Install and maintain temporary erosion and sediment controls within the Work Area*
5. *Provide temporary shoring at existing crib wall if required to complete the work*
6. *933 SF Asphalt pavement demolition.*
7. *32 LF Concrete pavement saw cutting.*
8. *94 SF Concrete pavement demolition*
9. *209 FF Stone wall demolition and material salvage*
10. *15 LF 18” culvert removal.*
11. *Remove and salvage 1 surface mounted bench.*
12. *Remove and salvage 1 interpretive sign.*
13. *1000 FF wood crib wall demolition.*

14. *176 LF Wood handrail demolition.*
15. *154 SF Wood deck demolition*
16. *2232 SF Slope grading and restoration*
17. *129 FF Stone retaining wall – Type 1*
18. *845 SF 12" depth cobblestone rip-rap slope protection*
19. *1137 SF Erosion blanket*
20. *26 SF Riprap embankment*
21. *252 LF Sediment logs*
22. *922 SF Prefabricated boardwalk (elevated walkway) with guardrails & toe rails*
23. *22 Elevated walkway foundations*
24. *2 Cast in place concrete abutments for elevated walkway*
25. *1799 SF Lawn restoration and seeding*
26. *462 SF Concrete paved walkway (including excavation, base preparation, and grading)*
27. *90 LF Split rail fence*

Contract Line Item No. 2 – Central Work Area includes the follow approximate quantities of work:

1. *Install and maintain temporary erosion and sediment controls within the Work Area*
2. *1011 SF Asphalt pavement demolition*
3. *Remove and salvage 1 surface mounted bench.*
4. *Install 2 salvaged surface mounted benches.*
5. *110 SF Riprap embankment*
6. *15 LF 6" Culvert with stone headwall and end section.*
7. *51 FF Stone retaining wall – Type 2*
8. *1177 SF Concrete paved walkway (including excavation, base preparation, and grading)*
9. *420 SF Compacted soil preparation*
10. *50 LF Split rail fence*

Contract Line Item No. 3 – Eastern Work Area includes the follow approximate quantities of work:

1. *Install and maintain temporary erosion and sediment controls within the Work Area*
2. *Provide temporary protective measures at existing bridges if required to complete the work*
3. *805 SF Asphalt pavement demolition.*
4. *Remove and salvage 1 surface mounted bench.*
5. *13 SF Concrete pavement demolition*
6. *Remove 25 LF 4" Sock drain*
7. *Remove 3 wooden bridges (including 3 concrete abutments and 3 wood piles)*
8. *Relocate 1 landscape boulder*
9. *60 FF Stone retaining wall – Type 2*
10. *1216 SF Prefabricated boardwalk (elevated walkway) with guardrails & toe rails*
11. *30 Elevated walkway foundations*
12. *4 Cast in place concrete abutments for elevated walkways*
13. *307 SF Concrete paved walkway (including excavation, base preparation, and grading)*
14. *149 SF Compacted soil excavation and preparation*

15. 23 LF Split rail fence

C. All work will be performed under a single contract.

D. Permits:
   a. NPS will obtain the following permits as required:
      i. Michigan Department of Environment, Great Lakes & Energy (EGLE) – General Permit.
      ii. Michigan Department of Environment, Great Lakes & Energy (EGLE) – Floodplain Permit.
   b. Contractor shall obtain the following permits:
      i. Alger County - Soil Erosion and Sedimentation Permit
      ii. All miscellaneous permits required to complete the work including but not limited to: temporary utility, hot work, hauling, and disposal permits.

E. Period of performance: Work shall be completed within *365* calendar days of the start date provided on the Notice to Proceed.

   a. Clarification: The Notice to Proceed will be issued with a period of performance that is all inclusive of supply lead times, material deliveries, decommissioning, installation, anticipated average weather days for location, final commissioning, and acceptance of completed work. The contractor will be expected to provide a project schedule with adequate critical path details to ensure all work is completed within the stated calendar days from issuance of the Notice to Proceed. If weather impacts project beyond typical average weather patterns, contractor shall provide documentation in request for additional days.

1.3 Existing Condition Protections:

A. Preservation of Historical and Archeological Fabric:
   i. The Historic and Archeological Data Preservation Act of 1974, provides for the preservation of historical and archeological data that might otherwise be lost as the result of alterations to the terrain caused by a federal or federally licensed activity or program.
   ii. Refer to plans for site specific project requirements and notes.
   iii. IF, in connection with operations under this contract, the Contractor, subcontractors, or employees of any of them, discovers, encounters or becomes aware of any possible historical or archeological data, objects or sites of cultural value on the project area, such as historical ruins, graves or grave markers, fossils, or artifacts, the Contractor shall immediately suspend all operations in the vicinity of the discovery and notify the Contracting Officer immediately, when safe to do so, and follow up in writing within 2 days, giving the location and nature of the findings. No objects of cultural resource value may be removed. Contracting Officer will contact other entities as required.
   iv. If or when ground disturbance stops for archeological documentation, work may continue in another project location outside of the delineated corduroy road area identified in the project. Work stoppage for archeological documentation may vary in time duration, depending on the size and complexity of the features encountered. Feature documentation is most likely anticipated to take 1-2 days.

v. Where appropriate by reason of discovery, the Contracting Officer may order delays in the time of performance and/or changes in the work. If such delays and/or changes are ordered, the time of performance and contract price shall be adjusted in accordance with Changes clause.

vi. The Contractor will be responsible for protecting the cultural resources within and adjacent to the project area from damage. In addition, the Contractor will be liable for all damage to the cultural resources caused by their actions or the actions of their agents or representatives. The Contractor shall immediately notify the Contracting Officer or their representative if any damage occurs to any cultural resource and immediately suspend work in the area in which damage has occurred until authorized to proceed. Refer to Drawings for additional project specific information.

vii. None of the investigations being proposed as a part of this project are intended or designed to excavate, uncover, disturb, or remove Native American human remains or NAGPRA-related cultural items (i.e., funerary objects, sacred objects, or objects of cultural patrimony). If human remains or cultural items are discovered by some aspect of research in this study, procedures identified in the Native American Graves Protection and Repatriation Act Regulations (43 CFR 10.4(b); 10.5; 10.7) will be followed.

viii. If Native American human remains or cultural items are discovered anywhere within the project area, the contractor shall immediately suspend all operations in the vicinity of the discovery and notify the contracting officer immediately. The COR will then enact standard NPS NAGPRA protocols.

ix. The Contractor agrees to include this language within all subcontracts.

B. Should Contractor's operations or employees uncover or find any historic artifacts or archeological remains not specifically noted within the contract, the Contractor shall suspend operations at the site of discovery; notify the Contracting Officer immediately of the findings and continue operations in other areas outside a 50 foot radius of discovery.

C. The Contractor shall take all necessary measures to provide protection for all trees, fencing, walks and other landscape features and surrounding structures near the work site as noted with the contract. Any such surrounding features damaged, scarred or broken as a result of the Contractor's operations at the site outside of agreed upon documented extents, shall be treated, repaired or replaced in kind to the satisfaction of the Contracting Officer at no additional expense to the Government.

ITEM 2 – PROTECTING EXISTING UTILITIES

2.1 Protecting Existing Utilities: Notify Contracting Officer (CO), Contracting Officer's Representative (COR) and utility companies as required to request location services prior to and to coordinate any excavation/digging operations, and/or for demolition if within Scope of Work.

2.2 Contractor shall be responsible for locating and preventing damage to known utilities on site or indoors. If contractor damage occurs, alert CO and COR as soon as safely possible, and repair utility at no additional expense to the Government. If damage occurs to an unknown utility, contact CO and COR as soon as safely possible.

2.3 Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Government or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated below:

A. Notify CO and COR not less than two business days in advance of proposed utility interruptions.

B. Hours for Utility Shutdowns: Shutdowns shall not exceed 2 to 3 hours. Temporary provisions will be needed by the Contractor for periods longer than stated allowance or if required for critical systems as determined by COR.

ITEM 3 - CONTRACTOR'S USE OF PREMISES

3.1 Conduct of Operations: At all times the contractor shall conduct his operations in conformance with the rules and regulations promulgated by the Secretary of the Interior for the National Park Service, and applicable park rules and regulations prescribed by the Park Superintendent as detailed at https://www.nps.gov/piro/learn/management/suptcompendium.htm

A. Communications: Contractor shall provide the Contracting Officer and COR with methods of communications including land and/or cell phone numbers (note some areas of work have limited service coverage), email and in case of emergency 24-hour contact options for duration of time operations.

B. No signs or advertisements (except those specified herein and as required for safety) shall be displayed on the construction site or within the park unless approved by the Contracting Officer.

C. Smoking is not permitted within any Federal building or within 25 feet of entrances, operable windows, or outdoor air intakes.

D. Public Use of Site: Contractor shall at all times conduct operations to ensure the least inconvenience to the public. The trail and trailhead restroom building will be closed to public for the duration of construction; however it must remain available for NPS staff use. The Visitor Center will remain open to the public and the contractor shall maintain public access via paved walkways to the building for the duration of construction unless otherwise approved in writing by Contracting Officer. The adjacent North Country Trail will remain open to the public and the contractor shall maintain public access to the trailhead for the duration of construction unless otherwise approved in writing by Contracting Officer. Parking areas, driveways, sidewalks and trails outside the project Limits of Work shall remain accessible to the public for the duration of construction unless otherwise approved in writing by the Contracting Officer.

3.2 On-site work hours: Work shall be generally performed during normal business working hours of 8 a.m. to 5 p.m., Monday through Friday, except when otherwise indicated.

A. Work on Saturdays, Sundays, Federal holidays, early morning, or at night may not be performed without prior consent from the CO and COR. Submit requests for work outside of

the stated normal business hours to the CO and COR for approval at least 48 hours in advance of the work.

The following Federal holidays are observed by the National Park Service:
New Year Day
Martin Luther King, Jr's Birthday
Washington's Birthday
Memorial Day
Juneteenth National Independence Day
Independence Day
Labor Day
Columbus Day
Veterans Day
Thanksgiving Day
Christmas Day

B. Note: Any of the above holidays falling on a Saturday will be observed on the preceding Friday; holidays falling on Sunday will be observed on the following Monday. The specific day that each holiday is recognized for each year can be found at the following site: Federal Holidays (opm.gov).

3.3 Contractor Use of Site:

A. General: Contractor shall have limited use of the site for construction operations and shall limit use of premises to areas depicted on the project plans. The Limits of Work (or "Work Area"), including areas acceptable for staging, storage and other construction activities are shown on the Construction Staging Plan Sheet L0.1 and Sheets L1.0 an L1.1. Do not disturb portions of Project site outside the Limits of Work or other areas beyond those where the Work is indicated.

B. Driveways and Entrances: Paved driveways and entrances may be used by the contractor to access the project Work Area. Keep driveways, access roads, and entrances serving premises clear and available to Government, Government's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials. Schedule deliveries to minimize use of driveways and entrances.

C. Do Not disturb site outside of the Limits of Work shown on the Drawings and minimize site disturbance within the Limits of Work to the greatest extent feasible. Only disturb areas within the Limits of Work as required to complete the Work. With the exception of site access via paved driveways and entrances, earthwork, clearing of vegetation, foot traffic, vehicle traffic and all other construction activity is prohibited. Contractor shall provide appropriate matts and/or other protective measures for equipment on turf areas to reduce soil compaction, and on paved areas and areas of completed work to prevent damage. Where protective mats or other protective measures are required on walkways and other pedestrian routes open to the public, they shall meet Architectural Barriers Act Accessibility Standards (ABAAS) for facilities for visitors and employees. Contractor shall remediate soil compaction as directed to do so by the CO/COR. Soil compaction and damage to pavement or other site features shall be

repaired or replaced in kind to the satisfaction of the Contracting Officer at no additional expense to the Government.

D. Utilities
   1. General: Cost or use charges for temporary facilities shall be included in the Contract Sum as required.

   2. Water Service: Water from existing water system is not available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations without any additional permit costs. Use resources wisely and minimize waste of water.

   3. Electric Power Service: Electric power from existing system is not available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations without any additional permit costs. Power may or may not meet your construction power tool requirements, provide generators if questionable. Use power in a resourceful manner and avoid excess power waste.

   4. Waste Operation:

      a. Toilets: Contractor must provide toilets for contractor personnel, sufficiently lighted and ventilated toilet facilities in weatherproof, sight proof, handicap accessible (if required), sturdy enclosures with privacy locks. Coordinate with COR for approved location if not shown on Drawings. Alternatively, contractor may utilize the site restroom facilities in accordance with requirements specified on the Drawings
      b. Waste Removal / Recycling: Contractor is responsible for removing all waste created by the project. Contractor shall recycle to the highest degree possible and empty dumpsters as necessary to avoid debris on site. Locate as shown on site plan or coordinated with COR.

E. Security and Protection facilities:

   1. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction in ways and by methods that comply with state and federal environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.

   2. Cleaning of Equipment: The Contractor shall ensure that prior to moving on to the Project Area, all equipment, is free of soil, seeds, vegetative matter, or other debris that could contain or hold seeds. Ensure that all equipment has been pressure washed and is free of exotic species prior to start-up of operations and moving of equipment to Project Area. Equipment shall be considered free of soil, seeds, and other debris when a visual inspection does not disclose such material. Disassembly of equipment components or specialized inspection tools are not required.

   3. Tree and Plant Protection: All equipment traffic and construction activity must be contained within the Limits of Work. Provide Tree Protection fence along the trail corridor as required to protect trees and vegetation in and adjacent to the Work Area. Coordinate with COR. Restore damaged areas to original condition, repairing or replacing damaged trees and plants, at no additional expense to the Government.

      b. Provide temporary barriers to protect existing trees and plants and root zones.

c. Do not remove, injure, or destroy trees or other plants outside the limits of work without prior approval. Consult with Contracting Officer Representative and remove agreed-on roots and branches that interfere with construction.
d. Do not fasten ropes, cables, or guys to trees.
e. Carefully supervise excavating, grading, filling, and other construction operations near trees to prevent damage.
f. Groundcover type vegetation is expected to be impacted within the limits of work area and is not subject to protection measures, however contractor shall limit disturbance of existing vegetation within the limits of work to the maximum extent feasible.

4. Pest Control: Not applicable

5. Temporary Enclosures: Where site enclosure fence is not specified on the plans, provide temporary enclosures such as snow fence as required for protection of construction in progress and completed, from access by visitors or staff, other construction operations, and similar activities.

6. Site Enclosure Fence: Before construction operations begin, furnish, and install portable fencing as shown on the plans and as otherwise required to prevent people and animals from easily entering site work and storage areas, except by secured entrance gates.

   a. Extent of Fence: As required to enclose portion determined sufficient to accommodate construction operations and storage.
   b. Locate vehicular gates to avoid interference with traffic on public thoroughfares.
   c. Locate pedestrian entrance gates as required to provide controlled personnel entry.
   d. Maintain security by limiting number of keys and restricting distribution to authorized personnel. Provide CO and or COR with one set of keys or utilize double lock with NPS lock.

7. Hot Work Permit: Submit HW-1 Hot work permit form and receive approval from COR prior to Hot work activities commencing on site.

3.4 Storage - Staging Areas:

A. Confine Storage of materials and equipment to the project staging area noted on the plans/aerial. Specific storage units shall be provided by the contractor and exact location within staging area may be discussed at the preconstruction briefing. All storage units provided by the contractor shall be in a clean and acceptable condition to the COR. Security of the materials and equipment on site is the Contractor's responsibility. Refer to the Construction Staging Plan Sheet L0.1 for approved storage and staging areas. Limits of use and control shall be subject to Contracting Officer's approval. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site and impact to park visitors (avoid high use times.).

3.5 Preservation of Natural Features: Protection of Munising Creek and preventing materials, debris and sediment from entering the waterway is required. Preservation of the landscape, including soils and vegetation, within and adjacent to the Limits of Work is required. The Contractor shall ensure compliance with project plans, specifications, permits and all applicable regulatory requirements related to protection of the site's natural features. In-stream work and/or removal of trees or vegetation not specifically identified on the plans, is subject to CO and/or COR review and approval. COR will coordinate with NPS staff if tree removal is requested by contractor.

3.6 Hauling Restrictions: Contractor shall verify and be responsible for the path accessing the site and obtaining / maintaining all local, state and federal permits/licenses associated with hauling/road requirements and dumping of materials associated with the project.

3.7 Housekeeping:

A. Keep project neat, orderly, and in a safe condition at all times.

1. Dispose of waste materials and recycling legally outside the park. The contractor shall not use park dumpsters

2. Address Recycling: Government goal is to salvage and recycle as much nonhazardous construction waste as possible. Use sustainable methods to extent possible during this project, recycling material as is probable with local means. Maintain accurate documentary records for submittal of all recycled materials used including fly ash and slag cement.

3.8 Occupancy Requirements for Buildings:

A. Existing Buildings:

1. Full Government Occupancy: Government will occupy the Visitors Center building located immediately adjacent to the Work Area during the entire contract period. Cooperate with Government during construction operations to minimize conflicts and facilitate Government usage. Perform the Work so as not to interfere with Government's day-to-day operations. Maintain existing exits, unless otherwise indicated.

a. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from the CO or COR.
b. Repair damage caused by construction operations. Protect building and its occupants during construction period.
c. Provide temporary accessible parking stalls, ramps, and signage as indicated on the Drawings. Submit shop drawing showing stall layout, ramp layout and construction details, and signage mounting system for approval prior to construction. Remove all temporary parking measures upon completion of the work.

B. New /Existing Buildings Unoccupied: N/A

3.9 Photo Documentation:

A. Contractor must provide existing condition, progress, and completion photos. All photos shall be in focus, show maximum range of depth of field general photo and then close up detail photo as needed. Shall be in JPEG digital form and submitted preferably electronically by email or optional via CD-R Archival Gold or DVD-R Archival Gold media with printed labels and 8 mega pixels minimum within 7 days from time of taken or as approved by COR.

B. Existing Condition Images:

1. Before starting construction, take color, dated, digital images of project site and adjacent property/roads/etc. that may be impacted by construction activity/traffic. Include existing items to remain or be salvaged from different vantage points and with context for location identification.

C. Construction Progress Images:

1. Document all sub-surface work/ trenches etc. prior to backfill with photos covering enough overall field view to show location and then zoom in for details. (Locations and dimensions shall also be noted on as built drawing set.)
2. Maintain organized index for photos with date, description, etc.
3. Additional images as needed when questions or emergency situations occur. Submit within 24 hours.

D. Completion Images:

1. Document all completed work within scope of work.
2. Maintain organized index for photos with date, description, etc..
3. Additional images as needed when questions or emergency situations occur. Submit within 24 hours.

3.10 Fire and Life Safety:

A. As a minimum, conduct one weekly 15 minute "toolbox" safety meetings. These meetings shall be conducted by a foreman or supervisor and attended by all construction personnel at the worksite. Topics need to coincide with work scheduled for the following week. Document and submit meeting minutes to the CO and COR within one day after the meeting and document the meetings on the daily reports.

B. Comply with the requirements of NFPA 241 (Standard for Safeguarding Construction, Alteration, and Demolition Operations). Take all necessary precautions to prevent fire during construction. Provide adequate ventilation during use of volatile or noxious substances.

C. Store and handle hazardous materials in accordance with manufacturers and OSHA 29CFR1926 Subpart D requirements 1926 | Occupational Safety and Health Administration (osha.gov). Maintain readily available, on site, MSDS/Safety Data Sheets (SDS) for each chemical.

1. Immediately report all spills of hazardous materials to the CO, COR, and park.
2. Maintain a spill emergency response kit.
3. Train employees how to respond to a spill and use the emergency response kit.

3.11 Noise and Acoustics Management

A. Contractor shall not have personal radios or other media sources and they shall not be broadcast within NPS property.

B. Noise Control: Perform construction operations to minimize noise. Perform noise-producing work in less sensitive hours of the day or week as directed by the Contracting Officer or COR.

C. Repetitive and/or intermittent, high-level noise: Permitted only during Daytime.
Do not exceed the following dB(A) limitations at 50 feet:

Sound Level in dB(A)	Time Duration of Impact Noise
70	More than 12 minutes in any hour
80	More than 3 minutes in any hour

1. Maximum permissible construction equipment noise levels at 50 feet:

EARTHMOVING	dB(A)	MATERIALS HANDLING	dB(A)
Compressors	75	Pneumatic Tools	80
Pumps	75	Saws	75
Generators	75	Vibrators	75

D. Ambient Noise:

1. Maximum noise levels (dB) for receiving noise area at property line shall be as follows:

a. Residential receiving area :
Daytime: 65 dB Nighttime: 45 dB

b. Commercial/Industrial receiving area:
Daytime: 67 dB Nighttime: 65 dB

ITEM 4 - COMMENCEMENT, PROSECUTION, AND COMPLETION

4.1 The Contractor shall commence work in accordance with the terms and conditions of the contract. Contractor shall coordinate and incorporate long lead and delivery time items within the schedule.

ITEM 5 - EXAMINATION OF THE SITE

5.1 All bidders are urged to visit the job site and examine existing conditions before submitting bids. Contractors will be accountable for understanding existing conditions. No cost changes for items visible during site visit will be allowed.

ITEM 6 - ABBREVIATIONS

6.1 The list of abbreviations, standards and organizations which may be used in/referred within the Construction Specifications or Special Provisions, may be found linked from the listed page below. On the home page, follow the link under **"Contracting and Procurement"** labeled **"NPS Reference Standards."** https://www.nps.gov/orgs/1671/do-business-with-us.htm

ITEM 7 - ACCIDENT PREVENTION

7.1 Description: The work of this section consists of establishing and implementing an effective accident prevention program (APP) and providing a safe environment for all personnel and visitors.

7.2 Submittals:

A. Accident Prevention (Safety) Plan (APP): Submit a **site-specific** accident prevention (safety) plan. The Plan shall be written to comply with OSHA and project requirements (a generic plan is not acceptable) including but not limited to the following:

1. Name and qualifications of responsible supervisor to carry out the program.
2. First aid and rescue procedures.
3. Training, both initial and continuing.
4. Outline of each phase of the work, the hazards associated with each major phase, and the methods proposed to provide for property protection and safety of the public, National Park Service personnel, and Contractor's employees. Identify the work included under each phase, with a Job Hazard Analysis (JHA)/Job Safety Analysis (JSA), etc. A sample JHA template may be provided upon request.
5. Planning for possible emergency situations, such as cave-ins, earthquake, explosions, fires, floods, power outages, slides, and windstorms. Such planning shall take into consideration the nature of construction, site conditions, and degree of exposure of persons and property.
6. Contractor to identify nearest location of medical facility for emergencies
7. Recognition that works will be performed in remote areas with limited communication or cell phone coverage if applicable.
8. Supplemental hazard specific plans may be required IAW 29 CFR 1926 or 1910.

B. Meeting and Inspection Reports: Safety Meetings: As a minimum, conduct 15 minute "toolbox" safety meetings. These meetings shall be conducted by a foreman and attended by all construction personnel at the worksite. Submit a report of safety meetings and inspections to CO and COR within one day after the meeting and document the meetings on the daily reports.

7.3 Qualification of Employees:

A. Ensure that employees are physically qualified to perform their assigned duties in a safe manner to include operators of vehicles and equipment. Provide operating instructions for all equipment.

B. Do not allow employees to work whose ability or alertness is impaired because of drugs, fatigue, illness, intoxication, or other conditions that may expose themselves or others to injury.

7.4 Accident Reporting: The Contractor shall report all accidents to the CO and COR as soon as safely possible and assist the CO and COR and other officials as required in the investigation of the accident.

7.5 First Aid Facilities: Provide access to facilities for the number of employees and appropriate to the hazards associated with the types of ongoing construction work at the site.

7.6 Emergency Instructions: Post telephone numbers and reporting instructions for ambulance, physician, hospital, fire department, and police in conspicuous locations at the work site.

7.7 Personal Protective Equipment (PPE): It is the Contractor's responsibility to require all those working on or visiting the site to wear necessary protective equipment at all times.

A. PPE must meet requirements of applicable ANSI standards. Selection shall conform to OSHA 29CFR 1926 Subpart E.

B. A hard hat use area shall be designated by the Contractor. The hard hat area shall be posted by the Contractor in a manner satisfactory to the Contracting Officer.

C. All PPE will be serviceable at all times. At a minimum, maintain four sets of PPE including hard hats and all other Accident Prevention Plan required equipment.

7.8 Hazardous Materials: It shall be the responsibility of all operators and contractors, functioning within the park to properly cleanup, mitigate and remediate if necessary, all unauthorized discharges of hazardous materials or non-hazardous chemical and biological products released from fleet and/or other support vehicles or stationary sources. Response shall be consistent with guidelines established by federal, state, and local regulations, and as outlined within the operator's Safety or Hazardous Materials Business Plan.

A. If a spill, leak, or other release occurs, the operator shall as soon as possible, without impeding cleanup, notify the local 911 Emergency Response, COR and or the National Park Service Emergency Dispatch.

ITEM 8 - PRECONSTRUCTION CONFERENCE

8.1 If the Contracting Officer decides to conduct a preconstruction conference, the successful offeror will be notified and will be required to attend. The Contracting Officer’s notification will include specific details regarding the date, time, and location of the conference, any need for attendance by subcontractors, and information regarding the items to be discussed. See Item 9.1C below.

ITEM 9 - SUBMITTALS

9.1 General Contracting Submittal Procedures:

A. General: Prepare and submit submittals required by individual Technical Specification Sections. Types of submittals are indicated in individual specific sections.

1. CM-16 Transmittal Form: All submittals shall be transmitted via electronic email using National Park Service form CM-16 form. The form will be provided by the Contracting Officer. No action will be taken on a submittal item unless accompanied by the CM-16 transmittal form. Submit completed CM-16 forms to the CO and the COR

B. Submittal List: administrative required submittals are listed below in 9.1.C and does not include technical section submittal requirements included in each technical section.

C. Preconstruction Conference Submittal: Satisfactory evidence of liability insurance coverage and workman’s compensation, and any applicable bonds, must be submitted within 10 calendar days of Notice of Award. The following items are to be submitted prior to the Preconstruction Conference or as specified at the CO’s discretion. The timeline for the documents to be submitted will be addressed at the pre-construction conference for those items that were not received and approved prior. Notice to Proceed may not be issued, and

the Contracting Officer will consider other contractual remedies if not resolved as directed. Work shall not commence until written Notice to Proceed has been issued. Contracting Officer will notify Contractor of tentative date for the Pre-Construction Conference:

1. Letter designating Project Superintendent.
2. Construction Schedule. (Must include shop drawings, procurement time including long lead time items, mobilization, work near historic resources, trade work progression, and completion at minimum.)
3. A comprehensive breakdown of the Schedule of Values.
4. Accident Prevention (Safety) Plan (see section 7 of this document).
5. A list of Subcontractors for this project.
6. Written statements from subcontractors certifying compliance with applicable labor standard clauses (SF1413).
7. Quality Control Plan.
8. Waste Management Plan.
9. Temporary Storm Water Pollution Prevention Plan (SWPP or UPPP) and Soil Erosion and Sediment Control Permit Submitted to Alger County / AHJ (Authority Having Jurisdiction).
10. List of Required Construction Permits. Include the following information for each permit:
    a. Name of Permit.
    b. The Agency(ies) with Jurisdiction issuing the permit.
    c. Information required from the Government to complete the permit application.

9.2 Project Submittal Process (Shop Drawings, Product Data, and Samples): Contracting Officer will provide sample cover sheet and a list of required submittals is included in each technical specification or attached at the end of this document.

A. Shop Drawings: Indicate all coordinating materials and work impacting the installation coordination, connection details, anchorage requirements, hardware locations, and installation details and locations.

    1. Submit Shop Drawings according to Part 9.1 of this section to include one digital file (.PDF or .TIF) and two full size hardcopy documents to COR.

B. Product Data: Provide component construction and specification data sheets, anchorage requirements and any other product specific data.

    1. Submit Product Data according to Part 9.1 of this section to include one digital file (.PDF or .TIF) to COR.

C. Samples: Submit 2 color samples 4” x 6” minimum in size for all product color selections. Paint samples shall be actual paint finish drawdown for all project colors.

    1. Submit Samples CM-16 Transmittal Form according to Part 9.1 of this section to include one digital file (.PDF or .TIF) and physical samples of actual material to COR.

D. For submittals specified above, forward submittals to Contracting Officer and COR at least 15 days before need for approval (depends on length of project).

E. After approving submittals, Contracting Officer and/or COR will return one copy to the Contractor. If submittals are not approved, Contracting Officer will return all copies to Contractor with reasons for rejection. Resubmit, identifying changes. Any work done before approval shall be at Contractor's own risk.

9.3 Approved Equals: All brand names noted are subject to 'or equal' products. If an item in this solicitation is identified as "brand name or equal" or lists more than 1 manufacturer, the description of the proposed item must reflect the characteristics and level of quality that will satisfy the Government's needs as demonstrated by the salient physical, functional, or performance characteristics that "equal" products must meet and/or exceed that as specified in the solicitation or relevant specification. Contractor shall incorporate and be responsible for all collateral costs due to the or equal proposed as required to provide a complete project.

A. For each item proposed as an "approved equal," submit supporting data, including:

1. Drawings and samples as appropriate.
2. Comparison of the characteristics of the proposed item with that specified and with the salient characteristics provided.
3. Changes required in other elements of the work because of the substitution.
4. Name, address, and telephone number of vendor.
5. Manufacturer's literature regarding installation, operation, and maintenance, including schematics for electrical and hydraulic systems, lubrication requirements, and parts lists. Describe availability of maintenance service, and state source of replacement materials.

B. A request for approval constitutes a representation that General Contractor:

1. Has investigated and shall provide documentation in request showing that the proposed item is equal or superior in all respects to the salient characteristics specified.
2. Will meet or exceed warranties for the proposed item specified.
3. Has determined that the proposed item is compatible with interfacing items.
4. Will coordinate the installation of an approved item and make all changes required in other elements of the work because of the substitution.
5. Waives all claims for additional expenses that may be incurred as a result of the substitution.

C. Approved Equals will be evaluated and approved/disapproved during the submittal process.

9.4 Schedule of Values: Submit the Schedule of Values a minimum of one week prior to the Preconstruction Conference for COR review. Schedule of Values shall include defined work line items with cost break downs including labor, material, and equipment for COR approval.

9.5 Progress Reporting: The initial Construction Schedule and Schedule of Values are required a minimum of one week prior to the Preconstruction Conference. After the Notice to Proceed is issued and after on-site work begins, progress will be documented via daily logs and by providing an updated Construction Schedule and Schedule of Values when requested, but minimally once per month. Submit digital copy electronically (PDF preferred) of all required documents. Construction Schedules are normally in bar chart form and indicate estimated starting and

completion dates for each part of the work. For a pay application to be reviewed and processed in a timely manner, the following information must either be submitted prior to or accompany submission of the pay application:

A. Daily/weekly progress reports during construction as part of the administration process.

B. Updated Schedule of Values: Breakdown each lump-sum item into component work activities used in the schedule, for which progress payments may be requested. The Schedule of Values will form the basis for payment. The work activities broken out within the schedule of values shall be integrated into and made a logical part of the construction baseline schedule submitted under this specification. The total costs for the component work activities shall equal the contract price for that lump-sum item. The Contracting Officer may request data to verify accuracy of dollar values. A sample Schedule of Values format may be provided upon request.

ITEM 10 – TEMPORARY SERVICES

10.1 It is the Contractor's responsibility to provide temporary services, equipment, tools, and skilled labor as required for the chosen means and methods to perform the work in accomplishing this Contract.

ITEM 11 - PROJECT CLOSEOUT

11.1 Description: The work of this section consists of final cleanup, closeout submittals, final inspection procedures working toward Final Acceptance.

11.2 Cleaning: Remove all tools, equipment, surplus materials, and rubbish. Move attic stock to location coordinated with COR. At time of final inspection, project shall be thoroughly clean and ready for intended use. Inspector holds the right to reschedule if project is not ready for inspection.

11.3 Completion and Final Inspection: Contractor shall submit written certification of project completion and request a final inspection to the Contracting Officer and COR. The Contracting Officer or designee will make an inspection within 10 days of receipt of request or at a mutually agreeable time.

A. If the work is determined to be complete following the final inspection with minor comments, the COR will prepare and provide the Contractor a Punch List noting outstanding items to be addressed.
B. If the work is not determined to be complete following the final inspection, the Contracting Officer will notify Contractor in writing, stating reasons. Contractor, after completing the work according to the Contract Documents, shall resubmit completion and request a new final inspection. Re-inspection costs may be charged against the Contractor in accordance with the Inspection of Construction contract clause.

C. Contractor shall complete the Punch List within 30 calendar days, or a time directed by the CO.

D. Once Contractor completes all items of work on the Punch List and all contractually required items are accepted, Contracting Officer will issue Letter of Final Acceptance of Work and request the final pay application.

E. If the Contractor fails to complete the work within the time frame, the Contracting Officer may correct the work with an appropriate reduction in contract price or charge for re-inspection costs in accordance with the Inspection of Construction contract clause.

F. Disposition of any permits and warranties required by the specifications in this section.

11.4 Final Acceptance of the Work: After all punch list deficiencies have been corrected, a Letter of Final Acceptance will be issued. A Release of Claims document must be executed and submitted to the Contracting Officer before final payment can occur.

11.5 Warranties

A. Construction Warranty shall be based on date of final acceptance of the work and remain in effect for one year.

B. Provide all manufacturer warranty information of products installed organized by Division. All contact information, extent of coverage and conditions shall be clearly noted as well as date of overall final acceptance.

C. Information shall include operation and maintenance manuals for each warranted product.

ITEM 12 - DEFINITION OF CONTRACT LINE ITEMS

12.1 Summary

A. The intent of this section is to explain, in general, what is and what is not included in a contract line item, and the limits or cut off points where one item ends and another begins.

B. If no contract line item exists for a portion of the work, include the costs in a related item.

12.2 List of Contract Line Items

A. **Contract Line Item No. 1** – Western Work Area

1. This item consists of all temporary and permanent work from the western limit of work to trail Station 2+28 (east end of Elevated Walkway #1). This includes all work within the construction staging area.
2. Payment will be made per the contract and percentage of completion level.

B. **Contract Line Item No.2** – Central Work Area

1. This item consists of all temporary and permanent work from trail Station 2+28 (east end of Elevated Walkway #1) to trail Station 4+09 (west end of Elevated Walkway #2)
2. Payment will be made per the contract and percentage of completion level.

C. **Contract Line Item No.3** – Eastern Work Area

1. This item consists of all temporary and permanent work from trail Station 4+09 (west end of Elevated Walkway #2) to the eastern limit of work.
2. Payment will be made per the contract and percentage of completion level.

D. **Option A** (NOT USED)

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXCUTION (NOT USED)

END OF SECTION

DIVISION 02

Existing Conditions

SECTION 02 41 13
SELECTIVE SITE DEMOLITION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Demolition and removal of selected on-site elements.

B. Sawing and removal of concrete pavement where indicated in the drawings.

C. Removal of asphalt/bituminous trail, existing wood crib walls, wood handrails, storm sewer pipe, existing bridge components, and existing railings.

D. Removal and reinstallation of benches.

E. Removal, relocation and protection of existing items, materials and equipment indicated on contract drawings.

F. Removal and salvage of retaining wall stone.

1.02 RELATED REQUIREMENTS

A. Section 31 11 00 Clearing and Grubbing

B. Section 31 25 00 Erosion and Sedimentation Controls

C. Section 32 91 19 Landscape Grading

1.03 DEFINITIONS

A. Remove: Remove and legally dispose of items except those indicated to be reinstalled, salvaged, or to remain the Owner's property.

B. Remove and restore: Items indicated to be removed and restored remain the Owner's property. Remove, clean, and pack or crate items to protect against damage. Identify contents of containers.

C. Remove and Reinstall: Remove items indicated; clean, service, and otherwise prepare them for reuse; store and protect against damage. Reinstall items in the same locations or as indicated on the construction documents.

D. Existing to Remain: Protect construction indicated to remain against damage during demolition. When permitted by the Contract Officer or Contracting Officer’s Representative, items may be removed to a suitable, protected storage location during demolition and then cleaned and reinstalled in their original locations.

1.04 MATERIALS OWNERSHIP

A. Except for items or materials indicated to be reused, reinstalled, or otherwise indicated to remain the Owner's property, demolished materials shall become the Contractor's property and shall be removed from the site with further disposition at the Contractor's option.

B. Historical items found shall remain the Owner's property. Carefully remove and salvage each item in a manner to prevent damage and deliver promptly to the Owner.

1.05 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections, for information only, unless otherwise indicated.

B. Inventory of items to be removed and salvaged.

1.06 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with governing EPA notification regulations before starting demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Pre-demolition Conference: Conduct conference at Project site to comply with pre installation conference requirements of Division 1.

1.07 PROJECT CONDITIONS

A. Storage or sale of removed items or materials on-site will not be permitted.

B. Damage: Promptly repair damage caused to adjacent facilities by demolition work.

C. Owner assumes no responsibility for actual condition of site for demolition activities.

D. Utility Services: Maintain existing utilities and protect them against damage during demolition operations.

PART 2 – PRODUCTS

2.01 REPAIR MATERIALS

A. Use repair materials identical to existing materials.
   1. Where identical materials are unavailable or cannot be used for exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible.
   2. Use materials whose installed performance equals or surpasses that of existing materials.

PART 3 – EXECUTION

3.01 EXAMINATION

A. Stake the limits of work shown on the drawings for review and approval prior to beginning work. Maintain limits or work thought construction and remove when directed by the COR

B. Survey existing conditions and correlate with requirements indicated to determine extent of demolition required.

C. Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged.

3.02 UTILITY SERVICES

A. Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
   1. Do not interrupt existing utilities serving occupied or operating facilities, except when authorized in writing by Owner and authorities having jurisdiction. Provide temporary services during interruptions to existing utilities, as acceptable to Owner and to governing authorities.
      a. Provide not less than 72 hours notice to Owner if shutdown of service is required during changeover.

3.03 PREPARATION

A. Notify MISS DIG 811 and other qualified utility locating service 48 hours prior to proceeding with selective demolition operations. Contractor shall be responsible for verification of all underground utilities within demolition and excavation area. Test pits are anticipated.

B. Conduct demolition operations and remove debris to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.
   2. Protect existing site improvements, appurtenances, and forest features to remain.

C. Provide and maintain exterior shoring, bracing, or structural support to preserve stability and prevent movement, settlement, or collapse of existing features to remain within the right- of-way.
   1. Strengthen or add new supports when required during progress of demolition activities.

3.04 POLLUTION CONTROLS

A. Use water mist, temporary enclosures, and other suitable methods to limit the spread of dust and dirt. Comply with governing environmental protection regulations.
   1. Do not use water when it may damage existing construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.

B. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

C. Clean adjacent structures and improvements of dust, dirt, and debris caused by demolition operations. Return adjacent areas to condition existing before start of demolition.

3.05 DEMOLITION

A. Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete Work within limitations of governing regulations.

3.06 CULVERT REMOVAL

A. Excavate for and remove culverts indicated to be removed. Refer to Section 33 42 13 Stormwater Culverts for information on installation of culvert replacements.

B. Dispose of off-site in accordance with all laws and regulations.

3.07 BENCH REMOVAL AND REINSTALLATION

A. Remove only those benches indicated on drawings. Contractor is responsible for salvage and storage of benches until they are reinstalled or possession is taken by NPS.

B. Reinstall benches as noted on the Drawings. Obtain approval of bench location prior to installation.

3.08 DISPOSAL OF DEMOLISHED MATERIALS

A. General: Promptly dispose of demolished materials. Do not allow demolished materials to accumulate on-site.

B. Burning: Do not burn demolished materials.

C. Disposal: Transport demolished materials off Owner's property and legally dispose of them.

3.09 CLEANUP AND REPAIR

A. Debris, Rubbish, Tools, and Protection: Upon completion of demolition work, remove tools, equipment, and demolished materials from site. Remove protection and leave areas broom clean.
   1. Remove and transport debris and rubbish in a manner that will prevent spillage on adjacent areas.
   2. Clean up spillage from adjacent areas.

B. Repair: Repair demolition performed in excess of that required. Return elements of construction and surfaces to remain to condition existing prior to start operations. Repair adjacent construction or surfaces soiled or damaged by demolition work.

END OF SECTION 02 41 13

DIVISION 03

Concrete

SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes but is not limited to the following as shown on the drawings and as specified herein:

1. Foundation systems including footings, caissons, caisson caps, piles, walls, beams, piers, pilasters, pits and similar concrete.
2. Furnishing and installing all required anchors and inserts.
3. Placing in the forms all inserts, anchors, anchor bolts, bearing plates and the like furnished by other trades for casting into the concrete and cleaning of same after stripping of forms.
4. Protection of all inserts, anchors, hangers, sleeves and supports furnished and set by others for the attachment of other work to the concrete, or required to permit the passage of other work through the concrete.
5. Supply, fabricate and place all required reinforcing bars, mesh and other reinforcement for concrete where shown, called for, and/or required complete with proper supporting devices.
6. Erection and removal of all formwork required to properly complete the work.
7. Finishing of all concrete work as hereinafter specified.
8. Curing and protection of all concrete work.
9. Site concrete consisting of curbs, walls, pads, boxes and the like as shown on the drawings.
10. Cutting, patching, grouting, repairing and pointing up as required.
11. Under slab drainage course.
12. Dewatering.
13. Grouting of all beam bearing plates and column base plates.
14. All other work and materials as may be reasonably inferred and needed to make the work of this section complete.
15. Waste Management

1.2 RELATED REQUIREMENTS

1. Section 02 41 13 Selective Site Demolition
2. Section 05 12 00 Structural Steel Framing
3. Section 31 23 00 Earthwork
4. Section 32 13 13 Concrete Paving
5. Section 32 34 00 Prefabricated Boardwalks

1.3 SUSTAINABLE DESIGN REQUIREMENTS

A. The Contractor is encouraged to implement sustainable practices and procedures, as described in this Section and in Related Sections of the Contract Documents.

B. The Contractor is encouraged to efficiently use resources and energy while executing the Work of this Section. Resource efficient aspects to be considered in completing this Project may include the use of techniques that minimize waste generation, reuse of construction materials on site where possible, and recycling of waste generated during the construction process.

1.4 SUBMITTALS

A. Product Data: Submit data for proprietary materials and items, including the following:

1. Reinforcement
2. Supports for reinforcement
3. Forming accessories
4. Admixtures
5. Patching compounds
6. Curing compounds
7. Mechanical splice couplers.
8. Others items as requested by Contracting Officer Representative.

B. Shop Drawings; Reinforcement: Submit original shop drawings for fabrication, bending, and placement of concrete reinforcement. Comply with ACI 315 "Details and Detailing of Concrete Reinforcement" showing bar sizes, lengths, materials, grades, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, location of splices, lengths of lap splices, details of mechanical splice couplers, details of welded splices, tie spacing, hoop spacing, and supports for concrete reinforcement. Include special reinforcement required for openings through concrete structures. The shop drawings shall be prepared only by competent detailers, checked by the contractor prior to submission.

1. The shop drawings shall show construction, contraction and isolation joint locations and the added reinforcement required at same.
2. Obtain and coordinate information for sleeves, openings, and conduits in concrete, which are required for the work of other trades. Make coordinated drawings showing size and location of all openings, sleeves, and conduits and incorporate this information on the reinforcing drawings.
3. Only those splices indicated on the approved shop drawings will be permitted.
4. Provide elevations of all foundation walls and other structural elements to a minimum 1/4" scale.

C. Shop Drawings Formwork: Submit shop drawings for fabrication and erection of specific finished concrete surfaces. Show form construction including jointing, special form joint or reveals, location and pattern of form tie placement, and other items which affect exposed concrete visually. Contracting Officer Representative’s review is for general architectural applications and features only. Design of formwork for structural stability and efficiency is Contractor’s responsibility, prepared by or under the supervision of a qualified professional engineer detailing fabrication, assembly, and support of formwork.

1. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and reshoring installation and removal.

D. Scaling of the drawings is not permitted. This applies to hard paper, electronic, and all other versions.

E. Samples: Submit samples of materials as requested by Contracting Officer Representative, including names, sources and descriptions.

F. Laboratory Test Reports: Submit laboratory test reports for concrete materials, mix design test and microwave test.

G. Material Certificates: Provide materials certificates in lieu of materials laboratory test reports when permitted by Contracting Officer Representative. Manufacturer and Contractor, certifying that each material item complies with, or exceeds, specified requirements shall sign material

certificates. Provide certification from admixture manufacturers that chloride content complies with specification requirements.

H. Cold Weather and Hot Weather Concreting Procedures: Submit written descriptions of contractor's proposed cold weather and hot weather concreting procedures, when applicable.

I. Certification that pozzolanic materials conforms to ASTM C 618-01 (noting class C or class F), ASTM C 989 or ASTM C1240.

J. Certified recycled steel content. Provide cut sheets clearly indicating whether the rebar used meets the minimums for post-consumer OR post-industrial recycled contents. Or, if cut sheets are not available, obtain a written affidavit from the manufacturer stating the recycled content percentage and if the recycled content is post-consumer or post-industrial.

K. Formwork: Specify whether reusable, permanent, salvaged or new wood forms are to be used.

L. Recycled Aggregate: Provide laboratory reports indicating that aggregate conforms to ASTM C33 for structural concrete or ASTM D1241-00 for sub-base material. Provide cut sheets clearly indicating the source, total weight and volume of the recycled aggregate. If aggregate provided is a mix of virgin and recycled aggregates obtain a written affidavit from the manufacturer stating the recycled content percentage

M. VOC content for curing compounds, sealants and release agents: Provide a cut sheet and a Material Safety Data Sheet (MSDS) for each curing compound, sealant, hardener and release agent used highlighting VOC contents. VOC content must be less than or equal to limits stated under "PRODUCTS".

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.

B. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.

C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4/D 1.4M, "Structural Welding Code - Reinforcing Steel."

D. Codes and Standards: Comply with provisions of following codes, specifications, and standards, except where more stringent requirements are shown or specified:

1. 2024 International Building Code.
2. ACI 117 "Standard Specifications for Tolerances for Concrete Construction and Materials and Commentary."
3. ACI 211.1 "Standard Practice for Selecting Proportions for Normal, Heavyweight and mass concrete."
4. ACI 214R, "Evaluation of Strength Test Results of Concrete."
5. ACI 232.2R, "Use of Fly Ash in Concrete."
6. ACI 233R, "Guide to Use of Slag Cement in Concrete and Mortar."
7. ACI 234, "Guide for the Use of Silica Fume in Concrete."
8. ACI 301 "Specifications for Structural Concrete."
9. ACI 302.1R "Guide for Concrete Floor and Slab Construction."
10. ACI 304R, "Guide for Measuring, Mixing, Transporting and Placing Concrete."

11. ACI 305R “Hot Weather Concreting.”
12. ACI 306R-10 “Guide to Cold Weather Concreting.”
13. ACI 308.1 “Standard Specification for Curing Concrete.”
14. ACI 309R, “Guide for Consolidation of Concrete.”
15. ACI 311.4R, “Guide for Concrete Inspections.”
16. ACI 315, “Details and Detailing of Concrete Reinforcement.”
17. ACI 318 “Building Code Requirements for Structural Concrete and Commentary.”
18. ACI 347 “Guide to Formwork of Concrete.”
19. Concrete Reinforcing Steel Institute, (CRSI) “Manual of Standard Practice.”
20. CRSI-WCRSI, “Placing Reinforcing Bars.”
21. AWS D1.4, “Structural Welding Code Reinforcing Steel.”
22. The ACI Field Reference Manual, SP-15 shall be kept at the job site, and the practices set forth therein shall be strictly adhered to.
23. ASTM Standards as applicable in the building code of the local jurisdiction and as noted in this specification.
24. AASHTO T 318, “Standard Method of Test for Water Content of Freshly Mixed Concrete Using Microwave Oven Drying.”

E. Concrete Testing Service: Contractor will engage a testing laboratory acceptable to the Contracting Officer Representative to perform material evaluation tests and to design concrete mixes.

F. Materials and installed work may require testing and retesting at anytime during progress of work. Tests, including retesting of rejected materials for installed work, shall be done at Contractor's expense.

G. Construction Meeting:

1. At least 35 days prior to the start of the concrete construction schedule, the Contractor shall conduct a meeting to review the proposed mix designs and to discuss the required methods and procedures to achieve the required concrete construction. The Contractor shall send a pre-concrete conference agenda to all attendees 20 days prior to the scheduled date of the conference.
2. The Contractor shall require responsible representatives of every party who is concerned with the concrete work to attend the conference, including the Contracting Officer Representative. The Contractor shall notify the Contracting Officer Representative at least 10 days prior to the scheduled date of the conference.
3. Minutes of the meeting shall be recorded, typed and printed by the contractor and distributed by the contractor to all parties concerned within 5 days of the meeting. The minutes shall include a statement by the concrete contractor indicating that the proposed mix design and placing can produce the concrete quality required by these specifications. One copy of the minutes shall also be transmitted to the following for information purposes: Contracting Officer Representative.

1.6 PROJECT CONDITIONS

A. The Contractor, before commencing work, shall examine all adjoining work on which this work is in any way dependent for proper installation and workmanship according to the intent of this specification, and shall report to the Contracting Officer Representative any condition which prevents this contractor from performing first class work.

B. Protection of Footings Against Freezing: Cover completed work at footing level with sufficient temporary or permanent cover as required to protect footings and adjacent subgrade against possibility of freezing; maintain cover for time period as necessary.

C. Protect adjacent finish materials against spatter during concrete placement.

D. Provide all barricades and safeguards at all pits, holes, shaft and stairway openings, etc., to prevent injury to workmen and others within and about the premises. Also provide all safeguards as required by the Building Code, OSHA, or any other departments having jurisdiction. Take full responsibility for all safety precautions and methods.

E. Procedure of Work: The contractor shall keep themself constantly informed as to the progress of the work in the field, materials and workers ready to start work immediately when conditions of preceding work are available or ready, wholly or in part, so as not to delay the progress of building work or to interfere with the progress of work of other contractors, and in any event the contractor shall, within 24 hours after notice from the Contractor Officer Representative, proceed with such work as directed to maintain the uninterrupted progress of the work.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings on steel reinforcement.

PART 2 - PRODUCTS

2.1 FORM MATERIALS

A. Forms for Exposed Finish Concrete: Unless otherwise indicated, construct of plywood, metal, metal-framed plywood faced, or other acceptable panel-type materials, to provide continuous, straight, smooth, exposed surfaces. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown on drawings. Provide form material with sufficient strength and thickness to withstand pressure of newly placed concrete without bow or deflection.

1. Use plywood complying with U.S. Product Standard PS-1 “B-B (Concrete Form) Plywood”, Class I, Exterior Grade or better mill oiled and edge-sealed, with each piece bearing legible inspection trademark.

B. Forms for Unexposed Finish Concrete: Plywood, lumber, metal, or other acceptable material. Preference shall go to salvaged or re-used Dimensional Lumber. Provide lumber dressed on at least 2 edges and one side for tight fit.

C. Sustainability Requirements For Wood Used For Formwork

1. New Dimensional Lumber for Formwork: Provide wood certification documentation from the manufacturer/distributor, declaring conformance with Forest Stewardship Council (FSC) guidelines for certified wood building components The following independent certification organizations are accredited by the FSC and provide the manufacturer/distributor with documentation:

    a. Scientific Certification Systems, Inc..
    b. Smart Wood Certification Program: Rainforest Alliance

2. Salvaged or re-used Dimensional Lumber for Formwork: Provide documentation certifying products are from salvaged wood sources. Provide grading certificate for structural applications. For wood salvage wood resources see GreenSpec.
3. If new dimensional Lumber is neither Certified nor salvaged: select regionally grown lumber with the lowest grade that meets performance requirements.

D. Form Coatings: Provide VOC compliant commercial formulation form- coating compounds that will not bond with, stain nor adversely affect concrete surfaces, and will not impair subsequent treatments of concrete surfaces. Use biodegradable form release agent listed below or equivalent made from soy or rapeseed oil.

1.	“Clean Strip J1EF”	Dayton Superior
2.	“Bio-Form”	M Chem Solutions
3.	“Duogard II”	W. R. Meadows, Inc.
4.	“Atlas Bio-Guard”	Atlas Construction Supply, Inc.

E. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that produce surfaces not exceeding specified formwork surface class.

1. Provide forms with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.

F. Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.

G. Form Ties: Form ties and spreaders: prefabricated assemblies by Richmond; Superior, Dayton or approved equal. Wire ties shall not be used. Ties for foundation work shall be of snap design with removal cones and water seal washer.

1. Furnish units that will leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
2. Furnish ties that, when removed, will leave holes no larger than 1inch in diameter in concrete surface.

H. Earthen Forms: The existing sands encountered at the site and documented in the geotechnical borings are subject to sloughing and caving. Due to these conditions, earth-formed foundations are likely not feasible for this project and the use of man-made forms will likely be required. However, subject to approval by the subgrade inspector hired by the Contractor, use of earthen forms may be permitted if trenched or cored excavations result in vertical side walls (where practical) that are maintained during foundation concrete placement. Excavations must not be allowed to “mushroom out” at the top, creating a “frost lip” that is subject to frost heave.

2.2 REINFORCING MATERIALS

A. Reinforcing Bars: ASTM A615/A615M, Grade 60, deformed. All reinforcing bars shall be Grade 60 unless otherwise noted. Provide Grade 75, Grade 80, or Grade 100 reinforcing bars where indicated on the contract documents.

B. Weldable Reinforcing Bars: ASTM A 706/A 706M, Grade 60.

C. Epoxy-Coated Reinforcing Bars: ASTM A 775 (as noted on Drawings and/or in section).

D. Mechanical Splice Couplers: ACI 318/ACI 318M, same material of reinforcing bar being spliced. Provide mechanical couplers as an alternate to standard tension lap splices where indicated on the contract documents and in areas of rebar congestion. A mechanical splice coupler shall develop in tension or compression, as required, at least 1.25 times the yield strength of the bar being spliced.

E. Steel Wire and Welded Wire Reinforcement: ASTM A 1064. Galvanized at exterior locations, conditions permanently exposed to weather and/or water, and where noted on drawings (plan and/or sections).

F. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60plain-steel bars, cut true to length with ends square and free of burrs.

G. Epoxy-Coated Joint Dowel Bars: ASTM A 615/A 615M, Grade 60plain-steel bars, ASTM A 775/A 775M epoxy coated.

H. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A 775/A 775M.

I. Zinc Repair Material: ASTM A 780, zinc-based solder, paint containing zinc dust, or sprayed zinc.

J. Supports for Reinforcement: Bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcing bars and welded wire reinforcement in place. Use wire bar type supports complying with CRSI specifications.

1. For epoxy coated reinforcement provide plastic protected chairs and plastic ties. All imperfections in the epoxy coating are to be repaired prior to placement of concrete.

a. Use recycled plastic rebar supports (give preference to local supplier if available). Subject to compliance with requirements, provide one of the following:

1) International Plastics Group
2) Eclipse Plastic

2. For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with legs which are plastic protected (CRSI, Class I) or stainless steel protected (CRSI, Class 2), at a spacing not to exceed 4'-0" on center in either direction.

2.3 CONCRETE MATERIALS

A. Cement: Portland cement (ASTM C 150, Types I, II, or I/II) or Portland limestone cement (ASTM C 595). Total percentage of Portland Cement is NOT to exceed 75% of the cementitious content of each mix, except mixes assigned to exposure class F3. Use one brand of cement throughout project, unless otherwise acceptable to Contracting Officer Representative. Provide supplementary cementitious materials in mixes per sections below.

a. Fly Ash: Cast-in-place concrete shall incorporate fly ash as a replacement for at least 25% (by weight) of the Portland cement. All design mixes must be reviewed and approved by the Contracting Officer Representative. Where concrete is assigned to exposure class F3, limit the replacement of Portland cement with fly ash (by weight) to 25% max.
b. Ground Granulated Blast Furnace Slag (GGBF): Cast-in-place concrete shall incorporate GGBF as a replacement for at least 40% (by weight) of the Portland cement. All design mixes must be reviewed and approved by the Contracting Officer Representative. Where concrete is assigned to exposure class F3, limit the replacement of Portland cement with GGBF slag (by weight) to 50% max.
c. Post-Consumer Recycled Ground Glass Pozzolan (GGP): Cast-in-place concrete shall incorporate GGP as a replacement for at least 25% (by weight) of the Portland cement. All design mixes must be reviewed and approved by the Contracting Officer Representative.
d. Pozzolans and Slags: These must be completely accounted for in the design mix. Mix design must meet minimum design requirements set in the contract documents. Additional admixtures may be required to meet early strength requirements and alternative cementitious material goals. If a "blended cement" is used which already

contains a certain percentage of Pozzolans or Slags this content may offset or entirely satisfy the minimum percentage required.

1) Coal Fly Ash: ASTM C 618 (Class C or Class F): ASTM C 618 (Note: Class F fly Ash will require higher amounts or air entraining ad-mixtures than class C).
2) Blast Furnace Slag: ASTM C989
3) Ground Glass Pozzolan: ASTM C1866
4) Silica Fume: ASTM C 1240
5) Rice Hull (or "husk") Ash: ASTM C 618 Blended hydraulic cement, as defined by ASTM C 595 or ASTM C 1157

B. Normal Weight Aggregates: ASTM C 33, and as herein specified. Provide aggregates from a single source for exposed concrete.

1. Local aggregates not complying with ASTM C 33 but which have shown by special test or actual service to produce concrete of adequate strength and durability may be used when acceptable to Contracting Officer Representative.
2. Normal weight Fine Aggregate: washed, inert, natural or manufactured or combination thereof, sand conforming ASTM C33 gradation.
3. Normal weight Coarse Aggregate: well graded crushed stone or washed gravel conforming to ASTM C33, sizes 57 for foundations and 67 for slabs and structure.

    a. Recycled crushed concrete aggregate in concrete mixes is only to be used with approval of Contracting Officer Representative. Recycled aggregate shall be used only as a substitute for coarse aggregate and must also be washed and well-graded, conforming to ASTM C33.
    b. For sub-base, slabs on grade and non-structural applications and Recycled Aggregate Materials are NOT required to meet the ASTM C 33 standard. In addition to concrete rubble, glass, porcelain, and tire chips can be used as filler material. Any inert material conforming to ASTM D1241 is acceptable for the applications described in this paragraph.

C. Water: Free from oils, acids, alkali, organic matter and other deleterious material to conform to ASTM C94. ASTM C94 for gray water use in the production of ready mixed concrete per approval by the Contracting Officer Representative.

D. Air Entraining Admixture: ASTM C 260.

1. Liquid air entrainment: Subject to compliance with requirements, provide one of the following or equal approved by Contracting Officer Representative:

    a. "Air Mix" — Euclid Chemical Co.
    b. "AEA-92" — Euclid Chemical Co.
    c. "Darex AEA" — GCP Applied Technologies
    d. "MasterAir AE200" — Master Builders Solutions

E. Water-Reducing Admixture: ASTM C 494.

1. Products: Subject to compliance with requirements, provide one of the following or equal approved by Contracting Officer Representative:

    a. "MasterPolyheed 997" — Master Builders Solutions
    b. "Eucon MR" — Euclid Chemical Co.
    c. "WRDA 64" — GCP Applied Technologies

F. High-Range Water-Reducing Admixture (Superplasticizer): ASTM C 494, Type F or Type G and containing not more than 0.05 percent chloride ions.

1. Products: Subject to compliance with requirements, provide one of the following or equal approved by Contracting Officer Representative:

a.	"Eucon 37, 1037 or Plastol 5000"	Euclid Chemical Co.
b.	"Rheobuild 1000"	Master Builders Solutions
c.	"MasterGlenium Series"	Master Builders Solutions
d.	"Daracem-100"	GCP Applied Technologies

G. Water Reducing, Non-Corrosive Accelerating Admixture: The admixture shall conform to ASTM C 494, Type C or E, and not contain more chloride ions than are present in municipal drinking water. The admixture manufacturer must have long-term non- corrosive test data from an independent testing laboratory (of at least a year's duration) using an acceptable accelerated corrosion test method such as that using electrical potential measures. Accelerating admixtures are not to be used as antifreeze agents. Accelerating admixtures are permitted only upon review by Contracting Officer Representative.

1. Products: Subject to compliance with requirements, provide the following or equal approved by Contracting Officer Representative:

a.	"Accelguard NCA, 80, 90, or G3"	Euclid Chemical Co.
b.	"Daraset 400 or 422”	GCP Applied Technologies
c.	“MasterSet FP 20”	Master Builders Solutions

H. Water-Reducing, Retarding Admixture: ASTM C 494, Type D, and contain not more than 0.05 percent chloride ions.

1. Products: Subject to compliance with requirements, provide one of the following or equal approved by Contracting Officer Representative:

a.	"Eucon Retarder 75 or 100"	Euclid Chemical Co.
b.	"MasterSet R 100"	Master Builders Solutions
c.	"Plastiment"	Sika Chemical Co.
d.	"Daratard"	GCP Applied Technologies.

I. Microsilica Admixture shall be dry densified or slurry formed. Microsilica shall come from the same source throughout the project. If a single source cannot be maintained, laboratory testing of each new source shall be required before acceptance by the Contracting Officer Representative at no cost to the Government.

1. Products: Subject to compliance with requirements, provide one of the following or equal approved by Contracting Officer Representative:

a.	"Emsac F 100"	Elkem Chemical, Inc.
b.	"Eucon MSA"	Euclid Chemical Co.
c.	"Force 10,000 D"	GCP Applied Technologies

J. Prohibited Admixtures: Calcium chloride, thyocyanates or admixtures containing more than 0.05 percent chloride ions are not permitted.

K. Certification: Written conformance to the above-mentioned requirements and the chloride ion content of admixtures will be required from the admixture manufacturer prior to mix design review by the Contracting Officer Representative.

L. Macro-Fibers: Engineered macro-synthetic fibers.

1. Products: Subject to compliance with requirements, provide one of the following or equal approved by Contracting Officer Representative:

a.	“Tuf-Strand SF”	Euclid Chemical Co.
b.	“Fibermesh 650”	Sika Chemical Co.
c.	“Strux 90/40”	GCP Applied Technologies
d.	“Forta-Ferro”	Forta

M. Micro-Fibers: Engineered micro-synthetic fibers.

1. Products: Subject to compliance with requirements, provide the following or equal approved by Contracting Officer Representative:

a.	"Fiberstrand 100 or F":	Euclid Chemical Co.
b.	"Fibermesh 150":	Sika Chemical Co
c.	“Ultra-Net”	Forta

N. Natural Fiber Reinforced Concrete: Natural fiber reinforced concrete is permitted only upon review by Contracting Officer Representative. Refer to ACI 544.1R, chapter 5

O. Corrosion Inhibitor: 30% calcium nitrite (where called for in the specifications or on the drawings). Subject to compliance with requirements, provide the following at 3 gal/cy:

1.	“Eucon CIA	Euclid Chemical Co.
2.	“DCI”	GCP Applied Technologies
3.	“MasterLife CI 30”	Master Builders Solutions

P. Contractor will be required to provide information demonstrating successful use in prior placement involving all admixtures.

2.4 GROUT

A. Non-Shrink, Non-Metallic Grout: The non-shrink grout shall be a factory pre-mixed grout and shall conform to ASTM C1107, "Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-Shrink)." In addition, the grout manufacturer shall furnish test data from an independent laboratory indicating that the grout when placed at a fluid consistency shall achieve 95% bearing under a 4' x 4' base plate.

1. Products: Subject to compliance with requirements, provide one of the following or equal approved by Contracting Officer Representative:

a.	"NS Grout"	Euclid Chemical Co.
b.	"Five Star Grout"	Five Star
c.	"Masterflow 713"	Sika Chemical Co.

B. High Flow Grout: Where high fluidity and/or increased placing time is required, use high flow grout. The factory pre-mixed grout shall conform to ASTM C1107, "Standard Specification for Packages Dry, Hydraulic-Cement Grout (Non-shrink)." In addition, the grout manufacturer shall furnish test data from an independent laboratory indicating that the grout when placed at a fluid consistency shall achieve 95% bearing under a 18" x 36" base plate.

1. Products: Subject to compliance with requirements, provide one of the following or equal approved by Contracting Officer Representative:

a.	"Hi-Flow Grout"	Euclid Chemical Co.
b.	"Masterflow 928"	Sika Chemical Co.
c.	“Five Star Fluid Grout 100”	Five Star

2.5 RELATED MATERIALS

A. Granular Fill: Clean mixture of crushed stone or crushed or uncrushed gravel; ASTM D 1241, Size 57, with 100 percent passing a 1-1/2inch sieve and 0 to 5 percent passing a No. 8 sieve.

B. Fine-Graded Granular Material: Clean mixture of crushed stone, crushed gravel, and manufactured or natural sand; ASTM D 1241, Size 10, with 100 percent passing a 3/8 inch sieve, 10 to 30 percent passing a No. 100 sieve, and at least 5 percent passing No. 200 sieve; complying with deleterious substance limits of ASTM C 33 for fine aggregates.

C. Non-slip Aggregate Finish: Provide fused aluminum oxide grits, or crushed emery, as abrasive aggregate for non-slip finish with emery aggregate containing not less than 40% aluminum oxide and not less than 25% ferric oxide. Use material that is factory-graded, packaged, rustproof and non-glazing, and is unaffected by freezing, moisture, and cleaning materials.

D. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz. per sq. yd., complying with AASHTO M 182, Class 2.

E. Moisture-Retaining Cover: One of the following, complying with ASTM C 171.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Waterproof paper
   b. Polyethylene film
   c. Polyethylene-coated burlap

F. Curing Compounds: The compound shall conform to ASTM C 309. Limit VOC content to 130 g/L. Use water-based curing compound. For surfaces receiving both a curing compound and additional flooring, verify that the curing compound and additional flooring are compatible.

1. Products: Subject to compliance with requirements, provide one of the following or equal approved by Contracting Officer Representative:

a.	“SealTight 1100”	W.R. Meadows
b.	“Kurez W VOX”	Euclid Chemical Co.

G. Curing & Sealing Compounds: Only specify for slabs that will remain exposed, i.e. will not receive additional flooring. The compound shall conform to ASTM C1315. Limit VOC content to 130 g/L. Use water-based curing compound.

1. Products: Subject to compliance with requirements, provide one of the following or equal approved by Contracting Officer Representative:

a.	“Super Diamond Clear VOX”	Euclid Chemical Co.
b.	“VOCOMP-25”	W.R. Meadows

H. Curing, Sealing, & Hardening Compounds: For use on concrete surfaces that will remain exposed. Slabs that will receive additional flooring do not require sealing or hardening. Sealers and hardeners must not yellow under ultra violet light after 500 hours of test in accordance with and have a maximum moisture loss of 0.039 grams per sq. cm. when applied at a coverage rate of 250 sq. ft. per gallon. Limit VOC content to 130 g/L. Use water- or vegetable-based product.

1. Products: Subject to compliance with requirements, provide one of the following or equal approved by Contracting Officer Representative:

   a. “Kure-N-Harden” BASF

I. For concrete floors subjected to heavy vehicular traffic use a Liquid Sealer/Densifier: The product must be a high performance, deeply penetrating concrete densifier conforming to ASTMC836; odorless, colorless, VOC - compliant, non-yellowing siliconate based solution designed to harden, dustproof and protect and to resist black rubber tire marks on concrete surfaces. The compound must contain a minimum of 20% solids content of which 50% is siliconate

J. Evaporation Retardant:

1. Products Subject to compliance with requirements, provide one of the following or equal approved by Contracting Officer Representative:

   a. "Eucobar" Euclid Chemical Co.
   b. "MasterKure ER 50" Master Builders Solutions

K. Certify that all curing compounds, sealers and hardeners are compatible with all adhesive products intended for attaching co-lateral floor material. In conformance with ASTM F 710, coordination with flooring manufacturer is required to insure concrete coatings will not obstruct the bond between the concrete and the adhesive. Insure coatings and adhesives are “benignly compatible” -- in other words, do not combine substances whose constituents are reactive. Reactivity releases VOCs and /or other toxic fumes.

L. Crack Sealer: Elastomeric liquid crack sealer resistant to water, gasoline, oil and salts.

1. Products: Subject to compliance with requirements, provide one of the following or equal approved by Contracting Officer Representative:

   a. "Eucolastic 1NS" Euclid Chemical Co.
   Maximum allowable depth of this product is ½”.

M. Underlayment Compound: Free flowing, self-leveling, pumpable cementitious base compound.

1. Products: Subject to compliance with requirements, provide the following or equal approved by Contracting Officer Representative:

   a. "EucoFloor SL 160" Euclid Chemical Co.
   b. "Ardex" Ardex Co.
   c. "MasterTop 110 SL" Sika Chemical Co.

N. Bonding Admixture: The compound shall be a latex, non-rewettable type.

1. Products: Subject to compliance with requirements, provide one of the following or equal approved by Contracting Officer Representative:

   a. "Flex-Con" Euclid Chemical Co.
   b. "SBR Latex" Euclid Chemical Co.

O. High Strength Polymer Repair Mortar: For form and pouring or large horizontal repairs, provide the flowable on-part, high strength repair mortar.

1. Products: subject to compliance with requirements, provide the following or equal approved by Contracting Officer Representative:

a. "Eucocrete or EucoRepair SCC" Euclid Chemical Co.
b. "Euco Speed MP" (Cold Weather) Euclid Chemical Co.
c. “Emaco R” Master Builders Solutions

P. Bonding Agent: ASTM C 1059/C 1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

a. “Daraweld C” GCP Applied Technologies
b. “Acrylic Bonding Agent J40” Dayton Superior
c. Eucoweld 2.0 Euclid Chemical Co.

Q. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:

1. Type IV for bonding hardened concrete to hardened concrete, and Type V for bonding freshly mixed concrete to hardened concrete.

R. Reglets: Fabricate reglets of not less than 0.022 inch thick, galvanized-steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

S. Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than 0.034 inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

T. Water: Potable.

2.6 PROPORTIONING AND DESIGN OF MIXES

A. Preparation of Design Mixes

1. All mix designs shall be proportioned in accordance with Section 26.4.3.1(b) of ACI 318 and prepared by a licensed testing laboratory approved by the Contracting Officer Representative but paid for by the contractor. Submit mix designs on each class of concrete for review.
2. If previously used mixes are submitted, all materials shall be from the same sources and with the same brand names as the previously utilized mix.
3. If trial batches are used, the mix design shall be prepared by an independent testing laboratory and shall achieve an average compressive strength 1200 psi higher than the specified strength. This over-design shall be increased to 1.10f’c+700 psi when concrete strengths greater than 5000 psi are used.
4. The proposed mix designs shall be accompanied by complete standard deviation analysis or trial mixture test data.

B. Submit each proposed mix to the Contracting Officer Representative for review at least 5 days prior to the pre-concrete conference. Do not begin concrete production until Contracting Officer Representative has reviewed and approved mixes.

1. Submit Test reports for any pozzolans or slags indicating compliance with ASTM C 618, ASTM C 989, or ASTM C1866 respectively.
2. Provide cut sheets clearly indicating the percentages of pozzolans or slags used in the mix design as replacement for Portland cement. Or, if cut sheets are not available, obtain a written affidavit from the manufacturer stating the percentage.
3. Test reports for recycled aggregate indicating compliance with ASTM C 33. Provide cut sheets clearly indicating the percentage of aggregates used that are recycled. Or, if cut

sheets are not available, obtain a written affidavit from the manufacturer stating the recycled content percentage and source or sources of the material.

4. Provide cut sheets clearly indicating the percentage of sub-base and filler aggregate materials that are recycled. Or, if cut sheets are not available, obtain a written affidavit from the manufacturer stating the recycled content percentage and source or sources of the material.

C. Design mixes to provide concrete with strength as indicated on drawings and schedules.

D. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant; at no additional cost to The Government and as accepted by the Contracting Officer Representative. Laboratory test data for revised mix design and strength results must be submitted to and accepted by the Contracting Officer Representative before using in work.

E. Admixtures:

1. Use water-reducing admixture or high range water-reducing admixture (superplasticizer) in all concrete as required for placement and workability.
2. Use non-corrosive, non-chloride accelerating admixture in concrete slabs placed at ambient temperatures below 50°F (10°C).
3. Use high-range water-reducing admixture in pumped concrete, architectural concrete, parking structure slabs, fiber concrete, concrete required to be watertight, concrete with ultimate strength of 5,000 psi or more, and concrete with water/cement ratios below 0.50.
4. Use air-entraining admixture in exterior exposed concrete, unless otherwise indicated. Exposure category for exterior concrete is F2. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having total air content with a tolerance of plus-or-minus 1-1/2 percent within following limits:

    a. Concrete structures and slabs exposed to freezing and thawing or deicer chemicals.
        1) 1-1/2” maximum aggregate: 4.5 percent (exposure class F1, moderate exposure); 5.5 percent (exposure class F2 and F3, severe exposure)
        2) 1” maximum aggregate: 4.5 percent (exposure class F1, moderate exposure); 6 percent (exposure class F2 and F3, severe exposure)
        3) ¾” maximum aggregate: 5 percent (exposure class F1, moderate exposure); 6 percent (exposure class F2 and F3, severe exposure)
        4) ½” maximum aggregate: 5.5 percent (exposure class F1, moderate exposure); 7 percent (exposure class F2 and F3, severe exposure)
        5) 3/8” maximum aggregate: 6 percent (exposure class F1, moderate exposure); 7.5 percent (exposure class F2 and F3, severe exposure)

5. Use admixtures for water-reducing and set-control in strict compliance with manufacturer's directions.

F. Water-Cement Ratio: Provide concrete for following conditions with maximum water-cement (W/C) ratios as follows:

1. Concrete for architecturally exposed structural elements or architecturally exposed surfaces: W/C 0.40.
2. All other concrete: no maximum W/C ratio.
3. Refer to the concrete mix design table in the structural drawings for other W/C ratio requirements based on exposure class, element type, etc.
4. Refer to the requirements for concrete by exposure class in ACI 318 for balance of info related to maximum W/C ratios, minimum f’c values, and additional requirements.

G. Slump Limits: Proportion and design mixes to result in concrete slump at point of placement as follows:

1. Ramp slabs and sloping surfaces: Not more than 3".
2. Reinforced foundation systems, including mud slabs below hydrostatic slabs: Not less than 1" and not more than 3".
3. Concrete containing HRWR admixture (superplasticizer): Not more than 9" unless otherwise approved by the Contracting Officer Representative.
4. Other Concrete: Not less than 1" or more than 4".

H. Chloride Ion Level: Chloride ion content shall be tested by the laboratory making the trial mixes. The total chloride ion content of the mix including all constituents shall not exceed the limitations set forth in Table 19.3.2.1 of ACI 318.

2.7 CONCRETE MIXING

A. Ready-Mix Concrete: Comply with requirements of ASTM C 94, and as herein specified.

B. Provide batch ticket for each batch discharged and used in work, indicating project identification name and number, date, mix type, mix time, quantity, and amount of water introduced.

C. During hot weather, or under conditions contributing to rapid setting of concrete, a shorter mixing time than specified in ASTM C 94 may be required. When air temperature is between 85°F (30°C) and 90°F (32°C), reduce maximum mixing and delivery time from 1-1/2 hours to 75 minutes, and when air temperature is above 90°F (32°C), reduce maximum mixing and delivery time to 60 minutes.

D. No water shall be added after mixing to concrete containing HRWR (Superplasticizer). If loss of slump occurs, the concrete treated with HRWR may be redosed as long as a "flash set" has not occurred. Redosage procedures must be discussed and approved by the Contracting Officer Representative and the manufacturer.

PART 3 - EXECUTION

3.1 GENERAL

A. Coordinate the installation of joint materials and vapor retarders with placement of forms and reinforcing steel.

3.2 INSPECTION

A. Examine all work prepared by others to receive work of this section and report any defects affecting installation to the Contractor for correction. Commencement of work will be construed as complete acceptance of preparatory work by others.

3.3 CONCRETE

A. Concrete shall develop the minimum compressive strengths shown on drawings at 28 days when sampled and tested in accordance with ASTM C 31 and C 39 with the maximum slump in accordance with the approved mix design.

B. Concrete shall be in accordance with the requirements and specifications of "Building Code Requirements for Structural Concrete" as modified by the building code noted above.

C. Fly Ash Concrete & Slag Concrete: Concrete mixes containing high volumes of fly ash or Slag have slower set times and may take up to 56 days to reach full strength. The Contractor must coordinate with the Contracting Officer Representative to ensure that the form stripping schedule is consistent with the ability of the structure to support itself and all imposed construction loads.

3.4 FORMS

A. Design formwork to maximize its reusability, reduce resources devoted to formwork construction and minimize waste generated. Where appropriate choose alternative formwork systems (refer to sections listed above). Reference Section 2.1.

B. Design, erect, support, brace and maintain formwork to support vertical and lateral, static, and dynamic loads that might be applied until such loads can be supported by concrete structure. Construct formwork so concrete members and structures are of correct size, shapes, alignment, elevation and position. Maintain formwork construction tolerances complying with ACI 347. Provide Class A tolerances for concrete exposed to view. Provide Class C tolerances for other concrete surfaces.

C. Design formwork to be readily removable without impact, shocks or damage to cast-in-place concrete surfaces and adjacent materials.

D. Construct forms to size shapes, lines and dimensions shown, and to obtain accurate alignment, location, grades, level and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required in work. Use selected materials to obtain required finishes. Solidly butt joints and provide back- up at joints to prevent leakage of cement paste.

E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, recesses, and the like, to prevent swelling and for easy removal.

F. Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete. Securely brace temporary openings and set tightly to forms to prevent loss of concrete mortar. Locate temporary openings on forms at inconspicuous locations.

G. Chamfer exposed corners and edges as indicated, using wood, metal, PVC or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.

H. Provisions for Other Trades: Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses and chases from trades providing such items. Accurately place and securely support items built into forms.

I. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt or other debris just before concrete is placed. Retightening forms and bracing after concrete placement is required to eliminate mortar leaks and maintain proper alignment.

3.5 PLACING REINFORCEMENT

A. Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars", for details and methods of reinforcement placement and supports, and as herein specified.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials, which reduce or destroy bond with concrete.

C. Accurately position, support and secure reinforcement against displacement by formwork, construction, or concrete placement operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as required.

D. Place reinforcement to obtain at least minimum coverage's for concrete protection. Arrange, space and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.

E. Splices: Lap splices as indicated on Drawings.

1. Bars indicated to be continuous, and all vertical bars shall be lapped not less than values indicated in the contract documents.
2. Stagger splices in accordance with ACI 318/ACI 318M
3. Mechanical Splice Couplers: Install in accordance with manufacturer's instructions.
4. Weld reinforcing bars in accordance with AWS D1.4/D 1.4M, where indicated on Drawings.

F. Install welded-wire reinforcement in longest practicable lengths.

1. Support welded-wire reinforcement in accordance with CRSI "Manual of Standard Practice."
2. Lap edges and ends of adjoining sheets at least one wire spacing plus 2 inches (50 mm) for plain wire and 8 inches (200 mm) for deformed wire.
3. Offset laps of adjoining sheet widths to prevent continuous laps in either direction.
4. Lace overlaps with wire.

G. Micro-Fibers: All concrete where indicated on the drawings shall contain the specified micro-fibers. Length shall be per the manufacturer’s specification. The dosage rate shall be 1.0 – 1.6 lbs per cubic yard per the manufacturer’s specification. Submit proposed dosage rate to Contracting Officer Representative for review prior to concrete placement.

H. Macro-Fibers: All concrete where indicated on the drawings shall contain the specified macro-fibers. Length shall be per the manufacturer’s specification. The dosage rate shall be 3.0 – 5.0 lbs per cubic yard per the manufacturer’s specification. Submit proposed dosage rate to Contracting Officer Representative for review prior to concrete placement.

I. Epoxy-coated reinforcing bars supported from formwork shall rest on coated wire bar supports. Reinforcing bars used as support bars shall be epoxy-coated. In walls having epoxy-coated reinforcing bars, spreader bars where specified by the Contracting Officer Representative, shall be epoxy-coated. Proprietary combination bar clips and spreaders used in walls with epoxy-coated reinforcing bars shall be made of corrosion-resistant material.

J. Epoxy-coated reinforcing bars shall be fastened with nylon- , epoxy- , or plastic-coated tie wire, or other acceptable materials.

K. Repair of damaged epoxy-coating: When required, damaged epoxy-coating shall be repaired with patching material conforming to ASTM A775. Repair shall be done in accordance with the patching material manufacturer's recommendations.

L. Unless permitted by the Contracting Officer Representative, epoxy-coated reinforcing bars shall not be cut in the field. When epoxy-coated reinforcing bars are cut in the field, the ends of the bars shall be coated with the same material used for repair of coating damage.

3.6 JOINTS

A. Construction Joints:

1. Construct joints true to line with faces perpendicular to surface plane of concrete.
2. Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Contracting Officer Representative.
3. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, except as otherwise indicated.
4. Provide keyways at least 1-1/2" deep in construction joints in walls, slabs and between walls and footings; accepted bulkheads designed for this purpose may be used for slabs.
5. Locate joints for beams, slabs, joists, and girders in the middle third of spans.

    a. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.

6. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
7. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.

B. Isolation Joints in Slabs-on-Ground: Construct isolation joints in slabs-on-ground at points of contact between slabs-on-ground and vertical surfaces, such as column pedestals and elsewhere as indicated.

1. Joint filler and sealant materials are specified in the section for "Related Materials"

C. Contraction (Control) Joints in Slabs-on-Ground: Maximum joint spacing shall be 36 times the slab thickness unless otherwise noted on the drawings. The dry cut saw shall be used immediately after final finishing and to a depth of 1-1/2". A conventional saw shall be used as soon as possible without dislodging aggregate and to a depth of 1/4 slab thickness.

1. Joint sealant material is specified in the section for "Related Materials".

3.7 INSTALLATION TOLERANCES

A. Comply with ACI 117/ACI 117M.

3.8 INSTALLATION OF EMBEDDED ITEMS

A. General: Set and build into work anchorage devices and other embedded items required for other work that is attached to, or supported by, cast-in-place concrete. Use setting drawings, diagrams, instructions and directions provided by suppliers of items to be attached thereto.

B. Edge Forms and Screed Strips for Slabs: Set edge forms or bulkheads and intermediate screed strips for slabs to obtain required elevations and contours in finished slab surface. Provide and secure units sufficiently strong to support types of screed strips by use of strike-off templates or accepted compacting type screeds.

C. Embedded Plates at Foundation Walls: Install plate at top of forms so that exterior face of steel plate is level and plumb. Use construction documents for locations, sizes and elevations.

3.9 PREPARATION OF FORM SURFACES

A. Clean re-used forms of concrete matrix residue, repair and patch as required to return forms to acceptable surface condition.

B. If form-release compound is required, coat contact surfaces of forms with a form-coating compound *before* reinforcement is placed.

C. Thin form-coating compounds only with thinning agent of type, and amount, and under conditions of form-coating compound manufacturer's directions. Do not allow excess form-coating material to accumulate in forms or to come into contact with in- place concrete surfaces against which fresh concrete will be placed. Apply in compliance with manufacturer's instructions.

D. Coat steel forms with a non-staining, rust-preventative form oil or otherwise protect against rusting. Rust-stained steel formwork is not acceptable.

3.10 CONCRETE PLACEMENT

A. Ready-mix concrete shall comply with the requirements of ASTM C 94 and ACI 304. All plant and transporting equipment shall comply with the concrete plant standards and truck mixer and agitator standards of the National Ready Mix Concrete Association.

B. Cold weather mixing procedures shall be submitted to the Contracting Officer Representative for approval.

C. Placement of structural concrete with a least dimension greater than or equal to 4 feet shall be considered “mass concrete” per ACI definition. Contractor shall adhere to mass concrete procedures and recommendations of ACI 301 and ACI 211.

D. Notify the Contracting Officer Representative at least 36 hours (1 1/2 regular working days) before each pour so that forms and reinforcing may be examined. Do not place concrete until inspection has been made or waived.

E. Preplacement Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast-in. Notify other crafts to permit installation of their work; cooperate with other trades in setting such work. Moisten wood forms immediately before placing concrete where form coatings are not used.

1. Apply temporary protective covering to lower 2' of finished walls adjacent to poured floor slabs and similar conditions, and guard against spattering during placement.

F. General: Comply with ACI 304 “Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete,” and as herein specified.

1. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause the formation of seams or planes of

weakness. If a section cannot be placed continuously, provide construction joints as herein specified. Deposit concrete as nearly as practicable to its final location to avoid segregation.

G. Placing Concrete in Forms: Deposit concrete in forms in horizontal layers not deeper than 18" and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints. Use internal vibrators penetrating both the top and preceding layers.

H. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding or tamping. Use equipment and procedures for consolidation of concrete in accordance with ACI recommended practices.

I. Use and type of vibrators shall conform to ACI 309 “Recommended Practice for Consolidation of Concrete.” Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than visible effectiveness of machine. Place vibrators to rapidly penetrate placed layer and at least 6" into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of mix.

J. Placing Concrete Slabs:

1. Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until the placing of a panel or section is completed.
2. Per ACI 318, beams, girders, or slabs supported by columns or walls shall not be cast or erected until concrete in the vertical support members is no longer plastic.

K. Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.

L. Slabs: Bring slab surfaces to correct level with straightedge and strikeoff. Use highway straightedge, bull floats or darbies to smooth surface free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations. See also "MONOLITHIC SLAB FINISHES" below.

M. Maintain reinforcing in proper position during concrete placement operations.

N. Cold Weather Placing: Protect concrete work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperatures, in compliance with ACI 306 and as herein specified.

1. When air temperature has fallen to or is expected to fall below 40°F (4°C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50°F (10°C), and not more than 80°F (27°C) at point of placement.
2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. Use only a non-corrosive, non-chloride accelerator. Calcium chloride, thiocyanates or admixtures containing more than 0.05% chloride ions are NOT permitted.
4. Care must be taken to store water-based curing and sealing compounds where they will not freeze. In most cases, they cannot be reconstituted after thawing.

O. Hot Weather Placing: When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.

1. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90°F (32°C). Mixing water may be chilled, or chopped ice may be used to control temperature provided water equivalent of ice is calculated to total amount of mixing water. Use of liquid nitrogen to cool concrete is Contractor's option.
2. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.
3. Fog spray forms, reinforcing steel and subgrade just before concrete is placed.

3.11 FINISH OF FORMED SURFACES

A. Concrete mixes containing pozzolans or slags do not set at the same rate or with the same bleed water characteristic as plain Portland cement. Therefore attention must be directed to the proper procedures. Refer to ACI 232.2R and ACI 301.

B. Rough Form Finish: For formed concrete surface not exposed-to- view in the finish work or by other construction, unless otherwise indicated. This is the concrete surface having texture imparted by form facing material used, with tie holes and defective areas repaired and patched and fins and other projections exceeding 1/4" in height rubbed down or chipped off.

C. Smooth Form Finish: For formed concrete surfaces exposed-to-view, or that are to be covered with a coating material applied directly to concrete, or a covering material applied directly to concrete, such as waterproofing, damp-proofing, painting or other similar system. This is as-cast concrete surface obtained with selected form facing material, arranged orderly and symmetrically with a minimum of seams. Repair and patch defective areas with fins or other projections completely removed and smoothed. Follow all requirements in ACI 301, Chapter 10 for smooth form finish. Surface preparation for surfaces receiving waterproofing must be approved by the waterproofing manufacturer prior to construction.

3.12 MONOLITHIC SLAB FINISHES

A. Float Finish: Apply float finish to slabs at crawl spaces, unless otherwise noted. After screeding, consolidating, and leveling concrete slabs, do not work surface until ready for floating. Begin floating when surface water has disappeared or when concrete has stiffened sufficiently to permit operation of power-driven floats, or both. Consolidate surface with power-driven floats, or by hand-floating if area is small or inaccessible to power units. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth, granular texture. Surface shall achieve an FF 20 - FL 17 tolerance.

B. Trowel Finish: Apply trowel finish to monolithic slab surfaces to be exposed-to-view, and slab surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile, paint, or other thin film finish coating system, unless otherwise noted. After floating, begin first trowel finish operation using a power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over surface. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance and with a surface leveled to an FF 25/ FL 20 tolerance (FL17 for elevated slabs). Grind smooth surface defects, which would telegraph through applied floor covering system.

C. Trowel and Fine Broom Finish: Where ceramic or quarry tile is to be installed with thin-set mortar, and slab surfaces which are to be covered with membrane or elastic waterproofing, or sand-bed terrazzo, and as otherwise indicated, apply single trowel finish as specified, then immediately follow with slightly scarifying surface by fine brooming. Surface preparation for surfaces receiving waterproofing must be approved by the waterproofing manufacturer prior to construction

D. Sealers, Hardeners and Liquid Densifiers: Apply a coat of the specified compound to all EXPOSED interior concrete floors where indicated on the drawings. This surface must be continuously moist cured by a method satisfactory to the Contracting Officer Representative. Apply and mechanically scrub compound into the floor in strict accordance with the manufacturer's printed instructions.

3.13 CONCRETE CURING AND PROTECTION

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

1. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Weather permitting, keep continuously moist for not less than 7 days.
2. Begin final curing procedures immediately following initial curing and before concrete has dried. Continue final curing for at least 7 days in accordance with ACI 301 procedures. Avoid rapid drying at end of final curing period.
3. In order to avoid plastic or drying shrinkage cracks during warm, dry or windy weather, ACI 302 and ACI 308 shall be followed using wind breaks and sun shades when recommended.
4. Care must be taken to store water based curing and sealing compounds where they will not freeze. In most cases, they cannot be reconstituted after thawing.

B. Curing Methods: Perform curing of concrete by moisture curing, moisture-retaining cover curing, curing and sealing compound, and by combinations thereof, as herein specified.

1. Provide moisture curing by following methods.

    a. Keep concrete surface continuously wet by covering with water.
    b. Continuous water-fog spray.
    c. Covering concrete surface with specified absorptive cover, thoroughly saturating cover with water and keeping continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with 4" lap over adjacent absorptive covers.

2. Provide moisture-retaining cover curing as follows:

    a. Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3" and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

3. Provide curing and sealing compound to exposed interior slabs not receiving additional flooring. A clear curing and sealing compound shall be used on exterior slabs, sidewalks and curbs not receiving a penetrating sealer.
4. Use the specified curing compound on surfaces to be covered with finish or coating material applied directly to concrete, such as liquid densifier/sealer, waterproofing, dampproofing, membrane roofing, flooring, painting, and other coatings and finish materials. Apply compound in accordance with manufacturer’s direction.

C. Curing Formed Surfaces: Cure formed concrete surfaces, including undersides of beams, supported slabs and other similar surfaces by moist curing with forms in place for full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.

D. Curing Unformed Surfaces: Cure unformed surfaces, such as slabs, floor topping, and other flat surfaces by application of the specified curing compound or a continuous moist curing method approved by the Contracting Officer Representative.

E. Certify that all curing compounds, sealers and hardeners are compatible with all adhesive products intended for attaching co-lateral floor material. In conformance with ASTM F710, coordination with flooring manufacturer is required to insure concrete coatings will not obstruct the bond between the concrete and the adhesive. In addition, insure coatings and adhesives are “benignly compatible” -- in other words, do not combine substances whose constituents are reactive.

F. Sealer and Dustproofer: Apply a second coat of the specified curing and sealing compound to exposed interior slabs not subjected to vehicular traffic, noted on the drawings. These slabs must have received an initial coat of the curing and sealing compound.

3.14 SHORES AND SUPPORTS

A. Comply with ACI 347 for shoring and reshoring in multistory construction, and as herein specified.

B. Extend shoring from ground to roof for structures 4 stories or less, unless otherwise permitted.

C. Extend shoring generally at least 4 floors under floor or roof being placed for structures over 5 stories. Shore floor directly under floor or roof being placed, so that loads from construction above will transfer directly to these shores. Space shoring in stories below this levels in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members where no reinforcing steel is provided. Extend shores beyond minimums to ensure proper distribution of loads throughout structure. Contractor shall provide the services of a registered Professional Engineer to design the shoring, and determine timing of removal.

D. Remove shores and reshore in a planned sequence to avoid damage to partially cured concrete. Locate and provide adequate reshoring to safely support work without excessive stress or deflection.

E. Keep reshores in place a minimum of 15 days after placing upper tier, and longer if required, until concrete has attained its required 28-day strength and heavy loads due to construction operations have been removed.

3.15 REMOVAL OF FORMS

A. Formwork not supporting weight of concrete, such as sides of beams, walls, columns, and similar parts of the work, may be removed after cumulatively curing at not less than 50°F (10°C) for 12 hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form removal operations, and provided curing and protection operations are maintained.

B. For formwork supporting weight of concrete, such as beam soffits, joints, slabs and other structural elements, comply with ACI 347 recommendations for various element types. Determine compressive strength of in-place concrete by testing field-cured specimens representative of concrete location or members.

C. Form facing material may be removed 4 days after placement, only if shores and other vertical supports have been arranged to permit removal of form facing material without loosening or disturbing shores and supports.

3.16 RE-USE OF FORMS

A. Clean and repair surfaces of forms to be re-used in work. Split, frayed, delaminated or otherwise damaged form facing material will not be acceptable for exposed surfaces. Apply new form coating compound as specified for new formwork.

B. When forms are intended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close joints. Align and secure joint to avoid offsets. Do not use "patched" forms for exposed concrete surfaces, except as acceptable to Contracting Officer Representative.

3.17 MISCELLANEOUS CONCRETE ITEMS

A. Filling-In: Fill-in holes and openings left in concrete structures for passage of work by other trades, unless otherwise shown or directed, after work of other trades is in place. Mix, place and cure concrete as herein specified, to blend with in- place construction. Provide other miscellaneous concrete filling shown or required to complete work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and steel-troweling surfaces to a hard, dense finish with corners, intersections and terminations slightly rounded.

C. Grout base plates and foundations as indicated using specified free-flowing non-shrink grout. Use non-metallic grout for exposed conditions, unless otherwise indicated.

D. Where high fluidity and/or increased placing time is required use the specified high flow grout. This grout shall be used for all base plates larger than 10 square feet.

3.18 CONCRETE SURFACE REPAIRS

A. Prior to all repairs, an as-built condition sketch and method of repair must be submitted to the Contracting Officer Representative for review and approval.

B. Patching Defective Areas: Repair and patch defective areas with cement mortar immediately after removal of forms, when acceptable to Contracting Officer Representative.

C. Cut out honeycomb, rock pockets, voids over 1/4" in any dimension, and holes left by tie rods and bolts, down to solid concrete but, in no case to a depth of less than 1". Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water, and brush-coat the area to be patched with a bonding grout containing the specified bonding admixture. Place patching mortar after while bonding grout is still tacky.

D. For exposed-to-view surfaces, blend white Portland cement and standard Portland cement so that, when dry, patching mortar will match color surrounding. Provide test areas at inconspicuous location to verify mixture and color match before proceeding with patching. Compact mortar in place and strike-off slightly higher than surrounding surface.

E. Repair of Formed Surfaces: Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of Contracting Officer Representative. Surface defects, as such, include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets; fins and other projections on surface; and stains and other discoloration's that cannot be removed by cleaning. Flush out form tie holes, fill with dry pack mortar, or pre-cast cement cone plugs secured in place with bonding agent.

F. Repair concealed formed surfaces, where possible, that contain defects that affect the durability of concrete. If defects cannot be repaired, remove and replace concrete.

G. Repair of Unformed Surfaces: Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface plane to tolerances specified for each surface and finish. Correct low and high areas as herein specified. Test unformed surfaces sloped to drain for tureens of slope, in addition to smoothness, using a template having required slope.

H. Repair finished unformed surfaces that contain defects, which affect durability of concrete. Surface defects, as such, include crazing, cracks in excess of 0.01" wide or which penetrate to reinforcement or completely through non-reinforced sections regardless of width, spalling, pop-outs, honeycomb, rock pockets, and other objectionable conditions.

I. Correct high areas in unformed surfaces by grinding, after concrete has cured at least 14 days, except at hydrostatic slabs.

J. Correct low areas in unformed surfaces during or immediately after completion of surface finishing operations by cutting out low areas and replacing with fresh concrete. Finish repaired areas to blend into adjacent concrete. The specified underlayment compound or repair toping may be used when acceptable to Contracting Officer Representative.

K. Repair defective areas, except random cracks and single holes not exceeding 1" diameter, by cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with clean, square cuts and expose reinforcing steel with at least 3/4" clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding compound. Mix patching concrete of same materials to provide concrete of same type or class as original concrete. Place, compact and finish to blend with adjacent finished concrete. Cure in the same manner as adjacent concrete.

L. Repair isolated random cracks and single holes not over 1" in diameter by dry-pack method. Groove top of cracks and cutout holes to sound concrete and clean of dust, dirt and loose particles. Dampen cleaned concrete surfaces and apply bonding compound. Mix dry-pack, consisting of one part Portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing. Place dry-pack after bonding compound has dried. Compact dry-pack mixture in place and finish to match adjacent concrete. Keep patched area continuously moist for not less than 72 hours.

M. Structural Repair: All structural repairs shall be made with prior approval of the Contracting Officer Representative as to method and procedure, using the specified polymer repair mortar and/or specified epoxy adhesive. Where epoxy injection procedures must be used, an approved low viscosity epoxy made by the manufacturers previously specified shall be used. In addition, all cracks shall be filled with the specified crack sealer or other method as approved by the Contracting Officer Representative. All garage slabs shall be repaired prior to the slab being treated with the specified penetrating anti-spalling sealer.

N. Underlayment Application: Leveling of floors for subsequent finishes may be achieved by use of specified underlayment material. Underlayment application shall achieve the tolerances specified in "MONOLITHIC SLAB FINISHES" above.

O. Specified Polymer Horizontal Repair Mortar: All exposed floors shall be leveled, where required, with the specified self-leveling repair topping.

P. Repair Methods not specified above may be used, subject to acceptance of Contracting Officer Representative.

3.19 WORK IN CONNECTION WITH OTHER TRADES AND CONTRACTS

A. Sleeves, pockets, openings, etc., shall be set in the concrete walls as shown on approved shop drawings; these shall be encased or built into the concrete work and shall be properly placed and secured in position in the forms before concrete is placed.

3.20 CUTTING AND PATCHING

A. Contractor for concrete work shall be responsible for all cutting, removing and patching work where concrete surfaces are not installed within the limits shown on the drawings or specified herein. All such work shall meet with the approval of the Contracting Officer Representative.

B. Where cutting and patching is required to accommodate the work of other subcontractors, such cutting shall be done at the expense of said subcontractors but shall be performed by the contractor for concrete work.

C. The location and extent of cutting in completed concrete work and the patching thereof shall meet with the approval of the Contracting Officer Representative.

3.21 QUALITY CONTROL TESTING DURING CONSTRUCTION

A. The Contractor will employ a testing laboratory to perform tests and to submit test reports.

B. Provide special inspections per the applicable Building Code and the requirements of all applicable ACI standards.

C. At locations previously indicated in this specification and on the contract drawings, verify the use of non-magnetic materials. No magnetic materials are permitted in locations where prohibited by this specification or the contract drawings.

D. Sampling and testing for quality control during placement of concrete may include the following, as directed by Contracting Officer Representative.

1. Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94.
2. Slump: ASTM C 143; one test at point of discharge for each truck; additional tests when concrete consistency seems to have changed.
3. Air Content: ASTM C 173, volumetric method for normal weight concrete; ASTM C 231 pressure method for normal weight concrete; one for each truck of air-entrained concrete.
4. Concrete Temperature: Test hourly when air temperature is 40°F (4°C) and below, and when 80°F (27°C) and above; and each time a set of compression test specimens made.
5. Compression Test Specimen: ASTM C 31; one set of 5 standard cylinders for each compressive strength test, unless otherwise directed. Mold and store cylinders for laboratory cured test specimens except when field-cure test specimens are required.
6. Compressive Strength Tests: ASTM C 39; one set for each day's pour exceeding 25 cu. yds. plus additional sets for each 50 cu. yds. over and above the first 25 cu. yds. of each concrete class placed in any one day; one specimens tested at 7 days, three specimens tested at 28 days, and one specimens retained in reserve for later testing if required.

    a. When frequency of testing will provide less than 5 strength tests for a given class of concrete, conduct testing from at least 5 randomly selected batches or from each batch if fewer than 5 are used.

b. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.
c. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength, and no individual strength test result falls below specified compressive strength by more than 500 psi.

7. Water Cementitious Ratio Test: Check water content of concrete in accordance with AASHTO T 318 “Standard Method of Test for Water Content of Freshly Mixed Concrete Using Microwave Oven Drying”. Frequency of this test shall be the same as that of compressive strength tests, noted above.
8. Test results will be reported in writing to the Contracting Officer Representative 24 hours after tests. Reports of compressive strength tests shall contain the project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials; compressive breaking strength and type of break for both 7-day tests and 28-day tests.

   a. Non Compliance: All test reports indicating non-compliance shall be faxed immediately to all parties on the test report distribution list and the hard copies submitted on different colored paper.
   b. Nondestructive Testing: Windsor probes, sonoscope, or other non-destructive device may be permitted but shall not be used as the sole basis for acceptance or rejection.

9. Additional Tests: The testing service will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by Contracting Officer Representative. Testing service may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed. Contractor shall pay for such tests when unacceptable concrete is verified.

3.22 MANAGEMENT

A. Separate and recycle waste materials to the maximum extent feasible.

B. Collect cut off steel and discarded reinforcement steel and place in area for recycling.

C. Place materials defined as hazardous or toxic waste in designated containers.

D. Use trigger operated spray nozzles for water hoses and closed loop system to reduce water consumption.

E. Reusable forms should be cleaned immediately after removal and non-reusable forms recycled to the maximum extent economically feasible.

F. Incorporate crushed concrete or masonry materials in sub-base to the maximum extent feasible in accordance with sub-base specifications.

G. Before concrete pours, designate location or uses for excess concrete. Options include:

1. Additional paving
2. Post footing anchorage

3. Landscaping -- site concrete features
4. Flowable fill

H. To avoid contamination of the local landscape, before concrete pours, designate a location for cleaning out concrete trucks where run-off can be contained, reused or incorporated. Options include:

1. Company owned site for that purpose
2. On-site area to be paved later in project

END OF SECTION

DIVISION 05

Metals

SECTION 05 12 00
STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes but is not limited to the following as shown on the drawings and as specified herein:

1. Furnish and deliver for installation by others, anchor bolts and bearing plates with complete instructions and templates to facilitate installation.
2. Furnish and erect all struts, bearing plates, beams, girders, bracing, and all related connections (bolted and welded).
3. Shop painting and field touch-up painting.
4. Erection bracing and supports, including steel wedges, shims or nuts required for leveling base plates.
5. Unless specifically excluded, furnish and install all other items for structural steel work indicated on the drawings, specified, or obviously needed to make the work of this Section complete.
6. Waste Management

1.2 RELATED REQUIREMENTS

A. Section 02 41 13 Selective Site Demolition
B. Section 03 30 00 Cast-In-Place Concrete
C. Section 31 63 33 Drilled Micropiles
D. Section 31 66 13 Helical Piles and Helical Anchors
E. Section 32 34 00 Prefabricated Boardwalks

1.3 SUSTAINABLE DESIGN REQUIREMENTS

A. The Contractor is to implement practices and procedures to meet the Project's Sustainable Design goals as applicable. The Contractor shall ensure that the requirements related to these goals, as defined in this Section and in Related Sections of the Contract Documents, are implemented. Substitutions, or other changes to the Work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the Project's Sustainable Design goals.

B. The Contractor is to efficiently use resources and energy while executing the Work of this Section. Resource efficient aspects to be considered in completing this Project include the use of techniques that minimize waste generation, reuse of construction materials on site where possible, and recycling of waste generated during the construction process.

C. Performance Requirements: The following criteria are required for the products included in this section

1. Preference shall be given to materials within 500 miles of the project site, and those steel components originating from mills/fabricators located nearest to the building site.

2. All steel shall contain a minimum of 50% (combined) pre-consumer/post-consumer recycled content.
3. Adhesives, sealants, paints and coatings used for the work of this section shall meet the Volatile Organic Compound (VOC) limits where applicable.
4. Maximize the re-use of salvaged steel (as approved by the Contracting Officer Representative) and, for work on existing buildings, alert the Contracting Officer Representative to any existing steel which could be re-used but has not been indicated on the drawings.
5. Maximize the recycled content of all steel products.
6. Design details penetrating the façade strictly in accordance with the architectural and structural directives.
7. Where possible all connections should be made using bolted as opposed to welded details.
8. Where welding is required use Submerged Arc Welding (SAW). The Gas Metal Arc Welding (GMAW) shall be used where SAW is not applicable (such as for angled connections and anything irregular or short). Field welding shall be allowed only in special circumstances; in such cases Flux Core Arc welding (FCAW) shall be specified with the use of portable fume exhaust system.
9. Use surface preparation techniques that minimize the use of halogenated solvents and solvents classified as volatile organic compounds.
10. Use high strength HSS round tubes instead of A36 Steel pipes with approval of the Contracting Officer Representative.

1.4 DEFINITIONS

A. Structural Steel: Elements of structural-steel frame, as classified by AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

1.5 PERFORMANCE REQUIREMENTS

A. Connections: Provide details of all connections required by the drawings to be completed by structural steel fabricator (including comprehensive engineering analysis by a qualified professional engineer) to withstand loads indicated and comply with other information and restrictions indicated, unless noted otherwise.

1. Select and complete connections using schematic details indicated and AISC 360.
2. Use design method indicated on structural drawings.
3. Moment Connections: Fully restrained unless otherwise noted on drawings.

B. Lateral Force Resisting System: Type used is indicated on structural drawings.

1.6 SUBMITTALS

A. Product Data: Submit data for each type of product indicated in the contract documents.

B. Shop Drawings: Submit shop drawings in accordance with the specifications as follows:

1. Show clearly all work, including relationship of structural steel to the adjacent work of other trades and to significant lines of finishes of other trades.
2. Do not fabricate or deliver work to the site before drawings reviewed by the Contracting Officer Representative have been returned.

3. Before preparing steel shop drawings, submit proposed submittal schedule for review by Contracting Officer Representative.
4. Before preparing steel shop drawings, submit for review a set of job standards showing all necessary joint details with full particulars of connection pieces, shop and field welds, and holes for erection bolts and permanent bolts. These shall include any moment and shear connections. Appropriate marks for designating all types and sizes of joint details shall be included. After approval of these job standards, the erection plans are to be submitted and shall be marked to indicate unmistakably the type and size of joint to be used for every beam connection. Do not order steel in advance of approval of the job standards and the erection plans with joint marks, except at own risk
5. Submit calculations for design of connections on job standards and all other connections such as moment and brace frames. Calculations shall be signed and sealed by a Professional Engineer licensed in the state in which the project is located.
6. Prepare remainder of steel shop drawings after approval of job standards and erection plans. Drawings submitted prior to approval of job standards will be returned without review.
7. Prepare shop drawings in conformance with the applicable procedures shown in "*Detailing for Steel Construction*," latest edition, published by AISC. Prepare shop drawings under the supervision of competent engineering personnel, licensed by the state in which the construction is to take place. During the preparation of shop drawings, and prior to submittal, coordinate and cross check all shop drawings, including those prepared by subcontractors, for compliance with the Contract Documents.
8. Indicate clearly the size and grade of steel for each component. Identify rolled shapes, tubes and plates by using the standard designations used in "Steel Construction Manual" Latest Edition, by AISC.
9. Indicate welds and nondestructive tests by using the symbols conforming to AWS A2.4 "Symbols for Welding and Nondestructive Testing." Where necessary for clarity, indicate welding procedure designations or other data in the tail of the welding symbol.
10. Show explicitly the type of connection used in each location, including the grade, size, and number of bolts; the type, number, position, designation and orientation of each washer; and the size of each hole, whether slotted or round. Ensure that adequate wrench clearance for correct bolt tightening is provided and note special bolt tightening sequences where applicable and necessary.
11. Show all camber dimensions in the shop drawings. Where specific camber is not shown in the drawings, note on each affected shop drawing that such members are to be fabricated with the natural camber up.
12. Show holes required for securing work specified in other sections to structural steelwork, as well as all holes required for passage through structural steelwork of work of other trades. Provide field work drawings for all such holes not shown in shop or erection drawings. Addition of, or change in size or location of openings will not be permitted without prior approval.
13. Use bolted connections wherever possible; avoid field welding unless otherwise noted on drawings.
14. Make details in such a way as to avoid having steel, connections, bracing, bolts, etc., interfere with architectural details or in any way reduce the areas of shafts, openings, clearances, etc.
15. Detail and schedule cleaning and painting data and requirements, including specific indication of "no-paint" areas.
16. The use of the electronic drawing files as a base for the erection shop drawings will be permitted at the request of the structural steel detailer upon completion and return of the waiver form. The use of the electronic drawing files as a base for shop drawing details will not be permitted. The structural steel detailer will be responsible for compatibility of the files with his hardware or software. The electronic files are not to be considered the contract documents, the design team makes no representation regarding the accuracy or

completeness of the electronic files given to the structural steel detailer and their use will be at the structural steel detailer's sole risk and without liability to the design team. The structural steel detailer shall remove the project title box and all references to the structural drawings including drawing numbers and structural drawing sections and details. The structural steel detailer shall also remove all reference to work not included in the steel contract.

17. Scaling of the drawings is not permitted. This applies to hard paper, electronic, and all other versions.
18. Show clearly the size and location of each member and the erection mark assigned to each member. Show each field connection with all data and details necessary for assembling the structure. Direct special attention to the possible need for special guying, bracing, or shoring to prevent deformation of existing or new structure due to stresses caused by erection procedures and equipment, by construction loadings, and by forces of natural phenomena.
19. Prepare, keep up-to-date, and submit a complete drawing index cross-referencing each assigned piece mark with the drawing number in which the piece is detailed. Detail drawings submitted without an up-to-date index and the applicable erection drawing(s) showing the location of each piece will be deemed an incomplete submission and will not be accepted as subject to any agreed shop drawing review schedule.
20. Prepare anchor bolt and base plate erection drawings containing complete location and placing details, including details of all templates. Provide anchor bolt erection drawings to the concrete trade in advance of applicable concrete work and in coordination with concrete construction sequence.
21. Submit, in writing, any proposed deviations from the Contract Documents, prior to the submission of shop drawings showing the proposed deviation. Submit requests for deviations on the steelwork subcontractor's letterhead. Deviations not identified, or identified only in letters of transmittal or in shop drawings or both, without the required written request, may not be accepted, and shall be sufficient cause for the Contracting Officer Representative to return each shop drawing containing such deviations without further action. Acceptance of shop drawings containing deviations not detected by the Contracting Officer Representative during shop drawing review shall not relieve the steelwork subcontractor from responsibility to conform strictly to the Contract Documents.
22. Prior to resubmission of shop drawings with additions or corrections, circle or bubble and identify all changes. Drawings submitted without each change being clearly identified are subject to return for resubmission.
23. Prior to making shop drawings for any portion of the work involving alterations to an existing structure, make all necessary field observations, measurements and surveys of existing conditions. If probes are required to accomplish such measurements, give timely notice where probes will be required.

C. Submit certified copies of each survey conducted by a surveyor licensed by the state in which the construction is to take place and employed by the structural steel subcontractor. Survey shall show elevations and locations of base plates and anchor bolts to receive structural steel, and final elevations and locations for major members. Indicate discrepancies between actual installation and Contract Documents.

D. Reports:

1. Submit certified copies of mill test reports for all steel furnished. Perform mechanical and chemical tests for all material regardless of thickness or use.
2. Submit certification of recycled steel content. Certification shall clearly indicate post-consumer AND post-industrial recycled steel content for the particular member or members used.
3. Submit anchor bolt checking certification as required.

4. Submit qualification certificates of all welders who will perform work on the project.
5. Submit survey of erected steelwork as required.

E. Submit verification of bio-degradable or low VOC, and low Hazardous Air Pollutants (HAPS) cleaning solutions. Provide a cut sheet for all cleaning solutions used in the surface preparation of steel components. Highlight VOC limits and chemical component limits.

1.7 QUALITY ASSURANCE

A. Except as modified by this specification, comply with the applicable provisions and recommendations of the following codes and standards:

1. 2024 International Building Code.
2. AISC "Specification for the Design, Fabrication and Erection of Structural Steel for Buildings".
3. AISC "Code of Standard Practice for Steel Buildings and Bridges" latest edition.
4. AISC “Seismic Provisions for Structural Steel Buildings”, latest edition.
5. Industrial Fasteners Institute "Handbook of Bolt and Bolted Joints" latest edition.
6. RCSC "Specifications for Structural Joints Using High-Strength Bolts."
7. ASTM Standards as applicable in the building code of the local jurisdiction and as noted in this specification.
8. AWS D1.1, "Structural Welding Code."
9. AWS A5.18 & A5.28, Structural Welding Code for GMAW
10. SSPC "Painting Manual, Volume 2, Systems and Specifications.", Latest edition.

B. Qualifications for welding work shall be as follows:

1. Qualify welding procedures and welding operators in accordance with the AWS "Standard Qualification Procedure."

    a. Include amended requirements of the building code as noted above.

2. Submit certification that all welders to be employed in work are AWS qualified. If re-certification of welders is required, retesting will be responsibility of structural steel subcontractor.

    a. Include licensing requirements as per the building code noted above and local jurisdiction.

1.8 TESTING AND INSPECTION

A. Special Inspection as required by the applicable Building Code of all structural steelwork in the shop and field will be performed by an inspection agency retained by the Contractor at no expense to the Government. The inspection agency shall work under the direction of the Contracting Officer Representative. Contractor shall provide the inspection agency with the following:

1. Schedule of all work in both shop and field with at least ten days' written notice before commencement of either activity.
2. A complete set of approved shop and erection drawings.
3. Cutting lists, order sheets, material bills, shipping bills and mill test reports.

4. Information as to time and place of all rollings and shipment of material to shops.
5. Representative sample pieces as requested by the testing agency.
6. Full and ample means and assistance for testing all material.
7. Proper facilities, including scaffolding, temporary work platforms, etc., for inspection of the work in the mills, shop and field.

B. Each person installing connections shall be assigned an identifying symbol or mark and all shop and field connections shall be so identified so that the inspector can refer back to the person making the connection.

C. The following minimum criteria shall be adhered to in testing of welds and bolts:

1. All welds and bolts shall be examined by visual means.
2. 25% of all welds, selected randomly, shall be measured.
3. Bolted joints shall be verified per the RCSC “Specification for Structural Joints Using High-Strength Bolts,” Section 9, based on installation method.
4. All welds subject to tensile stress shall be examined by the Ultrasonic Method for 100% of their length.
5. 10% of all manual fillet welds shall be tested by the magnetic particle method.
6. 1'-0" at each end of automatic fillet welds shall be tested by the magnetic particle method.
7. 100% of groove welds shall be tested by the ultrasonic method.

D. Shop inspection will include examination of steel for straightness and alignment, fissures, mill scale, and other defects and deformities, as described in ASTM A6, examination of fabricated pieces for conforming to approved shop drawings, testing of bolts and welds, and inspection of shop painting. All shop welds shall be visually inspected and spot tested using Ultrasonic Method ASTM E 114 and AWS, Chapter 6, Part C. All inspected welds shall be identified by the inspector.

E. Field inspection will include examination of erected steel for welding, proper fitting and tensioning of bolts, alignment, trueness and plumbness, touching-up of shop coat, level of billets and base plates.

F. Inspection of welding will be such as to assure that the work is within the quality requirements specified below and elsewhere in this section of the specifications and will include:

1. Ascertainment that the electrodes and flux used for the SAW, GMAW and FCAW welding processes conform to the requirements of this section of the specifications.
2. Ascertainment that the approved welding procedures and sequence are followed without deviation, unless specific approval for change is obtained from the Contracting Officer Representative.
3. The testing agency shall be prepared to utilize the following approved methods of testing:

    a. Liquid penetrant inspection: ASTM E 165.
    b. Magnetic particle: ASTM E 1444.
    c. Radiographic inspection: ASTM E 94 and E 1032.
    d. Ultrasonic inspection: ASTM E 114 and AWS, Chapter 6, Section C.

G. When defects are revealed, additional inspection by whatever method is deemed necessary by the inspector, shall be performed to the extent necessary to assure that the full amount of defect has been located. No further work shall be done on the assembly or sub-assembly in question until all the necessary corrections have been made. Defects shall be repaired, using the same welding procedure that was used initially in making the weld, unless otherwise approved by the Contracting Officer Representative. Inspection of the repaired weld shall be by the same method

that was used to reveal the defect. A second repair of a defective area shall not be made without approval of the Contracting Officer Representative.

H. Apparatus and procedures for measuring required tension in pretensioned and slip-critical high strength bolted connections shall be furnished and maintained by the steel contractor, in accordance with the RCSC “Specification for Structural Joints Using High-Strength Bolts,” and shall be approved by the inspection agency. The inspection agency shall observe the pre-installation verification testing required and shall ensure by routine observation that the bolted installations conform to the approved pretensioning method being used. The steel contractor shall provide a laborer and scaffolding as required for the testing of connections by the inspection agency, and shall, at his own expense, furnish such facilities and provide such assistance as may be required for proper inspection.

I. A distinguishing mark will be placed on all work that has been inspected and approved. Material or work that is not acceptable will be designated by words such as "REJECT" or "REPAIR" marked directly on the material or work.

J. Inspection of Shop Painting:

1. Visually evaluate surface preparation by comparison with pictorial standards in accordance with SSPC-Vis 1.
2. Measure dry film thickness of each coat with a magnetic film thickness gauge in accordance with SSPC-PA 2.
3. Visually inspect dried film for runs, sags, dry spray, overspray and missed areas.
4. Repair defective or damaged areas in accordance with painting requirements specified. Make repairs to shop or field coat as directed.

1.9 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to site at such intervals to ensure uninterrupted progress of work. Minimize the disturbances to site and soil conditions.

B. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete, in ample time not to delay work.

C. Store materials to permit easy access for inspection and identification. Keep steel members in a safe, dry, off ground location, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration, discoloration or staining.

D. Do not store materials on structure in a manner that might cause distortion or damage to members of supporting structures. Repair or replace damaged materials or structures as directed.

1.10 PROJECT CONDITIONS

A. The structural steel contractor shall coordinate the structural steel work with the work of other Contracts. Verify all dimensions and details of this Contract and those of other Contracts that affect the work before proceeding. Any discrepancies shall be immediately reported to the Contracting Officer Representative.

B. Be fully responsible for the accurate installation of the work. Any discrepancy which arises from

his failure to execute the work in conformity to the drawings and specifications shall be properly remedied at the contractor's own expense and in a manner acceptable to the Contracting Officer Representative.

C. Locate dimensionally on setting plans all anchor bolts, inserts, bearing and base plates, etc., and prepare and deliver all required templates and fully dimensioned setting plans in time for the proper execution of the work. Anchor bolts shall be set by another subcontractor. The structural steel contractor shall check all such settings for correctness after they have been cast in place, and before proceeding with erection work.

D. Report to the Contracting Officer Representative and certify compliance with the above checking requirements in writing and indicate any inaccuracies found in the location of anchor bolts or inserts, and corrections which must be made to their installation. Any inaccuracies not included in the report and found during or after steel erection shall be the responsibility of the structural steel contractor and the cost of corrective measures shall be borne by the structural steel contractor.

E. Use base lines, bench marks, or other standards for survey work that have been provided or verified by others. If permanent building bench marks have been established, these will be used for field checking.

F. Coordinate with all other trades to ensure that work of this section does not cause undue conflict. Ensure that location of erection devices such as cranes, derricks, booms or hoists, does not cause over-stresses to steel frame to work previously placed by other trades or to existing structures. When required, retain the services of a licensed professional engineer to ascertain that erection devices do not create unsafe conditions or cause overstresses.

G. Ensure full co-ordination with other related trades and professions.

1.11 SUBSTITUTION

A. Contracting Officer Representative reserves the right to require substitute shapes of other sizes than those indicated on the drawings when it is apparent that the shapes specified cannot be furnished within the time required for the progress of construction. Make said substitutions without additional cost to the Government.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Steel shapes, including structural steel wide flange and structural tee rolled shapes, channels, angles, plates, pipe, and hollow structural sections: As noted on structural drawings.

B. High Strength Bolts: As noted on Structural Drawings.

C. Anchor Rods: As noted on structural drawings

D. Filler metal for welding electrodes. As noted on structural drawings.

E. Structural steel primer paint: rust inhibitive primer conforms to the following criteria

1. Coordinate all paint requirements with applicable specification section.
2. Demonstrate a minimum of adhesion as classified by 4B of ASTM D 3359 method A
3. Demonstrate a minimum opacity as determined by ASTM D 2805
4. Demonstrate corrosion resistance per standards ASTM B 117 & ASTM D 5894
5. “Slip Critical” compatible rating where applicable
6. The product shall not contain any of the prohibited compounds as listed in Green Seal *Standard for Paintings and Coatings*, GS-11, latest edition and in Master Painters Institute (MPI) *Green Performance Standard*, GPS-1-08.
7. The product shall meet the VOC limits as set forth in the MPI Green Performance Standard, GPS-1-08, with a maximum allowable VOC of 340 g/L for rust preventative coatings. Limits are expressed in THINNED state. Preference shall be given to products with the least crystalline silica content.
8. The product shall meet all the requirements of MPI Standards: 23, 26, 76, 79, 95, 107, 135, 173, 275. Products not listed with MPI are acceptable if and only if they meet the same environmental criteria for the same product category.

    a. Exterior exposed steel, normal conditions: Use alkyd or polyamide solvent based paints (MPI #’s 76, 79 & 101)
    b. Interior exposed steel: Use water based paint (MPI # 107)
    c. Special Applications, highly corrosive environments: Use zinc rich paints (MPI #’s 20 & 200)

F. Structural steel field paint for exposed members: rust inhibitive primer conforms to the following criteria

1. Coordinate all paint requirements with applicable specification section.
2. Demonstrate a minimum of adhesion as classified by 4B of ASTM D 3359 method A
3. Demonstrate a minimum opacity as determined by ASTM D 2805
4. Demonstrate corrosion resistance per standards ASTM B 117 & ASTM D 5894
5. “Slip Critical” compatible rating where applicable.
6. The product shall not contain any of the prohibited compounds as listed in Green Seal *Standard for Paintings and Coatings*, GS-11, latest edition and in the Master Painters Institute *Green Performance Standard*, GPS-1-08.
7. The product shall meet the VOC limits as set forth in the MPI Green Performance Standard, GPS-1-08, with a maximum allowable VOC of 400 g/L for rust preventative coatings. Limits are expressed in THINNED state. Preference shall be given to products with the least crystalline silica content.
8. The product shall meet all the requirements of MPI Standards: 23, 26, 76, 79, 95, 107, 135, 173, 275. Products not listed with MPI are acceptable if and only if they meet the same environmental criteria for the same product category. Products not listed with MPI are acceptable if and only if they meet the same environmental criteria for the same product category.

    a. Exterior exposed steel, normal conditions: Use alkyd or polyamide solvent based paints (MPI #’s 23, 79)
    b. Interior exposed steel: Use water based paint (MPI # 107)

PART 3 - EXECUTION

3.1 FABRICATION

A. All shop connections shall be high strength bolted unless specifically shown otherwise. Fabricate work in shop in as large assemblies as practicable. Use welded connections ONLY where shown on drawings. If a bolted connection is not possible, obtain written approval from the Contracting Officer Representative for the welded connection.

B. Camber: As indicated on drawings.

C. Mill column ends and bearing stiffeners to give full bearing over the cross section. Plane contact surfaces of bearing plates when required by the AISC Specifications. It is not necessary to plane bottom surfaces of plates on grout beds.

D. Drill or punch holes at right angles to the surface of the metal, not more than 1/16" larger than the connector diameter. Do not make or enlarge holes by burning. Drill material having a thickness in excess of the connector diameter and material thicker than 7/8". Holes shall be clean-cut without torn or ragged edges. Remove outside burrs resulting from drilling operations.

E. Provide holes in members to permit connection of the work of other trades. Use suitable templates for proper location of these holes. Steel requiring adjustment or accurate alignment shall be provided with slotted holes or full bearing shims as shown.

F. Provide holes, slots and openings required by other trades together with necessary reinforcing required. Use suitable templates for proper location of these openings. All such openings shall be shown on the shop drawings. No change in size or location will be permitted without prior approval.

G. Manual flame cutting shall be done only with a mechanically guided torch. An unguided torch may be used provided the cut is within 1/8" of the required line.

3.2 SHOP CONNECTIONS

A. Provide connections as shown on the drawing exactly as detailed. Where connections are not detailed, the minimum connections shall comply with appropriate tables headed, "Framed Beam Connections" shown in the AISC "Manual of Steel Construction" unless otherwise noted on the drawings. Use high strength bolts unless otherwise shown.

B. Do not use welded connections unless shown on details. Field welding is not allowed without written instruction from the Contracting Officer Representative.

C. Proportion and detail all connections on shop drawings to resist forces shown on design drawings.

D. Bolting

1. Bolts shall be of a length that will extend not less than 1/4" beyond the nuts. Enter bolts into holes without damaging the thread.
2. Joint Type: As noted on the Structural Drawings.
3. Make high-strength bolted joints without the use of erection bolts. Bolt heads and nuts shall rest squarely against the metal. Where structural members have sloping surface, bolted connections shall be provided with beveled washers to afford square seating or framing for bolt heads or nuts.

4. All joints are to be compacted to the snug-tight condition in accordance with Section 8 of the RCSC “Specification for Structural Joints Using High-Strength Bolts.” Protect bolt heads and threads from damage during installation.
5. Pretensioned and slip-crtical joints are to be installed by one of the methods prescribed in Section 8.2 of the RCSC “Specification for Structural Joints Using High-Strength Bolts,” unless written approval is obtained from the Contracting Officer Representative.
6. Bolts that have been completely tightened shall be marked for identification.

E. Welding

1. The following environmentally preferable welding processes shall be used as described for the related application without exception:

    a. Submerged Arc Welding (SAW): Plate girders, fillet and butt joints in pipes, cylinders, columns and beams, and welds where ‘downhand’ or horizontal positions are possible.
    b. Gas Metal Arc Welding (GMAW) shall be used where SAW is not applicable (such as for angled connections and anything irregular or short).
    c. Field welding shall be allowed only in special circumstances; in such cases Flux Core Arc welding (FCAW) shall be specified

2. Do not begin structural welding until joint elements are inspected for surface preparation, fit-up, and cleanliness of surface to be welded and are then bolted or tacked in intimate contact and adjusted to dimensions shown on drawings, or both, with allowance for any weld shrinkage that is expected. No members are to be spliced without prior approval by the Contracting Officer Representative.

    a. Containment surface preparation debris must meet SSPC-Guide 6 guidelines.

3. Pre-heat and interpass temperature shall be in accordance with Table 4.2 (including footnotes) of the AWS Code for Welding in Building Construction. The temperature shall be measured from the side opposite to that which the pre-heat is applied, where possible.
4. All groove welds shall be continuous and full penetration welds unless otherwise shown on the design drawings. Welds made without the aid of a back-up bar shall have their roots chipped, ground or roughened out to sound metal from the second side, before welding is done from the second side.
5. All welds shall be sound throughout. There shall be no crack in any weld or weld pass. Weld may be considered sound if it contains only slight porosity or fusion defects which are well dispersed.
6. The heat, input, length of weld and sequence of weld shall be controlled to prevent distortions. The surfaces to be welded and the filler metals to be used shall be subject to inspection before any welding is performed.

3.3 SHOP PAINTING AND CLEANING

A. Finishing, coating, plating

1. Shop painting and factory finishing shall be preferred to field painting whenever possible. Where applicable, finishes and surface preparations based on a physical process such as abrasive blasting, grinding, buffing and polishing are preferred to coatings and solvent based cleaning. Where coatings are necessary powder-coated fabrication is preferred to painting and plating. Avoid plated metals especially those using cadmium and chromium

as plate material or cyanide or copper/formaldehyde based electroless copper as the plating solution.

B. Remove all rust, scale, grease and other detrimental foreign matter in accordance with SSPC-SP 3, Power Tool Cleaning, unless conditions/opportunities listed below apply.

1. Use surface preparation classification recommended by paint manufacturer, SSPC or Master Painters Institute (MPI) for paint product used.

a. SSPC-Guide 6, Guide for Containing Debris Generated During Paint Removal Operations, must be followed for all applicable surface preparation techniques.

C. Immediately after surface preparation, apply structural steel primer paint where specified, in accordance with manufacturer's instructions and at a rate to provide dry film thickness of not less than 2.0 mils. Use painting methods which result in full coverage of joints, corners, edges and exposed surfaces. Use type of primer paint as specified in "Materials" article above. Apply two coats to surfaces that will be inaccessible after erection

D. Paint all structural steel in accordance with the foregoing specification, except as follows:

1. Steel which is to receive spray-on fireproofing.
2. Within 2" of field welds or welds made after paint is applied.
3. Faying surfaces in bolted connections shall be prepared per Section 3.2 of the RCSC “Specification for Structural Joints Using High-Strength Bolts.”
4. Machined surfaces and threaded parts required for adjustment of the structure. Protect these with suitable rust inhibiting coating which may be removed after final installation of the work so that proper finished coatings may be applied.

3.4 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/A 123M.

1. Fill vent and drain holes that will be exposed in the finished Work unless they will function as weep holes, by plugging with zinc solder and filing off smooth.

3.5 SOURCE QUALITY CONTROL

A. Refer to testing and inspection requirements specified above.

3.6 EXAMINATION

A. Verify field measurements prior to start of erection. Check the alignment and elevation of all column supports and location of all anchor bolts with transit and level instruments before starting erection. Notify Contracting Officer Representative of any errors. Obtain Contracting Officer Representative's approval of methods proposed for correcting errors prior to proceeding with corrections and erection.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.7 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.

3.8 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.

B. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."

C. Column billets and bearing plates shall be supported and aligned on steel wedges, shims, or leveling nuts. After the supported members have been plumbed and properly positioned by instrument and anchor nuts tightened, the entire bearing area under the plate shall be packed solidly with grout specified in another Section. Wedges and shims shall be set back a minimum of 3/4" from the edges of plates and shall be left in place. Leveling plates are not permitted.

D. Plumbing, Leveling and Bracing

1. Structural steel shall be erected true and level, and temporary bracing shall be introduced wherever necessary to provide for all loads to which the structure may be subjected, including equipment and the operation thereof. Such bracing shall be left in place as long as may be required for safety. No welding shall be done or bolts drawn up tight until structural steel has been properly aligned. Obtain approval for guy locations to assure lack of interference with operations of other trades.

E. Drifting

1. Light drifting necessary to draw holes together will be permitted, but drifting of unfair holes will not be permitted. Twist drills shall be used to enlarge holes as necessary to the next larger size; use next larger size bolts as required. Reaming that weakens the members, or make it impossible to fill the holes properly or to adjust accurately after reaming, will not be allowed.

3.9 FIELD CONNECTIONS

A. In addition to the requirements for shop connections comply with the following:

1. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using High-Strength Bolts" for type of bolt and type of joint specified.
2. Joint Type: As noted on structural drawings.

B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.

2. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC 303 for mill material.

3.10 REPAIRS AND PROTECTION

A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A 780.

B. Touchup Painting: Immediately after erection, clean exposed areas where primer is damaged or missing and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Clean and prepare surfaces by SSPC-SP 3, Power Tool Cleaning.

C. After erection, all damaged areas in shop coat, exposed surfaces of bolt heads, nuts and washers, and all field welds and unpainted areas adjacent to field welds and high strength bolts shall be painted with a "touch-up" application of same paint used in the shop coat and then painted with same paint used for shop coat tinted another color. Retouch in field, any scraped, abraded, and unpainted surfaces. Painting shall be as specified for shop coats.

D. Structural steel which is to support mechanical equipment and will be left exposed to the weather in the finished project shall be field painted with one coat of anti-corrosive paint as described in Part 2 for Paint Materials.

3.11 WASTE MANAGEMENT

A. Contractor is encouraged to separate and recycle waste materials to the maximum extent feasible.

B. Place empty containers of solvent-based paints in areas designated for hazardous materials.

C. Do not dispose of paints or solvents by pouring on the ground. Place amounts too small to re-use in designated containers for proper disposal

D. Place materials defined as hazardous or toxic waste in designated containers.

END OF SECTION

DIVISION 31

Earthwork

SECTION 31 11 00
CLEARING AND GRUBBING

PART 1 – GENERAL

1.01 SUMMARY

A. This Section includes the following:
   1. Protecting existing trees, soil, and vegetation to remain.
   2. Removing existing vegetation
   3. Clearing and grubbing.
   4. Stripping and stockpiling topsoil and organic material

1.02 RELATED REQUIREMENTS

A. Section 02 41 13 – Selective Site Demolition

B. Section 31 23 00 – Earthwork

C. Section 31 25 00 – Erosion and Sedimentation Controls

D. Section 32 91 19 – Landscape Grading

E. Section 33 42 13 – Stormwater Culverts

1.03 DEFINITIONS

A. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil," but in disturbed areas such as urban environments, the surface soil can be subsoil.

C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow.

D. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction.

E. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.04 MATERIAL OWNERSHIP

A. Except for materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.05 FIELD CONDITIONS

A. Soil Stripping, Handling, and Stockpiling: Preform only when the soil is dry or slightly moist.

PART 2 – NOT USED

PART 3 – EXECUTION

3.01 PREPARATION

A. Stake the limits of work shown on the drawings for review and approval prior to beginning work. Maintain limits or work thought construction and remove when directed by the COR.

B. Protect and maintain benchmarks and survey control points from disturbance during construction.

C. Protect existing site improvements to remain from damage during construction.
   1. Restore damaged improvements to their original condition, as directed and approved by the COR at no additional cost to the Government.

3.02 TREE, SOIL, AND VEGETATION PROTECTION

A. Contractor shall take care to safeguard trees, soil, and vegetation to remain as indicated and noted on the drawings.

B. Contractor shall repair or replace trees, shrubs, and other vegetation indicated to remain that are damaged by construction operations as directed and approved by the COR at no additional cost to the Government.

3.03 EXISTING UTILITIES

A. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others.

3.04 CLEARING AND GRUBBING

A. Protect trees, roots, soils and vegetation as specified herein and noted on the Drawings.

B. Remove obstructions, trees, shrubs, and other vegetation only as required to permit installation of new construction. Perform in conjunction with topsoil stripping as shown and noted on the Drawings.

C. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

3.05 TOPSOIL STRIPPING

A. Strip topsoil, vegetation, and other organic materials as indicated and noted on the Drawings.

B. Store striped topsoil onsite and re-spread as indicated on the Drawings. Care shall be taken during stockpiling of topsoil to not contaminate it with other materials.

3.06 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

B. Burning trees, shrubs, other vegetation waste, other waste, and debris is not permitted.

END OF SECTION

SECTION 31 23 00
EARTHWORK

PART 1 - GENERAL

1.01 SUMMARY

A. Fill for Embankment

B. Preparing subgrades for aggregate surfacing.

C. Free Draining Base

D. Excavating and backfilling trenches for stormwater utility installation.

1.02 RELATED SECTIONS

A. Section 31 11 00 – Clearing and Grubbing

B. Section 31 25 00 – Erosion and Sedimentation Controls

C. Section 32 11 23 – Aggregate Base Courses

D. Section 32 32 53 – Stone Retaining Walls

E. Section 32 91 19 – Landscape Grading

F. Section 32 91 19 – Seeding

G. Section 33 42 13 – Stormwater Culverts

1.03 REFERENCES

A. The following list of Specifications which may be related to this section.
   1. ASTM International (ASTM)
      a. ASTM D 2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
      b. ASTM E 329, Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction
      c. ASTM D 3740, Standard Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
      d. ASTM E 548, Standard Guide for General Criteria Used for Evaluating Laboratory Competence
      e. ASTM D 2940, Standard Specification for Graded Aggregate Material for Bases or Subbases for Highways or Airports
      f. ASTM D 4759, Standard Practice for Determining the Specification Conformance of Geosynthetics

1.04 DEFINITIONS

A. Trench Bedding Course: Layer placed over the excavated subgrade in a trench before laying pipe.

B. Culvert Backfill: Aggregate used to backfill between the Trench Bedding Course and the Subgrade.

C. Borrow: Satisfactory soil imported from off-site for use as Fill or backfill.

D. Excavation: Removal of material encountered above subgrade elevations.

E. Fill: Unclassified materials used to raise existing grades.

F. Structures: Bridges, footings, foundations, retaining walls, slabs, or other man-made stationary features constructed above or below the ground surface.

G. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.

H. Topsoil: See Section 32 92 19 – Seeding for definition and specification.

1.05 SUBMITTALS

A. Product Data: For the following:
   1. Aggregate Materials

B. Material Test Reports: From a qualified testing agency, engaged by the Contractor, indicating and interpreting test results for compliance of the following with requirements indicated:

C. Classification according to ASTM D 2487 of each on-site or borrow soil material proposed for fill and backfill.

1.06 QUALITY ASSURANCE

A. Geotechnical Testing Agency Qualifications: Contractor shall engage an independent testing agency qualified according to ASTM E 329 to conduct soil materials and rock-definition testing, as documented according to ASTM D 3740 and ASTM E 548.

B. Pre-excavation Conference: Conduct conference at Project site to comply with Owner requirements

1.07 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Government or others unless permitted in writing by Contracting Officer and then only after arranging to provide temporary utility services according to requirements indicated:
   1. Do not proceed with utility interruptions without Contracting Officer's written permission.
   2. Contact utility-locator service for area where Project is located before excavating.

PART 2 – PRODUCTS

2.01 MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils for Fill Embankment: ASTM D 2487 soil classification groups GW, GP, GM, SW, SP, and SM, or a combination of these group symbols; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

C. Unsatisfactory Soils for Fill Embankment: ASTM D 2487 soil classification groups GC, SC, ML, MH, CL, CH, OL, OH, and PT, or a combination of these group symbols.

D. Trench Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve. All crushed stone provided shall be sandstone or other approved by the Contracting Officer. No Limestone shall be allowed.

E. Trench Backfill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve. All crushed stone provided shall be sandstone or other approved by the Contracting Officer. No Limestone shall be allowed.

F. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.

2.02 ACCESSORIES

A. Fabric for Separation: Nonwoven geotextile, specifically manufactured as a drainage geotextile; made from polyolefins, polyesters, or polyamides; and with the following minimum properties determined according to ASTM D 4759 and referenced standard test methods:

B. Grab Tensile Strength: 110 lbf; ASTM D 4632.

C. Tear Strength: 40 lbf; ASTM D 4533.

D. Puncture Resistance: 50 lbf; ASTM D 4833.

E. Water Flow Rate: 150 gpm per sq. ft.; ASTM D 4491.

F. Apparent Opening Size: No. 50; ASTM D 4751.

PART 3 – EXECUTION

3.01 PREPARATION

A. Protect structures, utilities, signs, benches marked to remain, trees that will remain and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.02 GENERAL EXCAVATION

A. Unclassified Excavation: Excavation to subgrade elevations regardless of the character of surface and subsurface conditions encountered, including rock, soil materials, and obstructions.
   1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

3.03 EXCAVATION FOR STORMWATER TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

B. Excavate trenches to uniform widths to provide a working clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit, unless otherwise indicated.
   1. Clearance: 18 inches on each side of pipe or conduit.

C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for barrels of pipes. Remove projecting stones and sharp objects along trench subgrade.
   1. Shape bottom of trench to support bottom 90 degrees of pipe circumference. Fill depressions with tamped bedding course backfill.

3.04 STORAGE OF SOIL MATERIALS

A. Stockpile borrow materials and satisfactory excavated soil materials. Stockpile soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

3.05 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:
   1. Inspecting stormwater culverts
   2. Removing trash and debris.

3.06 FILL

A. Refer to Spec Section 32 11 23 “Aggregate Base Courses” for requirements for placement of trail aggregate.

B. Preparation: Remove vegetation, topsoil, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface before placing fills.

C. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

D. Place and compact fill material in layers to required elevations as follows:
   1. Under grass and planted areas “green areas”, use satisfactory or unsatisfactory soils for fill embankment so long as they are clean and free of trash and debris.
   2. Under trail grade and pavements, use satisfactory soils for fill embankment
   3. Under footings and foundations, use satisfactory soils for fill embankment
   4. In sliver fills use Class 1 Rip Rap

3.07 MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill layer before compaction to within 2 percent of optimum moisture content.

B. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

C. Remove and replace, or scarify and air-dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.08 COMPACTION OF BACKFILLS AND FILLS

A. Place backfill and fill materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil in the following conditions:
   1. Under trail bed scarify and recompact top 6 inches below subgrade and compact. Use proof roll method with loaded transport vehicle or other NPS approved vehicle of similar weight and size.
   2. Under green or unpaved areas, place fill with tracked equipment or bucket of machine. Make compactive effort to stabilize the surface. Material shall not be dumped into place without tracking in of material.
   3. In areas of drainage pipe and structural backfill, backfill material shall be compacted to 95 percent of maximum density.

3.09 GRADING

A. General: Uniformly grade areas to a smooth surface, free from irregular surface changes. Comply with compaction requirements and grade to lines, and elevations indicated.
   1. Provide a smooth transition between adjacent existing grades, new grades and bridge/ramp approaches.
   2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Grading: Slope grades to direct water towards ditches and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

C. Trail bed: Plus 1/2 inch. Trail must meet flush with structures with cross slope as indicated in the Drawings.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: Contractor shall engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing.

B. Have testing agency inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.

C. Testing agency shall test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:
   1. Trench Backfill: Two compaction tests shall be performed for each culvert installation. Tests shall be scheduled to be taken at different lifts and areas of the pipe alignment.

D. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify, and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.

3.11 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris until accepted by NPS.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
   1. Scarify or remove and replace soil material to depth as directed by Contracting Officer; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
   1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to the greatest extent possible.

3.12 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Transport surplus satisfactory soil to acceptable offsite spoil yard.
   1. Remove waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Government's property.

END OF SECTION

SECTION 31 25 00
EROSION AND SEDIMENTATION CONTROLS

PART 1 - GENERAL

1.01 SUMMARY

A. Federal Regulations for controlling discharges of pollutants (including chemicals, erodible material, and trash) from municipal separate storm sewer systems, construction sites, and industrial activities, were brought under the National Pollution Discharge Elimination System (NPDES) permit process by amendments to the Clean Water Act (CWA), and promulgation of federal stormwater regulations issued by the United States Environmental Protection Agency (USEPA). The USEPA uses amount of ground disturbance as a measure of a project potential to generate pollution from erosion. NPDES Phase I regulates discharges from construction sites that disturb 5 acres or more. NPDES Phase II regulations expand existing General Permit requirements under Phase I to include/regulated discharges from construction sites that disturb land equal to or greater than one (1) acre and less than 5 acres, known as Small Construction Activity. Construction disturbances 1 acre and above typically require a formal NPDES permit and a formal Stormwater Pollution Prevention Plan (SWPPP) must be submitted to Agency(ies) with Jurisdiction for review and approval.

B. National Park Service (NPS) Standards and Guidelines require water quality be protected to ensure compliance with Organic Act. Contractor shall prepare an Under-An-Acre Pollution Prevention Plan (UPPP) for each project resulting in less than 1 acre of soil disturbance or not otherwise subject to requirements of NPDES program. (UPPP Guideline)

C. The work of this section consists of implementing measures to prevent discharges of pollutants, including temporary storm water pollution during construction activities, through compliance with NPDES permit program.

D. Work of this section consists of implementing measures to Temporary Storm Water Pollution during construction activities, through compliance with NPDES permit program.

1.02 DEFINITIONS

A. Definitions pertaining to sustainable development: As defined in ASTM E2114.

B. Environmental Pollution and Damage: The presence of chemical, physical, or biological elements or agents which adversely affect human health or welfare; unfavorably alter ecological balances; or degrade utility of the environment for aesthetic, cultural, or historical purposes.

C. National Pollution Discharge Elimination System (NPDES) Phase I: Regulates discharges from construction sites that disturb 5 acres or more.

D. NPDES Phase II: Regulations expand existing General Permit requirements under Phase I to include and regulate discharges from construction sites that disturb land equal to or greater than one (1) acre and less than 5 acres, known as Small Construction Activity.

E. Storm Water Pollution Prevention Plan (SWPPP): Developed and implemented stormwater management measures to protect surface water from pollutants during construction activities disturbing an acre or more in compliance with federal, state, and local requirements for permit approval under NPDES program.

1.03 SUBMITTALS

A. After contract award and before pre-construction conference, prepare and submit:

B. Inspection Schedule: Submit schedule for inspection and monitoring of pollution prevention measures.

C. Inspection Schedule: Submit schedule for inspection and monitoring of storm water pollution prevention measures.

D. Erosion Control Products: Submit manufacturer's product information and installation recommendations for silt fence, filter fabric, erosion control blanket, and other materials proposed for use on this project.

1.04 QUALITY ASSURANCE

A. Contractor shall prepare and submit a plan to Contracting Officer (CO) for review and concurrence.

B. Orientation Meeting: Contractor shall arrange and conduct an Erosion and Sediment Control meeting/briefing to inform parties, scheduled to be on-site during project, of measures to be implemented for proper erosion and sediment control (may be included as part of Pre-Construction Meeting).
   1. Installation of sediment control log, silt fences, storm drain protection, and other forms of erosion and sediment control shall not begin until after this meeting has occurred.

C. Pollution Prevention and Erosion Control Manager: Contractor shall designate Pollution Prevention and Erosion Control Manager responsible for implementation, inspection, maintenance, and amendments to approved plan.
   1. Pollution Prevention and Erosion Control Manager shall be familiar with temporary storm water pollution prevention procedures and Best Management Practices and ensure emergency procedures and plan are updated as needed and available for inspection.
   2. When changes in approved plan are required, Pollution Prevention and Erosion Control Manager shall prepare and certify an amendment and submit to Contracting Officer for review and concurrence.

PART 2 – PRODUCTS

2.01 TEMPORARY STORM WATER POLLUTION PREVENTION PLAN

A. Provide UPPP which includes:
   1. Site description.
   2. Identification and contract information for Pollution Prevention and Erosion Control Manager.
   3. Expected sequencing of operations and construction schedule.
   4. Weather monitoring procedure.
   5. Descriptions and details Best Management Practices for of pollution prevention and erosion controls, including dust control.
   6. Pollution prevention and erosion control drawings.
   7. Controls for other potential onsite storm water pollutants.
   8. Applicable specifications.
   9. Maintenance and inspection procedures and forms.
   10. Description of potential non-storm water discharges at site.
   11. Notice of Intent (NOI) form.
   12. Notice of Termination (NOT) form.
   13. Contractor and Sub-contractor Certification forms.
   14. Other record keeping forms and procedures.
   15. Housekeeping Best Management Practices, including vehicle wash-down areas, protection of equipment storage and maintenance areas, and sweeping of roadways related to hauling activities.

B. Erosion control products must only contain inert materials. Products containing straw, hay, and other materials that have the potential to contain weed seeds are prohibited.

PART 3 – EXECUTION

3.01 ENVIRONMENTAL PROTECTION

A. Protection of Natural Resources: Comply with applicable regulations and these specifications. Preserve natural resources within project boundaries and outside limits of work performed under this Contract in their existing condition or restore to an equivalent or improved condition as approved by Contracting Officer.

B. Show construction limits on drawings. Define allowable activities within different zones shown (deliveries only, disturbance, construction access, material storage, etc.)

C. Construction Zone: Arrange construction activities to minimize pollution (i.e., erosion, trash, etc.) to maximum practical extent.
   1. Clearing, excavation, and grading shall be limited to those areas of project site necessary for construction. Minimize area exposed and unprotected.
   2. Clearly mark and delineate limits of work activities.
   3. Equipment shall not be allowed to operate outside limits of work or to disturb existing vegetation.
   4. Excavation and grading shall be completed during dry season to maximum extent possible.
   5. Material shall be stored away from locations where water is present to greatest extent practicable.

3.02 REGULATORY REQUIREMENTS

A. Permits: Contractor shall obtain required EGLE JPA permits resulting in no impacts to scheduled work. Contractor shall account for possibility of significant lead time in scheduling and executing work.
   1. Implement requirements of the permit for erosion control due to storm water runoff during construction.
   2. Implement good housekeeping practices, inspections and record keeping.
   3. Prior to construction, Contractor and Subcontractors shall sign certifications (included in the plan) that they understand requirements of the permit.
   4. Subcontractors shall comply with requirements under supervision of Contractor.
   5. Accepted plan shall comply with terms and conditions of EPA permit.

B. Notice of Intent (NOI): Contractor shall file a Notice of Intent as required to the Agency(ies) with Jurisdiction.

C. Notice of Termination (NOT): After Substantial Completion of Work, file a Notice of Termination (NOT) with the Agency(ies) with Jurisdiction.

D. Contracting Officer Notification: Contractor shall notify Contracting Officer in writing and by telephone of these events:
   1. Erosion and sediment control meeting/briefing.
   2. Following installation of required sediment control structures.
   3. Prior to removal of or modification to sediment control structures.
   4. Prior to removal of sediment control structures.

3.03 TEMPORARY STORM WATER POLLUTION PREVENTION PLAN

A. Review and Acceptance: Contractor and Contracting Officer will jointly review draft Plan and agree to needed revisions. Contractor shall incorporate revisions, sign, and submit final Plan to Contracting Officer. Final Plan will be the document enforced on the project.
   1. Accepted Plan will describe and ensure implementation of practices to be used to reduce pollutants in storm water discharges.
   2. Contractor shall maintain current copy of Plan and associated records and forms at jobsite throughout duration of project.
   3. Plan shall be available for public inspection and inspection and use of Contracting Officer.
   4. Approval of Contractor’s Plan will not relieve Contractor of responsibility for compliance with applicable environmental regulations.

B. Implementation: Implement Plan as required throughout construction period and maintain erosion control elements in proper working order.

1. Do not perform clearing and grubbing or earthwork until Plan has been implemented.

3.04 SITE INSPECTIONS AND PLAN REVISIONS

A. Inspections: Contractor and Contracting Officer will perform a weekly inspection onsite.
   1. Inspection shall include disturbed areas not completely stabilized, areas used for storage of materials, locations where vehicles enter or exit site, and other erosion and sediment controls included in the Plan.
   2. Inspections shall be documented.
   3. Inspection forms shall be retained onsite in Plan notebook throughout construction period.

B. Plan Revisions: It may be necessary to revise Plan during construction to make necessary improvements, revisions, or to respond to unforeseen conditions noted during construction or site inspections.
   1. Plan shall specify mechanism whereby revisions may be proposed by Contractor or Contracting Officer.
   2. Contractor and Contracting Officer will jointly review each revision to Plan before changes incorporated and implemented. Contractor will then provide revised copy of Plan to Contracting Officer.
   3. Accepted modifications will be implemented within 7 calendar days following date of inspection when deficiencies or necessary corrections are first noted.

C. Negligence: Provide additional temporary erosion and pollution controls made necessary by Contractor’s errors or negligence at no additional cost.

3.05 HOUSEKEEPING AND SITE MANAGEMENT

A. Store materials onsite in conformance to Federal, state, local, and manufacturer’s regulations and specifications. Use Best Management Practices to minimize risk of materials coming into contact with environmental conditions (i.e. water and wind) that could disperse them.

3.06 EROSION CONTROL MEASURES

A. Erosion control measures shall consist of Best Management Practices for storm water discharges, including silt fencing, barrier protectors, sediment control log, temporary soil retention blankets, excelsior drainage filters, sediment traps and berms.

B. Divert surface runoff around and away from cut and fill slopes.

C. Place drainage filters around catch basins to create sediment traps to control run-off from construction area.

D. Excess water used for dust control shall be contained within demolition areas by erosion control measures.

E. Contractor shall prevent deposition of materials onto paved areas. Contractor shall inspect paved areas for deposited materials weekly and remove materials immediately.

F. Furnish, install, maintain, and operate necessary control measures and other equipment necessary to prevent erosion.

G. Before work begins, sufficient equipment shall be available on site to assure operation and adequacy of erosion control system can be maintained.

3.07 REPORTING

A. If a discharge occurs or if project receives written notice or order from regulatory agency, Contractor shall immediately notify Contracting Officer and shall file written report to Agency(ies) with Jurisdiction within 7 days of discharge event, notice, or order. Corrective measures shall be implemented immediately following discharge, notice, or order. The report to the Agency(ies) with Jurisdiction shall contain:
   1. Date, time, location, nature of operation, and type of discharge, including cause or nature of notice or order.
   2. Best Management Practices deployed before discharge event, or prior to receiving notice or order.

3. Date of deployment and type of Best Management Practices deployed after discharge event, or after receiving notice or order, including additional Best Management Practices installed or planned to reduce or prevent re-occurrence.
4. An implementation and maintenance schedule for affected Best Management Practices.

3.08 SEDIMENT DISPOSAL

A. Sediment excavated from temporary sediment control structures shall be disposed on site with general fill, or with topsoil. Sediment shall be allowed to dry out as required before reuse.

B. Contractor shall place sediment removed from traps and other structures where it will not enter a storm drain or watercourse and where it will not immediately reenter the basin.

3.09 REMOVAL OF TEMPORARY STORM WATER POLLUTION CONTROL MEASURES

A. Temporary control measures shall be removed with permission of Contracting Officer within 20 working days after final acceptance of project, and/or once grading is complete and slopes have stabilized.

END OF SECTION

SECTION 31 37 00
RIPRAP

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Riprap slope protection

B. Vegetated riprap embankments

1.02 RELATED REQUIREMENTS

A. Section 312300 - Excavation and Fill

B. Section 312500 - Erosion and Sediment Controls

C. Section 329116 - Planting Soil Stabilization

D. Section 329119 - Landscape Grading

1.03 SUBMITTALS

A. See Section 01 10 00 - Division 1 Short Form General Requiremtns for Submitttal procedures

B. Product Data: Manufacturer's data for riprap including location quarried, stone type, approximate dimensions, and a photograph of the material in bulk.

PART 2 PRODUCTS

2.01 RIPRAP

A. Riprap Imported: Rounded irregular glacially deposited igneous or metamorphic stone, quarried from a location within the upper peninsula of Michigan (commonly known as Michigan boulders or Michigan cobblestone). Blasted stone is prohibited. Size as indicated on the drawings.

B. Riprap Salvaged: If stone salvaged from the removal of existing stone retaining walls remains after construction of proposed stone retaining walls, it may be utilized for riprap. Size as indicated on the drawings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify survey benchmarks and intended elevations for work are as indicated on plans.

B. Identify required lines, levels, contours, and datum locations.

C. Verify riprap areas are uncompromised with surface or groundwater.

D. Do not place riprap over frozen or spongy subgrade surfaces.

3.02 PREPARATION

A. Grade riprap areas to indicated elevations, allowing for riprap thickness. Remove organic materials and compact.

3.03 PLACEMENT

A. Install as in accordance with the Drawings.

B. Place in full course lifts starting at slope base and working uphill.

C. Installed Thickness: As shown on the Drawings.

3.04 PROTECTION

A. Protect installed riprap from subsequent construction operations.

END OF SECTION

SECTION 31 63 33
DRILLED MICROPILES

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Furnish all materials, equipment, labor, supplies and load tests required for the installation of small diameter cast-in-place concrete piles as specified herein and as shown on the contract drawings. The minimum pile design loads are stated on the structural drawing set.

1.2 RELATED REQUIREMENTS

A. Section 02 41 13 Selective Site Demolition
B. Section 31 23 00 Earthwork
C. Section 31 66 13 Helical Pile and Helical Anchors
D. Section 32 34 00 Prefabricated Boardwalks

1.3 REFERENCES

A. American Society of Testing and Materials (ASTM) standards, latest editions.
   - A53 Grade B, Standard Specification For Pipe, Steel, Black and Hot Dipped, Zinc-coated Welded and Seamless.
   - A500 Grade C, Hollow Structural Sections
   - A501 Standard Specification For Cold-formed Welded and Seamless Carbon Steel Structural Tubing In Rounds and Shapes.
   - C31 Standard Methods of Making and Curing Concrete Test Specimens in the Field.
   - C33 Standard Specifications for Concrete Aggregates.
   - C109 Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-inch or 50 MM Cube Specimens).
   - C150 Standard Specification for Portland Cement.

B. "Standard Welding Symbols - A2.0" - American Welding Society (AWS).
C. Specification for Mild Steel Covered Arc - Welding Electrodes - A5.5 - AWS.
D. "Specification for low alloy steel covered arc - welding electrodes - A5.5 - AWS.
E. "Structural Welding Code - D1.1" - AWS.
F. "Code of Standard Practice for Steel Buildings and bridges" - AISC.
G. Federal Specifications SS-C192 for cements:
H. Portland, or current ASTM Standard, Designation C-150.
I. Corps of Engineers Specification CRD-C-79 for flow cone tests.
J. Corps of Engineers Specification CRD-C85 for grading.
K. Corps of Engineers Specification CRD-C-262 for Pozzolans.
L. Corps of Engineers Specification CRD-C-566 for grout fluidifiers.

1.4 SUBMITTALS

A. Piling designer/contractor shall submit drawings and typewritten procedures describing the exact sequence of pile installation. All piles shall be numbered. No work shall commence until procedures are approved.
B. Submit proportions for grout mix including source of supply or brand names for all materials.
C. Submit list of all equipment proposed for use on the project including casing hammer, grout pump, grout mixer, etc.
D. Submit pile locations, staked out on site by the Contractor, for review and approval by Contracting Officer Representative prior to on-site mobilization. Note: locations may require avoidance of archeological, geological, or other constraints. Notify the Contracting Officer Representative of any discrepancy between geometric pile parameters listed on the structural drawings.
E. Piling designer/contractor shall submit signed and sealed design shop drawings and calculations, based on staked pile locations and in accordance with the loading and design criteria provided in

the structural drawings, by a professional engineer licensed in the state of Michigan. Design shall include cased micropiles, fasteners of pile cap to pile coordinated with the steel boardwalk prefabricator (cap by boardwalk supplier), and any lateral bracing between foundation elements. Submittal is subject to review and approval by the Contracting Officer Representative.

F. Submit as-built documents including but not limited to pile locations, size, and cap elevations on the Drawings, as they were field-installed by the Contractor. Submittal is subject to review and coordination with the steel boardwalk supplier prior to boardwalk fabrication to ensure prefabricated frames can be installed as they are shipped to site.

1.5 QUALITY ASSURANCE

A. Qualifications
   1. The piling contractor shall have at least five years' experience in the kind of work specified herein and will be required to submit a list of projects successfully completed where he has installed this type of pile in similar ground conditions.

B. Regulatory Requirements
   1. Building Code: Work of this section shall conform to the requirements of the 2024 International Building Code, and all applicable regulations of governmental authorities having jurisdiction, including safety, health, noise and anti-pollution regulations. Where more severe requirements than those contained in the building code are given in this section, the requirements of this section shall govern.

C. Certifications
   1. Structural steel shall conform to the material acceptance, certification and inspection requirements of Chapter 17 of the International Building Code.
   2. Quality welding processes and welding operators in accordance with AWS "Standard Qualification Procedure".

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the site at such intervals as to insure uninterrupted progress of work.

B. Store materials to permit easy access for inspection and identification.

C. Protect material from the elements and from other damage at the site. Replace and pay for material and work damaged and rejected by the Contracting Officer Representative.

1.7 SITE CONDITIONS

A. Borings are furnished for information only. Conditions shown cannot be warranted or assumed to be uniform throughout the project.

B. Piling contractor shall visit the site and be thoroughly familiar with all existing conditions including surface disturbance limits, site access, topography, etc. The geotechnical report will be provided for reference.

C. Take field measurements as required by drawings. Where possible take field measurements of existing conditions prior to fabrication. Verify that field measurements are same as those shown on drawings and shop drawings. Report all deviations to the Contracting Officer Representative in writing.

D. Locations may require avoidance of archeological, geological, or other constraints. Notify the Contracting Officer Representative of any discrepancy between geometric pile parameters listed in the structural drawings.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Grout shall consist of a mixture of Portland cement, grout fluidifier, fine aggregate and water so proportioned and mixed as to produce a grout capable of maintaining the solids in suspensions without appreciable water gain and which may be pumped without difficulty. Pozzolan conforming to these specifications may be used at the option of the contractor. These materials shall be so

proportioned as to produce a hardened grout of required strength. Component materials shall meet the following standards:

1. Portland Cement shall conform to Federal Specifications SS-C192 for cements: Portland, or current ASTM Standard, Designation C-150.
2. Pozzolan shall be, if used, a finely sized material composed essentially of compounds of amorphous silica, alumina, and iron, which possesses the property of combining with lime liberated during the process of hydration of Portland cement, and shall conform to Corps of Engineers Specification CRD-C-262.
3. Grout fluidifier shall be the grout fluidifier manufactured by Concrete Chemicals Company of Cleveland, Ohio, or approved equal. It shall inhibit early stiffening, decrease bleeding, eliminate setting shrinkage, increase fluidity, produce the effect of an air entraining agent with respect to freezing and thawing, and shall otherwise conform to all requirements of Corps of Engineers Specification CRD-C-566 except that expansion as described in paragraph 4 shall be a maximum of 4%.
4. Water shall be fresh, clean and free from injurious amounts of sewage, oil, acid, alkali, salts or organic matter.
5. Other admixtures shall not be used.
6. Fine aggregate shall meet the requirements of current ASTM Standards, Designation C-33, except that grading, at the option of the contractor, may conform to Corps of Engineers Specification CRD-C 85.
7. The grout shall have a minimum 28-day cube strength of 4,000 psi.

B. Steel casing shall comply with ASTM A53, Grade B or A501 specifications for pipe sections or ASTM A500, Grade C for HSS sections. Casing sections shall be tightly connected by external threaded couplings or splice welded. Diameter will be based on loading and design criteria, not to exceed 9-5/8” dia. Casing shall be galvanized as lengths may be exposed to weather and deicing chemicals; these conditions shall be considered per casing wall thickness.

C. Filler metal for welding shall conform to be 70xx classification of AWS A5.1.

2.2 SOURCE QUALITY CONTROL

A. Testing
   1. Structural steel casings are subject to all tests required by the Special Inspection requirements of the International Building Code.
   2. Piles are subject to all tests and requirements of the International Building Code.
   3. Tests of grout in accordance with requirements of paragraph 3.07.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine all adjoining work on which this work is in anyway dependent for proper installation and workmanship. Report to the Contracting Officer Representative any conditions which prevents the performance of this work.

3.2 PILING INSTALLATION

A. The piles shall be installed by driving a casing below existing surface elevation to a depth of adequate and suitable subgrade material or as otherwise required and then withdrawing the casing as grout is pumped into the ground through the casing under pressure. The casing shall be seated in the upper part of the grout column. The equipment shall be of sufficient size and capacity to accomplish the specified work. The casing hammer shall have a minimum energy per blow of 400 foot-pounds.

B. Grout shall be pumped from a calibrated tank as approved by the pile designer/installer so that the quantity of grout used for each pile may be measured and recorded as part of the piling record for each pile. The number of strokes of positive displacement pumps shall be recorded if used.

C. The pile inspection engineer shall make accurate records showing the depth to which each pile is installed and the amount of material used in each pile. Any unusual conditions encountered during pile installation shall be noted.
D. Grout injection equipment shall be provided with a grout pressure gauge in clear view of the equipment operator. Rate of grout injection and rate of casing withdrawal from the soil shall be so coordinated as to maintain at all times a positive pressure on this gauge.
E. The volume rate of casing withdrawal shall be slower than the volume rate of grout pumped so that the grout will tend to consolidate soft or weak soil zones and create a minimum shaft diameter of 8 inches. Casing hoisting equipment shall be so designed as to enable the casing to be withdrawn smoothly and steadily at a constant rate.
F. If the casing jumps upwardly during removal, the casing shall be reinserted into the grout a sufficient distance as directed by the pile inspection engineer and regrouted by the specified procedure.

3.3 MIXING AND PUMPING OF GROUT

A. Only approved mixing and pumping equipment shall be used in the preparation and handling of the grout. A screen to remove oversize particles shall be used between the mixer and pump, or between the mixer and agitator. All oil or other rust inhibitors shall be removed from the mixing drums, stirring mechanisms, and other portions of the equipment in contact with the grout before the mixers are used.
B. All materials shall be accurately measured by volume or weight as they are fed to the mixer. The order of placing the materials in the mixer shall be as follows: (1) water, (2) fluidifier, (3) other solids in order of increasing particle size.
C. The quantity of water used shall be such as to produce a grout having a consistency of not less than 30 seconds when tested with a flow cone in accordance with Corps of Engineers Specification CRD C-79. Time of mixing shall be not less than one minute. If agitated continuously, the grout may be held in the mixer or agitator for a period not exceeding two hours at temperatures below 70 degrees F and for a period not exceeding one and one-half hours at the higher temperatures. If there is a lapse in the operation of grout injection, the grout shall be recirculated through the pump, or through the mixer drum (or agitator) and pump.

3.4 DETERMINATION OF PILE DIAMETER AND LENGTH

A. The length and diameter of the piles is by the pile designer/installer per loading and design criteria provided in the structural drawings, in conjunction with geotechnical information, and field testing. Dimensions may be revised as a result of soil foundation bearing information obtained during pile installation and subject to the approval of the special inspector.

3.5 LOCATION OF PILES

A. Piles shall be located as shown on the contract drawings or as otherwise directed by the Contracting Officer Representative. Pile centers shall be located to an accuracy of three inches and shall be plumb within 2%. In the event that non-drivable material is encountered which prevents installing a pile to the depth required, the short pile shall be completed as described herein, and, if necessary an additional adjacent pile or piles shall be placed as directed by the Contracting Officer Representative at no additional cost to the Government.
B. See Section 1.4 herein for further requirements.

3.6 PILE CUT-OFF

A. Pile cut-off shall be performed at elevation coordinated with the landscape drawing elevations to install the prefabricated boardwalk. Pile installer shall coordinate elevations with the drawing set and boardwalk supplier.

3.7 PREPARATION OF GROUT TEST SPECIMENS

A. Throughout each eight-hour shift at least six (6) test specimens of grout shall be prepared by pouring grout into 2" x 2" x 2" cube molds and tested in accordance with ASTM Designation C

109-64, Paragraph 12, 13 and 14. Molds shall be provided with a top cover plate so designed as to restrain grout expansion and to permit escape of air and water.

B. Contractor shall furnish cube molds, storage box and all labor required to make specimens.
C. Specimens shall be prepared by Engineer of Special Inspection. Testing will be performed by Testing Agency. Special inspections and testing shall be provided by the Contractor.

3.8 SPECIAL INSPECTIONS

A. Special inspections as required by the International Building Code will be performed by the Engineer of Special Inspection assisted by the Testing Agency, provided by the Contractor, at no cost to the Government.
B. Piling contractor shall give the Engineer of Special Inspection and the Testing Agency at least 7 days notice prior to commencing work on the project. Once project is underway, piling contractor shall notify each party at least 24 hours in advance of all work subject to their inspection.
C. Piling contractor shall furnish all access, labor and equipment as required by the Engineer of Special Inspection or Testing Agency to perform their duties.

3.9 PAYMENT

A. The base bid shall be for the total number of piles called for by the contract drawings and specifications. Contractor shall include a unit price for increase or decrease in total pile quantity by stating a unit cost per pile.
B. The costs for mobilization and demobilization shall be stated separately, if applicable, but in any case they will be paid only once for the project.

END OF SECTION

SECTION 31 66 13
HELICAL PILES AND HELICAL ANCHORS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

This work pertains to furnishing and installing Helical Piles, Helical Anchors, and Bracket Assemblies shown in the Contract in accordance with the Drawings and this specification. Each Helical Pile and Helical Anchor shall be installed at the location and to the elevation, minimum length, installation torque, and allowable capacities shown on the Drawingss or as established. This work also pertains to load testing and pre-loading Helical Piles and Helical Anchors (if required on the Drawings).

1.2 RELATED REQUIREMENTS

A. Section 02 41 13 Selective Site Demolition
B. Section 31 23 00 Earthwork
C. Section 31 63 33 Drilled Micropiles
D. Section 32 34 00 Prefabricated Boardwalks

1.3 REFERENCES

This specification is based on nationally recognized codes and standards including the references listed below. In case of a conflict between the reference and this specification, this specification shall govern.

A. American Society for Testing and Materials (ASTM):
   1. ASTM A36/A36M Structural Steel
   2. ASTM A123-02 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
   3. ASTM A153-05 Standard Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware
   4. ASTM A450/A450M-07 Standard Specification for General Requirements for Carbon and Low Alloy Steel Tubes
   5. ASTM D1143/D1143M-07 Standard Test Method for Piles Under Static Axial Compressive Load
   6. ASTM D3689 Standard Test Method for Individual Piles Under Static Axial Tensile Load
   7. ASTM D3966-07 Standard Test Method for Piles Under Lateral Loads

B. American Society of Mechanical Engineers (ASME):
   1. ANSI/ASME Standard B18.2.1-1996, Square and Hex Bolts and Screws, Inch Series

C. Occupational Safety and Health Administration (OSHA):
   1. Excavation Safety Guidelines

D. ICC-Evaluation Services, Inc.:
   1. AC358 Acceptance Criteria for Helical Foundation Systems and Devices

E. American Welding Society
   1. ANSI/AWS B2.1-00 Standard for Welding Procedure and Performance Qualification

1.4 DEFINITIONS

A. Helical Pile: Manufactured steel foundation with one or more helical bearing plates that is rotated into the ground to support structures.
B. Helical Anchor: Same as a Helical Pile. Term generally used when axial tension is the primary service load.
C. Contracting Officer Representative: Individual retained by Government to verify Helical Pile and Helical Anchor quality assurance with the Contract, the Drawings, and this specification.
D. Allowable Bearing Capacity: Ultimate bearing capacity of the bearing stratum divided by a factor of safety.

E. Lead Section: The first section of a Helical Pile or Helical Anchor to enter the ground. Lead Sections consist of a central shaft with a tapered end and one or more helical bearing plates affixed to the shaft.
F. Extension Section: Helical Pile or Helical Anchor sections that follow the Lead Section into the ground and extend the Helical Lead to the appropriate depth. Extension Sections consist of a central shaft and may have helical bearing plates affixed to the shaft.
G. Brackets: Cap plate, angle, thread bar, or other termination device that is bolted or welded to the end of a Helical Pile or Helical Anchor after completion of installation to facilitate attachment to structures or embedment in cast-in-place concrete.
H. Augering: Rotation of the shaft with little or no advancement. It can occur when the helical bearing plates pass from a relatively soft material into a comparatively hard material. Augering can also result from insufficient crowd or downward pressure during installation. In some cases, augering may be (temporarily) necessary in order to grind through an obstruction.
I. Pile Design Professional: Individual or firm responsible for the design of Helical Piles, Helical Anchors, and Brackets.

1.5 QUALIFICATIONS

A. Due to the special requirements for manufacture and quality control of Helical Piles, Helical Anchors, and Brackets, all Helical Piles, Helical Anchors, and Brackets shall be designed per the following inclusions:
   1. A product catalog and all necessary technical data sufficient to qualify the proposed product substitution.
   2. Evidence showing manufacturer has at least ten (10) years experience in the design and manufacture of Helical Piles and Helical Anchors.
   3. Current ICC-ES product evaluation report or complete description of product testing and engineering calculations used to assess product capacity.
   4. Current ISO 9001:2008 certification.
B. Due to the special requirements for installation of Helical Piles, Helical Anchors, and Brackets, all Helical Piles, Helical Anchors, and Brackets shall be installed by an organization specializing in the installation of those products. Contractor shall be an authorized installer and shall have completed training from the pile designer in the proper methods of installation of Helical Piles and Helical Anchors and the mounting of Brackets.
   Any Contractor desiring to bid as the Helical Pile and Helical Anchor installer for this project that is not currently trained and authorized by pile designer shall submit a request to the Contracting Officer Representative for review not less than seven (7) calendar days prior to the bid date. The request must include:
   1. A recent company brochure indicating experience in this type of work.
   2. Evidence of having installed Helical Piles and Helical Anchors on at least ten (10) projects, including project name, number and type of Helical Piles or Helical Anchors, project location, and client contact information.
   3. Resume of Contractor's foreman including experience in the oversight of Helical Pile and Helical Anchor installation on at least five (5) projects in the last five (5) years, including project name, number and type of Helical Piles or Helical Anchors installed, project location, and client contact information.
   4. List of installation and testing equipment and detailed description of proposed method of installation and load testing Helical Piles and Helical Anchors (if testing is required).
   5. Current ANSI/AWS welding certificate and documentation of welder experience within the last 5 years (if welding is required).
C. Due to the special requirements for design of Helical Piles, Helical Anchors, and Brackets, all Helical Piles, Helical Anchors, and Brackets shall be designed by a Pile Design Professional and shall submit a request to the Contracting Officer Representative for review not less than seven (7) calendar days prior to the bid date. The request must include:
   1. The curriculum vitae of the designated Pile Design Professional indicating at least ten (10) years experience in this type of work as well as graduate education in structural and/or geotechnical engineering.

2. Evidence of Pile Design Professional having designed Helical Piles and Helical Anchors on at least ten (10) projects, including project name, number and type of Helical Piles or Helical Anchors, project location, and client contact information.
3. Professional errors and omissions liability insurance certificate.
4. Evidence of current license to practice engineering in the project state

1.6 SUBMITTALS

A. Submittal including the following:
1. Helical Pile and Helical Anchor product identification number(s) and designation(s)
2. Maximum allowable mechanical compression and tensile strength of the Helical Piles and Helical Anchors
3. Number of Helical Piles and Helical Anchors and respective design allowable capacities from the Drawings
4. Planned installation depth and the number of lead and extension sections
5. Preliminary helical configuration (number and diameter of helical bearing plates)
6. Manufacturer's recommended capacity to installation torque ratio
7. Minimum final installation torque(s)
8. Product identification numbers and designations for all Bracket Assemblies and number and size of connection bolts or concrete reinforcing steel detail
9. Corrosion protection coating on Helical Piles, Helical Anchors, and Bracket Assemblies

B. Contractor's Pile Design Professional shall submit to the Contracting Officer Representative design calculations for the Helical Piles, Helical Anchors, and Brackets intended for use on the project at least 14 calendar days prior to planned start of installation. The Shop Drawings shall include the following:
1. Reduction in shaft dimension and strength by the sacrificial thickness anticipated based on corrosion loss over the design life for project soil conditions.
2. Considerations for downdrag, buckling, and expansive soils (as appropriate).
3. Minimum installation depth to reach bearing stratum and to achieve pullout capacity (if required).
4. Soil bearing and pullout capacity.
5. Lateral resistance of the shaft (if required).
6. Estimated pile head movement at design loads.

C. Contractor shall submit to the Contracting Officer Representative calibration information certified by an independent testing agency for the torque measurement device and all load testing and monitoring equipment to be used on the project. Calibration information shall have been tested within the last year of the date submitted. Calibration information shall include, but is not limited to, the name of the testing agency, identification number or serial number of device calibrated, and the date of calibration.

D. Load tests are highly recommended. The Contractor shall submit for review and acceptance the proposed load testing procedure. The proposal shall provide the minimum following information:
1. Type and sensitivity of load equipment
2. Type and sensitivity of load measuring equipment
3. Type and sensitivity of pile-head deflection equipment
4. General description of load reaction system, including description of reaction anchors or bearing plate
5. Calibration reports for equipment, including hydraulic jack, pressure gauges, and deflection dial gauges

E. Manufacturer shall provide a one year warranty against manufacturing defects on Helical Pile, Helical Anchor, and Bracket products. Any additional warranty provided by the Contractor shall be issued as an addendum to this specification.

F. Work shall not begin until all the submittals have been received and approved by the Contracting Officer Representative. The Contractor shall allow the Contracting Officer Representative a reasonable number of days to review, comment, and return the submittal package after a complete set has been received. All costs associated with incomplete or unacceptable submittals shall be the responsibility of the Contractor.

G. Piling designer/contractor shall submit drawings and typewritten procedures describing the exact sequence of pile installation. All piles shall be numbered. No work shall commence until procedures are approved.
H. Submit list of all equipment proposed for use on the project.
I. Submit pile locations, staked out on site by the Contractor, for review and approval by Contracting Officer Representative prior to on-site mobilization. Note: locations may require avoidance of archeological, geological, or other constraints. Notify the Contracting Officer Representative of any discrepancy between geometric pile parameters listed on the Drawings.
J. Piling designer/contractor shall submit signed and sealed design shop drawings and calculations, based on staked pile locations and in accordance with the loading and design criteria provided in the structural drawings, by a professional engineer licensed in the state of Michigan. Design shall Helical Pile, Helical Anchor, and Bracket products coordinated with the steel boardwalk prefabricator (cap by boardwalk supplier), and any lateral bracing between foundation elements. Submittal is subject to review and approval by the Contracting Officer Representative.
K. Submit as-built documents including but not limited to pile locations, size, and cap elevations on the Drawings, as they were field-installed by the Contractor. Submittal is subject to review and coordination with the steel boardwalk supplier prior to boardwalk fabrication to ensure prefabricated frames can be installed as they are shipped to site.

1.7 QUALITY ASSURANCE

A. Qualifications
   1. The piling contractor shall have at least five years' experience in the kind of work specified herein and will be required to submit a list of projects successfully completed where he has installed this type of pile in similar ground conditions.
B. Regulatory Requirements
   1. Building Code: Work of this section shall conform to all requirements of the International Building Code and all applicable regulations of governmental authorities having jurisdiction, including safety, health, noise and anti-pollution regulations. Where more severe requirements than those contained in the building code are given in this section, the requirements of this section shall govern.
C. Certifications
   1. Structural steel shall conform to the material acceptance, certification and inspection requirements of article 7, Chapter 1 - Subchapter 1 and tables 10-1 and 10-2 of the Building Code (title 27).
   2. Quality welding processes and welding operators in accordance with AWS "Standard Qualification Procedure".

1.8 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the site at such intervals as to insure uninterrupted progress of work.
B. Store materials to permit easy access for inspection and identification.
C. Protect material from the elements and from other damage at the site. Replace and pay for material and work damaged and rejected by the Contracting Officer Representative.
D. All Helical Pile, Helical Anchor, and Bracket Assemblies shall be free of structural defects and protected from damage. Store Helical Piles, Helical Anchors, and Bracket Assemblies on wood pallets or supports to keep from contacting the ground. Damage to materials shall be cause for rejection.

1.9 SITE CONDITIONS

A. Borings are furnished for information only. Conditions shown cannot be warranted or assumed to be uniform throughout the project.
B. Piling contractor shall visit the site and be thoroughly familiar with all existing conditions including surface disturbance limits, site access, topography, etc. The geotechnical report will be provided for reference.
C. Take field measurements as required by drawings. Where possible take field measurements of existing conditions prior to fabrication. Verify that field measurements are same as those shown on

drawings and shop drawings. Report all deviations to the Contracting Officer Representative in writing.

D. Locations may require avoidance of archeological, geological, or other constraints. Notify the Contracting Officer Representative of any discrepancy between geometric pile parameters listed in the structural drawings.

PART 2 - PRODUCTS

2.1 MATERIALS

A. All Helical Pile, Helical Anchor, and Bracket Assemblies shall be manufactured by Contractor's Pile Design Professional. It is the Contractor's Pile Design Professional's responsibility to select the appropriate size and type of Helical Piles, Helical Anchors, and Brackets to support the design loads shown on the Drawings. These specifications and the Drawings provide minimum requirements to aid the Contractor in making appropriate materials selections. The size and number of helical bearing plates must be such that the Helical Piles and Helical Anchors achieve the appropriate torque and capacity in the soils at the site within the minimum and maximum length requirements. Failure to achieve proper torque and capacity shall result in Contractor replacing Helical Piles and Helical Anchors as appropriate to support the required loads. All material replacements shall be acceptable to Contracting Officer Representative.

B. The design strength of the helical bearing plates, shaft connections, Brackets, and the pile shaft itself shall be sufficient to support the design loads specified on the Drawings times appropriate service load factors. In addition, all Helical Piles and Helical Anchors shall be manufactured to the following criteria.

1. Central Shaft: The central shaft shall be 3-inch, 4.5-inch, or 5.72-inch outside diameter (O.D.) high strength structural steel tube meeting the requirements of ASTM A450 Grade 65. The central shaft shall have design wall thicknesses of 0.125, 0.25, 0.31, 0.37, or 0.46 inches.
2. Helical Bearing Plates: One or more helical bearing plates shall be affixed to the central shaft. Helical bearing plates shall be 8, 10, 12, 14, 16, 20, or 24 inches in diameter depending on required bearing area. Helical bearing plates mounted to 3-inch, 4.5-inch, or 5.72-inch O.D. shafts shall have a minimum thicknesses of 3/8, 5/8, or 7/8 inches, respectively, and shall meet the requirements of ASTM A36. Helical bearing plates shall be attached to 3-inch, 4.5-inch, or 5.72-inch O.D. shafts via 3/16, 5/16, or 7/16 inch fillet welds, respectively, continuous on top and bottom and around the leading edges. Helical bearing plates shall be cold pressed into a near perfect helical shape that when affixed to the central shaft are perpendicular with the central shaft, of uniform pitch, and such that the leading and trailing edges are within 3/8 inch of parallel. Average helical pitch shall be within plus or minus 1/4 inch of the thickness of the helical bearing plate plus 3 inches.
3. Corrosion Protection: Depending on project requirements and soil corrosivity, Helical Piles, Helical Anchors, and Brackets shall be bare steel, powder coated, or hot-dip galvanized (per ASTM A123 or A153 as applicable).
4. Shaft Connections: The Helical Pile and Helical Anchor shaft connections shall consist of an external sleeve connection or a welded connection. External sleeve connections shall be in-line, straight and rigid and shall have a maximum tolerable slack of 1/16-inch. Welded connections shall consist of a full penetration groove weld all-around the central shaft. Shaft connections shall have a flexural strength at least as great as the shaft itself.
5. Bolts: External sleeve connections for 3-inch, 4.5-inch, or 5.72-inch O.D. shafts shall be made via one, two, or three bolts, respectively. Bolts shall be either 7/8, 1, 1-1/4, or 1-1/2-inch diameter as required for strength. Bolt holes through the external sleeve and central shaft shall have a diameter that is 1/16th inch greater than the bolt diameter. Bolts and nuts used to join Helical Pile and Helical Anchor sections at the shaft connections shall be bare steel, epoxy coated, or zinc coated to match the corrosion protection used for the central shaft. Bolts shall be ASME SAE Grade 8 for MH325R piles or ASME SAE Grade 5 for all other piles. All Helical Pile and Helical Anchor bolts shall be securely snug tightened.
6. Plug Welds: Alternatively, external sleeve connections may be made using plug welds matching the diameter and number of bolt holes.

7. External sleeve: External sleeve Helical Pile and Helical Anchor shaft connections shall consist of a 3.375-inch diameter by 0.13-inch thick wall, 3.625-inch diameter by 0.25-inch thick wall, 3.75-inch diameter by 0.31- inch thick wall, 5.25-inch diameter by 0.31-inch thick wall, or 6.77-inch diameter by 0.46-inch thick wall high strength structural steel tube outer sleeve meeting the requirements of ASTM A450 Grade 65. The outer sleeve shall be welded to the central shaft via a continuous fillet weld allaround. The fillet weld shall have a throat thickness equal to the external sleeve tube thickness.
8. Reinforced connections: Reinforced shaft connections shall have a 2.75- inch diameter by 0.125-inch thick wall, 2.500-inch diameter by 0.25-inch thick wall, 4-inch diameter by 0.25-inch thick wall, 3.88-inch diameter by 0.25-inch thick wall, 5.22-inch diameter by 0.25-inch thick wall, 4.97-inch diameter by 0.375 thick wall, or 4.80-inch diameter by 0.46-inch thick wall high strength structural steel tube inner sleeve meeting the requirements of ASTM A450 Grade 65. The inner sleeve shall be welded to the central shaft via plug welds oriented 90 degrees from and located slightly below the bolt holes.

C. Helical Piles and Helical Anchors shall be fitted with a manufactured Bracket that facilitates connection to the prefabricated steel boardwalk structure. Brackets shall be rated for the design loads shown on the Drawings. Brackets shall be affixed to the end of Helical Piles and Helical Anchors via bolts, plug welds, or continuous penetration welds meeting the requirements for shaft connections given previously in these specifications.

2.2 SOURCE QUALITY CONTROL

A. Testing
1. Structural steel is subject to all tests required by the Special Inspection requirements of the International Building Code.
2. Piles are subject to all tests and requirements of the International Building Code.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine all adjoining work on which this work is in anyway dependent for proper installation and workmanship. Report to the Contracting Officer Representative any conditions which prevents the performance of this work. Contractor shall take reasonable effort to locate all utilities and structures above and underground in the area of the Work. Contractor shall pot hole to determine the exact location of underground utilities and buried structures within a distance from a Helical Pile or Helical Anchor equal to three times the maximum helix diameter. Contractor is responsible for protection of utilities and structures shown on the Drawings. Costs of avoiding, relocating, or repair of utilities not shown on Drawings are the Contractor's responsibility at no additional cost to the Government.

B. Contractor shall review Drawings and soil borings in the Contract Documents to determine subsurface conditions for sizing and installation of Helical Piles and Helical Anchors. In addition, Contractor shall make a site visit to observe conditions prior to the start of Work.

C. Contractor shall notify Contracting Officer Representative of any condition that would affect proper installation of Helical Piles and Helical Anchors immediately after the condition is revealed. Contractor shall halt installation work until the matter can be resolved by the Contracting Officer Representative. Costs associated with construction delays, product substitutions, pile or anchor relocations, or other related costs shall be the responsibility of the Contractor.

D. If the number and size of helical bearing plates required for the project is not shown on the working drawings, the contractor shall have the option of performing subsurface tests using methods subject to the review and acceptance of the Contracting Officer Representative. The data collected along with other information pertinent to the project site shall be used to determine the required helical bearing plate configuration.

E. If excavation is required for proper installation of Helical Piles and Helical Anchors, Contractor shall make safe excavations in accordance with OSHA standards. All excavations greater than 20 feet in depth or not in strict accordance with OSHA standard details shall be designed by a registered design professional specializing in the design of excavations and shoring. The costs of all excavations, shoring, and related design shall be born by the Contractor.

F. Contractor shall notify Contracting Officer Representative at least 24 hours prior to installation of Helical Piles or Helical Anchors to schedule quality assurance observations required on the Drawings.

3.2 PILING INSTALLATION

A. INSTALLATION EQUIPMENT

1. Torque Motor: Helical Piles and Helical Anchors should be installed with high torque, low RPM torque motors, which allow the helical plates to advance with minimal soil disturbance. The torque motor shall be hydraulic power driven with clockwise and counter-clockwise rotation capability. The torque motor shall be adjustable with respect to revolutions per minute during installation. Percussion drilling equipment shall not be permitted. The torque motor shall have torque capacity equal to or greater than the minimum final installation torque required for the project. The connection between the torque motor and the installation rig shall have no more than two pivot hinges oriented 90 degrees from each other. Additional hinges promote wobbling and affect lateral capacity.
2. Installation Equipment: The installation equipment shall be capable of applying adequate crowd and torque simultaneously to ensure normal advancement of the Helical Piles and Helical Anchors. The equipment shall be capable of maintaining proper alignment and position.
3. Drive Tool: The connection between the torque motor and Helical Pile and Helical Anchor shall be in-line, straight, and rigid, and shall consist of a hexagonal, square, or round kelly bar adapter and helical shaft socket. To ensure proper fit, the drive tool shall be manufactured by the Helical Pile manufacturer and used in accordance with the manufacturer's installation instructions.
4. Connection Pins: The central shaft of the Helical Pile or Helical Anchor shall be attached to the drive tool by ASME SAE Grade 8 smooth tapered pins matching the number and diameter of the specified shaft connection bolts. The connection pins should be maintained in good condition and safe to operate at all times. The pins should be regularly inspected for wear and deformation. Pins should be replaced with identical pins when worn or damaged.
5. Torque Indicator: A torque indicator shall be used to measure installation torque during installation. The torque indicator can be an integral part of the installation equipment or externally mounted in-line with the installation tooling. The torque indicator shall be capable of torque measurements with a sensitivity of 500 ft-lb or less. Torque indicators shall have been calibrated within 1-year prior to start of Work. Torque indicators that are an integral part of the installation equipment shall be calibrated on-site. Torque indicators that are mounted in-line with the installation tooling shall be calibrated either on-site or at an appropriately equipped test facility. Indicators that measure torque as a function of hydraulic pressure shall be re-calibrated following any maintenance performed on the torque motor. Torque indicators shall be re-calibrated if, in the opinion of the pile installer, reasonable doubt exists as to the accuracy of the torque measurements.

B. INSTALLATION PROCEDURES

1. Unless shown on the Drawings, the number and size of helical blades shall be determined by the Contractor's Pile Design Professional in order to achieve the required torque and tensile/bearing capacity for the soil conditions at the site. The ratio of design load to the total area of the helical bearing plates shall not exceed the Allowable Bearing Capacity.
2. Connect the lead section to the Torque Motor using the Drive Tool and Connection Pins. Position and align the Lead Section at the location and to the inclination shown on the Drawings and crowd the pilot point into the soil. Advance the Lead Section and continue to add Extension Sections to achieve the Termination Criteria. All sections shall be advanced into the soil in a smooth, continuous manner at a rate of rotation between 10 and 40 revolutions per minute. Snug tight all coupling bolts.
3. Constant axial force (crowd) shall be applied while rotating Helical Piles and Helical Anchors into the ground. The crowd applied shall be sufficient to ensure that the Helical Pile and Helical Anchor advances into the ground a distance equal to at least 80% of the blade pitch per revolution during normal advancement.
4. The torsional strength rating of the Helical Pile or Helical Anchor shall not be exceeded during installation.

5. Bolt hole elongation due to torsion of the shaft of a Helical Anchor at the drive tool shall be limited to ¼ inch. Helical Anchors with bolt hole damage exceeding this criterion shall be uninstalled, removed, and discarded.
6. When the Termination Criteria of a Helical Pile or Helical Anchor is obtained, the Contractor shall adjust the elevation of the top end of the shaft to the elevation shown on the Drawings or as required. This adjustment may consist of cutting off the top of the shaft and drilling new holes to facilitate installation of Brackets to the orientation shown on the Drawings. Alternatively, installation may continue until the final elevation and orientation of the pre-drilled bolt holes are in alignment. Contractor shall not reverse the direction of torque and back-out the Helical Pile or Helical Anchor to obtain the final elevation.
7. The Contractor shall install Brackets in accordance with Helical Pile manufacturer's details or as shown on the Drawings.
8. All Helical Pile and Helical Anchor components including the shaft and Bracket shall be isolated from making a direct electrical contact with any concrete reinforcing bars or other non-galvanized metal objects since these contacts may alter corrosion rates.
9. After installation, Helical Anchors shall be pre-tensioned if indicated on the Drawings.

C. TERMINATION CRITERIA
1. Helical Piles and Helical Anchors shall be advanced until all of the following criteria are satisfied.
    a. Axial capacity is verified by achieving the final installation torque as shown on the Drawings, as provided by the Pile Design Professional, or as specified here. Helical Pile and Helical Anchor capacity in soil and on bedrock depends on the geometric configuration of the helical bearing plates and the subsurface conditions. The torque applied during installation provides a verification of axial capacity. An ultimate capacity to torque ratio of 8 ft-1, 5.7 ft-1, and 4.6 ft-1 shall be used to verify capacity for 3-inch, 4.5-inch, and 5.72-inch O.D. shafts, respectively. A minimum factor of safety of 2.0 shall be used to determine allowable capacity. Hence, all Helical Piles and Helical Anchors shall be advanced until a final installation torque is achieved equal to the design loads shown on the Drawings times a factor of safety of 2.0 divided by the capacity to torque ratio (e.g. final installation torque, ft-lbs = design loads, lbs x 2.0 / capacity to torque ratio, ft-1).
    b. Minimum depth is obtained. The minimum depth shall be as shown on the Drawings, that which corresponds to the planned bearing stratum, or the depth at which the final installation torque is measured, whichever is greater. In addition, Helical Anchors shall be advanced until the average torque over the last three (3) feet equals or exceeds the required final installation torque.
2. Pile cut-off shall be performed at elevation coordinated with the landscape drawing elevations to install the prefabricated boardwalk. Pile installer shall coordinate elevations with the drawing set and boardwalk supplier.
3. If the torsional strength rating of the Helical Pile or Helical Anchor and/or the maximum torque of the installation equipment has been reached or Augering occurs prior to achieving the minimum depth required, the Contractor shall have the following options:
    a. Terminate the installation at the depth obtained subject to the review and acceptance of the Contracting Officer Representative.
    b. Remove the Helical Pile or Helical Anchor and install a new one with fewer and/or smaller diameter helical bearing plates or with dual cutting edge helical bearing plates. The new helical configuration shall be subject to review and acceptance of the Contracting Officer Representative.
    c. Remove the Helical Pile or Helical Anchor and pre-drill a 4-inch diameter pilot hole in the same location and reinstall the anchor/pile.
    d. If the obstruction is shallow, remove the Helical Pile or Helical Anchor and remove the obstruction by surface excavation. Backfill and compact the resulting excavation and reinstall the anchor/pile.
    e. Remove the Helical Pile or Helical Anchor and relocate 1-foot to either side of the installation location subject to the review and acceptance of Contracting Officer Representative.

f. Reverse the direction of torque, back-out the Helical Pile or Helical Anchor a distance of 1 to 2 feet and attempt to reinstall by decreasing crowd and Augering through the obstruction.
g. Remove the Helical Pile or Helical Anchor and sever the uppermost helical bearing plate from the Lead Section if more than one helical bearing plate is in use. Reinstall the anchor or pile with revised helical bearing plate configuration.

4. If the final installation torque is not achieved at the contract length, the Contractor shall have the following options:
   a. Until the maximum depth is achieved (if any), install the Helical Pile or Helical Anchor deeper using additional Extension Sections.
   b. Remove the Helical Pile or Helical Anchor and install a new one with additional and/or larger diameter helical bearing plates
5. Decrease the rated load capacity of the Helical Pile or Helical Anchor and install additional Helical Piles or Helical Anchors. The rated capacity and additional unit location shall be subject to the review and acceptance of the Contracting Officer Representative.

D. ALLOWABLE TOLERANCES
1. Helical Piles and Helical Anchors shall be installed as close to the specified installation and orientation angles as possible or as otherwise directed by the Contracting Officer Representative. Pile centers shall be located to an accuracy of three inches and shall be plumb within 2%. In the event that non-drivable material is encountered which prevents installing a pile to the depth required, the short pile shall be completed as described herein, and, if necessary an additional adjacent pile or piles shall be placed as directed by the Contracting Officer Representative at no additional cost to the Government. Tolerance for departure from installation and orientation angles shall be +/- 5 degrees.
2. Helical Piles, Helical Anchors, and Bracket Assemblies shall be installed at the locations and to the elevations shown on the Drawingss. Tolerances for Bracket Assembly placement shall be +/- 1 inch in both directions perpendicular to the shaft and +/- 1/4 inch in a direction parallel with the shaft unless otherwise specified.
3. See Section 1.6 herein for further requirements.

E. QUALITY ASSURANCE
1. The Contractor shall provide the Contracting Officer Representative copies of installation records within 48 hours after each installation is completed. These installation records shall include, but are not limited to, the following information:
   a. Name of project and Contractor
   b. Name of Contractor's supervisor during installation
   c. Date and time of installation
   d. Name and model of installation equipment
   e. Type of torque indicator used
   f. Location of Helical Pile or Helical Anchor by grid location, diagram, or assigned identification number
   g. Type and configuration of Lead Section with length of shaft and number and size of helical bearing plates
   h. Type and configuration of Extension Sections with length and number and size of helical bearing plates, if any
   i. Installation duration and observations
   j. Total length installed
   k. Final elevation of top of shaft and cut-off length, if any
   l. Final plumbness or inclination of shaft
   m. Installation torque at minimum three-foot depth intervals
   n. Final installation torque
   o. Comments pertaining to interruptions, obstructions, or other relevant information
   p. Verified axial load capacity
2. Unless specified otherwise on the Drawings or by local codes, the Contracting Officer Representative, the Pile Design Professional, or an inspection agency shall observe and document at least 10 percent of Helical Pile and Helical Anchor installations.

F. LOAD TESTING
   1. Helical Pile Compression Tests
      a. Contractor shall perform the number of compression tests shown on the Drawings, if any
      b. Compression tests shall be performed following the “quick test” procedure described in ASTM D1143 specifications
      c. Load tests shall be observed and documented by the Contracting Officer Representative.
      d. Unless otherwise shown on the Drawings, the maximum test load shall be 200% of the allowable load shown on the Drawings
      e. The locations of Helical Piles to be tested shall be determined by the Contractor, unless noted on the Drawings
      f. Installation methods, procedures, equipment, products, and final installation torque shall be identical to the production Helical Piles to the extent practical except where otherwise approved by the Contracting Officer Representative.
      g. A load test shall be deemed acceptable provided the maximum test load is applied without Helical Pile failure and the deflection of the pile head at the design load is less than 1-inch unless noted otherwise on the Drawings. Failure is defined when continuous jacking is required to maintain the load.
   2. Helical Anchor Tension Loads
      a. Contractor shall perform the number of proof load tests shown on the Drawings, if any
      b. Proof load tests shall be performed following the procedure described in ASTM D3689 specifications
      c. Proof load tests shall be observed and documented by the Contracting Officer Representative.
      d. Unless otherwise shown on the Drawings, the maximum test load shall be 150% of the allowable load shown on the Drawings
      e. The locations of Helical Anchors to be tested shall be determined by the Contractor, unless shown on the Drawings
      f. Installation methods, procedures, equipment, products, and final installation torque shall be identical to the production anchors to the extent practical except where otherwise approved by the Contracting Officer Representative.
      g. A proof load test shall be deemed acceptable provided the maximum test load is applied without helical anchor failure. Failure is when continuous jacking is required to maintain the load.
   3. Helical Pile Lateral Load Tests
      a. Contractor shall perform the number of lateral load tests shown on the Drawings, if any.
      b. Lateral load tests shall be performed following the “free head” procedure described in ASTM D3966 specifications
      c. Lateral load tests shall be observed and documented by the Contracting Officer Representative.
      d. Unless otherwise shown on the Drawings, the maximum test load shall be 200% of the allowable lateral load shown on the Drawings
      e. The locations of test Helical Piles shall be determined by the Contractor, unless shown on the Drawings
      f. Installation methods, procedures, equipment, products, and final installation torque shall be identical to the production piles to the extent practical except where otherwise approved by the Contracting Officer Representative.
      g. A lateral load test shall be deemed acceptable provided the lateral deflection of the pile head measured at the ground surface at the maximum test load is equal to or less than 1-inch.
   4. If a load test fails the forgoing acceptance criteria, the Contractor shall modify the Helical Pile or Helical Anchor design and/or installation methods and retest the modified pile or anchor, as directed by the Contracting Officer Representative. These modifications include, but are not limited to, de-rating the load capacity, modifying the installation methods and equipment, increasing the minimum final installation torque, changing the helical configuration, or changing the product (i.e., duty). Modifications that require changes to the structure shall have prior

review and acceptance of the Contracting Officer Representative. Any modifications of design or construction procedures, and any retesting required shall be at the Contractor's expense.

5. The Contractor shall provide the Contracting Officer Representative copies of load test reports confirming configuration and construction details within 1 week after completion of the load tests. This written documentation will either confirm the load capacity as required on the working drawings or propose changes based upon the results of the tests. At a minimum, the documentation shall include:
    a. Name of project and Contractor
    b. Date, time, and duration of test
    c. Location of test Helical Pile or Helical Anchor by grid location, diagram, or assigned identification number
    d. Test procedure (ASTM D1143, D3689, or D3966)
    e. List of any deviations from procedure
    f. Description of calibrated testing equipment and test set-up
    g. Type and configuration of Helical Pile or Helical Anchor including lead section, number and type of extension sections, and manufacturer's product identification numbers
    h. Load steps and duration of each load increment
    i. Cumulative pile-head movement at each load step
    j. Comments pertaining to test procedure, equipment adjustments, or other relevant information

3.3 MEASUREMENT AND PAYMENT

A. The base bid shall be for:
    1. The total number of piles called for by the contract drawings and specifications. Contractor shall include a unit price for increase or decrease in total pile quantity by stating a unit cost per pile. One unit consists of the labor, equipment, and materials required to furnish and install a Helical Pile or Helical Anchor and associated Bracket at the location and to the elevation, orientation, inclination, length, and capacity shown in the Drawings.
    2. Total number of load tests where one unit consists of the labor, equipment, and materials required to perform each required load test.
B. The costs for mobilization and demobilization shall be stated separately, if applicable, but in any case, they will be paid only once for the project.

END OF SECTION

DIVISION 32

Exterior Improvements

SECTION 12 34 56

SECTION TITLE

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Aggregate base course on a prepared subgrade.

1.02 RELATED SECTIONS

1. Section 32 13 13 - Concrete Paving

1.03 REFERENCES

A. The following is a list of Specification which may be related to this section.
   1. American Association of Highway Transportation Officials (AASHTO):
      a. AASHTO T-96, Standard Method of Test for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
   2. ASTM International (ASTM):
      a. ASTM C 131, Standard Test Method for Resistance to Degradation of Small-Size Aggregate by Abrasion and Impact in the Los Angeles Machine
      b. ASTM D 4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

1.04 DELIVERY, STORAGE, AND HANDLING

A. Aggregate: Stockpile, remove, transport, and spread aggregates in a manner that will preserve specified gradation and avoid contamination. Do not intermingle stockpiles of aggregate having different gradations.

1.05 SUBMITTAL

A. Contractor shall provide sample of aggregate for approval.

B. Submit test results and a Certificate of Compliance verifying that aggregate gradation meets contract requirements. Sample the material before incorporation into the work as follows:
   1. For commercially produced aggregates: at the producer's plant or stockpile.

1.06 SEQUENCING AND SCHEDULING

A. Weather Limitations: To be placed at optimum moisture, placement is not recommended if the forecasted weather is too cold or wet to allow the material to meet compaction requirements.

B. Construct aggregate base only after all of the following have been completed:
   1. Subgrade has been checked for conformance to line and grade tolerances.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Aggregate Base: Conform to MDOT Spec 302, Class 22A aggregate.

PART 3 – EXECUTION

3.01 EXAMINATION

A. Examine trail for drainage concerns. Proceed with installation only after culvert installation and all unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Subgrade to be completed and approved by the CO prior to installation of aggregate base.

3.03 SPREADING AND COMPACTING

A. Aggregate should be placed from the furthest point working back towards the source to avoid running equipment on the final trail.

B. Use aggregate that is uniformly mixed at optimum moisture content and spread and compact to the final thickness and width. Obtain compaction by one of the following methods:

1. A roller with a minimum of weight of 5 tons shall be used. No vibratory on the drum shall be allowed.
2. A minimum of 4 passes shall be made for compaction.
3. Proof roll with fully loaded aggregate transport vehicle for acceptance.
4. Use mechanical tamping equipment in areas inaccessible to compaction equipment.

C. Immediately following final spreading, smoothing, and compacting, contractor shall correct any irregularities or depressions that develop by adding or removing material until the surface is smooth, uniform and compacted.

3.04 ACCEPTANCE, TESTING, SAMPLING, TOLERANCES

A. Do not vary the total compacted thickness of the aggregate or place it consistently below or above the specified depth.

B. Do not vary the aggregate width by more than 2 inches from the specified width or place it consistently narrower or wider than the specified width

3.05 PROTECTION

A. Protect aggregate base until it is covered by surface pavement.

B. Keep aggregate base free of ruts and irregularities until covered by surface paving.

C. Place water on aggregate base for dust control as required to eliminate nuisance conditions for adjacent properties.

END OF SECTION

SECTION 32 13 13
CONCRETE PAVING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Concrete paving including the following:
   1. Concrete pavement for on-grade walkways.

1.02 RELATED SECTIONS

A. Section 03 30 00 – Cast In Place Concrete

1.03 ACTION SUBMITTALS

A. Samples: For each type of product, ingredient, or admixture requiring color selection.

B. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

C. Product data for color pigment including color selection chart.

D. Installer Qualification Statement: Provide written documentation verifying all Installer Qualifications are met.

1.04 QUALITY ASSURANCE

A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.

B. Installer Qualifications: Firm specializing in concrete construction with minimum 5 years of documented experience installing cast in place concrete.
   1. Installer shall provide written description and references for five (5) completed projects of a similar scale and type. Include name, email address, and phone number for project contact(s). Provide a brief description of each project and the total contract amount.

C. Provide mockup as indicated on the Drawings.

1.05 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Ready-Mix-Concrete Manufacturer or the Contractor shall engage a third-party testing service to perform standard construction mix testing

PART 2 – PRODUCTS

2.01 CONCRETE, GENERAL

A. ACI Publications: Comply with ACI 301 unless otherwise indicated.

2.02 STEEL REINFORCEMENT

A. Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, fabricated from as-drawn steel wire into flat sheets.

B. Deformed-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, flat sheet.

C. Reinforcing Bars: ASTM A615/A615M, Grade 60; deformed.

D. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded-wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified.

2.03 CONCRETE MATERIALS

A. Cementitious Materials: Use the following cementitious materials, of same type, brand, and source throughout Project:
   1. Portland Cement: ASTM C150/C150M, white portland cement, Type I.
   2. Fly Ash: ASTM C618, Class C or F.
   3. Slag Cement: ASTM C989/C989M, Grade 100 or 120.

B. Normal-Weight Aggregates: ASTM C33/C33M, Class 4S, uniformly graded. Provide aggregates from a single source.

C. Air-Entraining Admixture: ASTM C260/C260M.

D. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

E. Color Pigment: ASTM C979/C979M, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black**,** nonfading, and resistant to lime and other alkalis.
   1. Concrete color additives shall be manufactured by Davis Colors, (800) 800-6856, www.daviscolors.com; or approved equal.
   2. Colors for mockup and pavement to be selected and approved by the COR, from manufacturer's full range of standard colors.

F. Water: Potable and complying with ASTM C94/C94M.

2.04 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry] [or] [cotton mats.

B. Moisture-Retaining Cover: ASTM C171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 1, Class B, dissipating.

2.05 RELATED MATERIALS

A. Joint Fillers: ASTM D1751, asphalt-saturated cellulosic fiber in preformed strips.

2.06 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
   1. Fly Ash or Pozzolan: 25 percent.
   2. Slag Cement: 50 percent.
   3. Combined Fly Ash or Pozzolan, and Slag Cement: 50 percent, with fly ash or pozzolan not exceeding 25 percent.

C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:
   1. Air Content: 6 percent plus or minus 1-1/2 percent.

D. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

E. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

F. Concrete Mixtures: Normal-weight concrete.
   1. Compressive Strength (28 Days): 3500 psi.
   2. Maximum W/C Ratio at Point of Placement: 0.45.
   3. Slump Limit: 4 inches plus or minus 1 inch.

PART 3 – EXECUTION

3.01 EXAMINATION

A. Verify layout, elevations, and grades are in accordance with the Drawings.

B. Proof-roll prepared subbase surface below concrete walks to identify soft pockets and areas of excess yielding.

C. Obtain inspection and approval of construction staking and layout prior to constructing forms.

D. Obtain inspection and approval of forms and reinforcement prior to placing concrete.

3.02 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.03 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.04 INSTALLATION OF STEEL REINFORCEMENT

A. Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

3.05 JOINTS

A. Joint type, size, and location shall be provided as indicated on the Drawings.

B. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.

C. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

D. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.

E. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness plus 1/2".

F. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes.

3.06 CONCRETE PLACEMENT

A. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

B. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

C. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

D. Screed paving surface with a straightedge and strike off.

E. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleedwater appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

3.07 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

C. Light-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface, perpendicular to line of traffic, to provide a uniform, fine-line texture.

3.08 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

D. Curing Methods: Cure concrete by curing compound.

3.09 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 and as follows:
1. Elevation: 3/8 inch.
2. Thickness: Plus 3/8 inch, minus 1/4 inch.
3. Surface: Gap below 10-feet-long; unleveled straightedge not to exceed 3/8 inch.
4. Joint Spacing: 3 inches.
5. Contraction Joint Depth: Plus 1/4 inch, no minus.
6. Joint Width: Plus 1/8 inch, no minus.

3.10 REPAIR AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by CO.

B. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

C. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Clean paving not more than two days before date scheduled for final inspections.

END OF SECTION

SECTION 32 31 29
WOOD FENCES AND GATES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Split Rail Fence

1.02 RELATED REQUIREMENTS

A. Section 321123: Aggregate Base Courses.

1.03 SUBMITTALS

A. See Section 01 10 00 - Division 1 Short Form General Requiremtns for Submitttal procedures.

B. Product Data: Manufacturer's data for wood fence components including wood species, post and rail dimensions, and photographs of the posts and rails.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing work of type specified, with minimum 3 years of documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver, handle, and store fence materials to prevent damage or deterioration. Store materials and components in a secure location to protect from damage and theft, and ensure public safety.

PART 2 PRODUCTS

2.01 WOOD FENCES

A. Split Rail Fence: Provide solid wood split rail fence posts and rails of the type and size indicated on the Drawings.

B. All wood materials for project fences shall be sourced from a single supplier.

2.02 BACKFILL

A. Mineral Soil: Native site soil consiting primarily of sand and gravel; free of topsoil, duff and other organic materials; free of clay.

PART 3 EXECUTION

3.01 EXAMINATION

A. Stake location of fence posts for approval prior to excavation and fence installation.

3.02 INSTALLATION

A. Install fence in accordance with the Drawings

B. Install posts plumb and compact backfill in lifts to secure post and prevent movement.

C. Field cut rails as required to meet plan dimensions. Taper filed cut rails to match factory ends and ensure a snug fit in post openings

D. Grade surface around posts to ensure positive drainage away post bases.

3.03 PROTECTION

A. Protect installed fencing from subsequent construction operations.

END OF SECTION

SECTION 32 32 53
STONE RETAINING WALLS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Stone Retaining Walls - Type 1

B. Stone Retaining Walls - Type 2

C. Geotextiles, backfill, and drainage pipe for retaining walls.

1.02 RELATED REQUIREMENTS

A. Section 31 1400 - Earth Stripping and Stockpiling

B. Section 31 23 00 - Excavation and Fill

C. Section 312500 - Erosion and Sedimentation Controls

1.03 REFERENCE STANDARDS

A. ASTM F2648 - Standard Specification for 2 in. to 60 in. Annular Corrugated Profile Wall Polyethylene (PE) Pipe and Fittings for Land Drainage Applications; 2023.

B. AASHTO M 288 - Standard Specification for Geosynthetic Specification for Highway Applications; 2022.

C. ASTM D448 - Standard Classification for Sizes of Aggregate for Road and Bridge Construction; 2012 (Reapproved 2022).

D. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)); 2012 (Reapproved 2021).

E. ASTM D1241 - Standard Specification for Materials for Soil-Aggregate Subbase, Base, and Surface Courses; 2015.

F. ASTM D4491/D4491M - Standard Test Methods for Water Permeability of Geotextiles by Permittivity; 2022.

G. ASTM D4632/D4632M - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles; 2015a (Reapproved 2023).

H. ASTM D4751 - Standard Test Methods for Determining Apparent Opening Size of a Geotextile; 2021a.

I. ASTM F405 - Standard Specification for Corrugated Polyethylene (PE) Pipe and Fittings; 2013.

1.04 SUBMITTALS

A. See Section 01 10 00 - Division 1 Short Form General Requiremtns for Submitttal procedures.

B. Product Data:
   1. Supplier data for wall stone including location quarried, stone type, approximate dimensions, and a photograph of the material in bulk.
   2. Supplier data for gravel backfill, including source, material name / classification, and sieve analysis.
   3. Manufacturer's data sheets for geotextiles
   4. Manufacturer's data sheets for drain pipe..

C. Installer Qualification Statement: Provide written documentation verifying all Installer Qualifications are met.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Firm specializing in construction of stone retaining walls with minimum 5 years of documented experience installing stone retaining walls.

1. Installer shall provide written description and references for five (5) completed projects of a similar scale and type. Include name, email address, and phone number for project contact(s). Provide a brief description of each project and the total contract amount.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle materials to prevent damage or marring. Do not use damaged, broken, or excessively marred material.

PART 2 PRODUCTS

2.01 MATERIALS

A. Retaining Wall Stone:
   1. Imported Stone: Rounded irregular glacially depostited igneous or metamorphic stone quarried from a location within the upper peninsula of Michigan (commonly known as Michigan boulders or Michigan cobblestone). Match Salvaged stone. Blasted stone is prohibited. Size as indicated on the drawings.
   2. Salvaged Stone: Stone salvaged from the removal of existing stone retaining walls. Do not use stone that has visible mortar on the exposed face. Size as indicated on the drawings.

B. Geotextile Soil Separator: Non-woven geosynthetic textile.
   1. Tensile Strength (Grab) - Non-Woven: 160 pounds, when tested in accordance with ASTM D4632/D4632M.
   2. Apparent Opening Size: 70 to 100 U.S. Sieve size, when tested in accordance with ASTM D4751.
   3. Permittivity: 0.5 per second, minimum, when tested in accordance with ASTM D4491/D4491M.
   4. Durability: Comply with minimum requirements of AASHTO M 288 Class 1; minimum mass of 8 ounces per square yard.

C. Gravel Backfill: Clean, crushed, freely draining aggregate meeting requirements of ASTM D448, Size No. 57, or approved equal. Do not use pea gravel.

D. Drainage Pipe: 4" diameter dual wall Perforated corrugated HDPE complying with ASTM F405 and ASTM F2648.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify location of proposed walkways, abutments, and other improvements prior to layout and excavation.

B. Stake limits of excavation and obtain approval of wall layout prior to excavation.

C. Protect adjacent improvements, vegetation, slopes, and soils from the effects of excavation.

D. Verify that layout dimensions are correct and substrate is in proper condition for wall installation.

E. Obtain inspection and approval of excavated keyway prior to installing wall.

3.02 EXCAVATION

A. Excavate to lines, grades, and dimensions indicated on drawings.

B. Do not disturb embankment or slopes beyond lines. Minimize over-excavation; fill over-excavated areas with compacted site soil backfill at no additional cost to the Government.

C. Where bottom of wall changes elevation, step keyway and maintain minimum depth.

D. Replace unsuitable bearing soil as directed by COR.

3.03 INSTALLATION

A. Install in accordance with drawings, applicable codes and regulations, and industry standards.

B. General:
   1. Place geotextile and base course in approved keyway and verify alignment and layout are correct. Check for base contact and stability prior to backfill.
   2. Backfill and compact gravel below stones on both sides of base course.
   3. Install drainage collection pipe with a continuous fall in the direction of flow. Cap open ends as necessary to prevent soil and debris from entering, and backfill around pipe.
   4. Place a maximum of 2 succeeding courses above level backfill. Check for proper alignment, batter, and backfill prior to placing additional courses.
   5. Where grade at top of wall changes elevation, utilize varied stone sizes to taper wall height and follow grade at top of wall. Taper wall height at wall ends to transition to adjacent grade.

C. Backfill:
   1. Gravel Backfill: Place backfill and compact in lifts 6" thick, maximum; decrease lift thickness where necessary to achieve sufficient compaction.
   2. Soil Backfill: Place and compact site soil behind gravel backfill to meet undisturbed soil while minimizing the development of slack in the geotextile. Place and compact in lifts 6" thick, maximum; decrease lift thickness where necessary to achieve sufficient compaction.
   3. Use only lightweight hand-operated compaction equipment within 3 feet of back wall face, or one half of wall height, whichever is greater.
   4. Compact backfill to 90 percent maximum density, standard Proctor, as determined in accordance with ASTM D698, or as recommended by a Geotechnical Engineer.
   5. Moisture content of backfill prior to and during compaction to be within plus or minus 2 percentage points dry of optimum and uniform throughout each layer.
   6. Prevent contamination of the gravel backfill and drainage materials with soil and debris.

D. Site Drainage:
   1. At end of each day and upon completion of wall construction install temporary sediment and erosion control measures at the crest of the wall to prevent sediment from contaminating the gravel backfill.

3.04 CLEANING

A. Clean wall face to remove excessive soil. Do not remove moss, lichens, or natural weathered patina from stones.

B. Clean adjacent walkways.

3.05 PROTECTION

A. Prevent damage to wall and earthwork by subsequent construction and uncontrolled runoff until Final Acceptance; repair damage due to failure to protect wall or earthwork at no additional cost to the Government.

B. Ensure drain pipe ends remain clear and free of soil and debris until Final Acceptance.

END OF SECTION

SECTION 32 34 00
PREFABRICATED BOARDWALKS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Prefabricated galvanized structural steel framed boardwalks with wood decking, guardrails, and toe rails. Include all fittings, accessories, and fasteners in accordance with the plans.

1.02 RELATED REQUIREMENTS

A. Section 033000 Cast-In Place Concrete: Concrete abutments, concrete anchoring, and epoxy.

B. Section 051200 Structural Steel Framing: Boardwalk Frames and miscellaneous steel components

C. Section 316333 Drilled Micropiles: Boardwalk foundations

D. Section 316613 - Helical Piles and Helical Anchors: Boardwalk Foundations

1.03 DEFINITIONS

A. The terms "Boardwalk", "Prefabricated Boardwalk", and "Elevated Walkway" are synonymous and used interchangeably in the construction specifications and drawings.

1.04 SUBMITTALS

A. See Section 01 10 00 - Division 1 Short Form General Requiremtns for Submitttal procedures.

B. Product Data: Material data sheets for all boardwalk components and materials.

C. Shop Drawings for Boardwalk System: Provide complete shop drawings stamped by an engineer licensed in the State of Michigan. Shop drawings shall indicate all components of the boardwalk system and the following minimum information:
   1. All materials with type and size labeled.
   2. Welding and material fastening methods and details.
   3. Dimensioned layout plans with information required to locate and install the boardwalk system and boardwalk foundations.
   4. Dimensioned elevation and section drawings as required to fabricate and install the boardwalk system.
   5. Written certification and structural calculations as required verifying the boardwalk system meets all project loading criteria.

D. Shop Drawings for Temporary Crib Wall Shoring: If temporary shoring is deemed necessary to facilitate completion of the work, provide detailed shop drawings for all shoring components and indicate the limits of any additional ground disturbance that may be required to install shoring. Provide drawings and calculations stamped by an engineer licensed in the State of Michigan.

E. Shop Drawings for Temporary Protective Measures at Existing Bridges: If temporary shoring, temporary ground protection, or other temporary protective measures are necessary to complete the work, provide detailed shop drawings for all proposed temporary measures. Provide drawings and calculations for tempary bridge shoring stamped by an engineer licensed in the State of Michigan.

F. Construction Sequencing Plan: Provide detailed plan describing the boardwalk installation process and sequencing. Plan shall include, but not be limited to:
   1. Equipment to be used for foundation installation, frame placement, and deck placement. Include model, overall dimensions, and maximum operating weight
   2. Equipment that will travel across the completed boardwalk to complete additional aspects of the work. Include model, overall dimensions, and maximum operating weight.
   3. Describe all temporary measures that will be utilized to facilitate equipment access across the existing crib wall and/or existing wood bridges.

4. Describe anticipated construction sequence and schedule.

G. Boardwalk Fabricator Instructions: Indicate boardwalk installation process and requirements.

H. Samples:
1. Submit physical sample of guardrail metal mesh.
2. Submit physical sample of decking lumber.

I. Fabricator's qualification statement: Provide written documentation verifying all Fabricator Qualifications are met.

J. Installer's qualification statement: Provide written documentation verifying all Installer Qualifications are met.

1.05 QUALITY ASSURANCE

A. Fabricator Qualifications: Company specializing in fabricating products specified in this section, with minimum 5 years of documented experience fabricating complete steel framed boardwalk systems; and
1. Fabrication company shall be in good standing with all agencies including, reporting agencies, banks, and the state for which it operates.
2. Fabricator shall provide certificate of insurance for liability and stored materials.
3. Fabricator shall provide affidavit of employed American Welding Society certified welders, and all welding must be performed by welders with the same certification.
4. Fabricator shall provide written description and references for five (5) completed projects of a similar scale and type. Include name, email address, and phone number for project contact(s). Provide a brief description of each project and the total contract amount. Contractor/Supplier shall furnish address of the nearest service office and/or warehouse facility.

B. Installer Qualifications: Company specializing in performing work of type specified, with minimum 5 years of documented experience installing prefabricated boardwalk systems on publicly owned property; and
1. Installer shall provide written description and references for five (5) completed projects of a similar scale and type. Include name, email address, and phone number for project contact(s). Provide a brief description of each project and the total contract amount.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver, handle, and store boardwalk components and materials to prevent damage or deterioration. Store materials and components in a secure location to protect from damage and theft, and ensure public safety.

1.07 WARRANTY

A. Fabricator Warranty: Workmanship of the frames shall be warrantied against defect for the life of the boardwalk. During this period, if the product is covered by the warranty and fails under normal use, fabricator shall repair or replace at original owners' discretion. The decking and other non-frame elements of the boardwalk are excluded. "Lifetime" is defined as the lifetime of the product in use. Material warranty for all non-boardwalk frame materials shall be that of the original manufacturer. Non-boardwalk materials include but are not limited to decks, handrail, toe rail, or other fixtures.

B. Installer Warranty: Provide Construction Warranty in accordance with Division 1.

PART 2 - PRODUCTS

2.01 BOARDWALK FABRICATORS

A. Boardwalk system shall be fabricated by the Wickcraft Company, Inc, 2317 Daniels Street, Madison, WI 53718; (608) 244-9177; or approved equal

B. Substitutions: Alternate boardwalk materials or fabricators must be submitted in writing no less than ten (10) business days prior to the bid close date. The substitution of boardwalk materials or fabricator must be pre-approved in writing prior to submitting bid and must satisfy all pre-qualification criteria. Pre-qualification criteria include meeting all all requirements described in this Section, Related Sections, and on the Drawings, which include but are not limited to:
   1. Fabricator Qualifications shall be met
   2. Fabricator warranty shall be met
   3. Source limitations shall be met
   4. Boardwalk materials and fabrication methods must match; or be equivalent in appearance, function, and service life. Specifically:
      a. Frames, guardrail brackets, and other mounting hardware must be constructed from welded structural steel that is hot-dip galvanized after fabrication.
      b. Decking, guardrails, and toe rails must be constructed from wood with metal components as specified on the drawings.
      c. Boardwalk system shall not require modifications to the horizontal or vertical alignment or other overall dimensions.
      d. Boardwalk system must be able to support required project loading criteria.

C. Source Limitations: All boardwalk components (excluding foundations) including but not limited to pile caps, frames, I-beams, decking, guardrails, toe rails, hardware, and fasteners to be fabricated and supplied as a complete system by a single fabricator.

2.02 STEEL COMPONENTS

A. Steel and steel fabrication materials shall comply with Section 051200 Structural Steel Framing; and

B. Steel components shall meet or exceed project loading criteria and applicable International Building Code requirements.

C. Structural steel frame sections shall be constructed from ASTM A500 Structural Steel

D. Frame connections to be fabricated from A36 Structural Steel.

E. Entire frame assembly and other fabricated components to be hot dipped galvanized post-fabrication with a minimum of 3.9 mill thickness of zinc based galvanizing.

F. All post-galvanized frame assemblies must be hand rasped and free of any sharp edges without compromising the galvanized integrity.

2.03 WOOD COMPONENTS

A. Lumber shall meet or exceed International Building Code requirements in accordance with project specific loading criteria.

B. Unless otherwise noted, all wood shall be non-incised pressure treated Hem/Fir, Grade #2 or better.

C. Pressure Treating Preservative: Alkaline Copper Quaternary (ACQ), meeting American Wood Protection Association (AWPA) standards, or approved equal. Alternate treatment methods and/or products must be approved in writing prior to bid and no environmentally caustic treatments (creosote, arsenic, pentachlorophenol, etc) will be allowed.

D. Lumber Color: Natural with no pigments, stains, or dyes, or approved equal.

E. Decking Lumber Finish: Rough sawn on walking surface.

F. Guardrail & Toe Rail Lumber Finish: S4S, surfaced on 4 sides.

G. End Cut Treatment: Pigment free penetrating / non-film forming wood preservative designed to treat cut ends of pressure treated lumber. Product shall be listed by the manufacturer as compatible with the type of pressure treated lumber used.

2.04 WIRE MESH PANELS

A. Wire mesh panels to be constructed from woven 3/8" diameter steel wire spaced 4" o.c. vertical and 4" o.c. horizontal (4"x4" square mesh). Panels to be bathed in phosphate prior to finishing. Panels to be finished with two coats of zinc rich powder primer and a black powder coat finish. Mesh panels shall be Wild Hog Products, Black Tahoe Panels, wildhogproducts.com, 888-246-4463, or approved equal;

2.05 ACCESSORIES

A. Steel Fasteners: Fasteners for steel-to-steel or steel-to-wood connections shall be hot dip galvanized, or approved equal, and approved by the manufacturer for exterior use in all types of treated lumber.

B. Wood fasteners: Wood-to-wood fasteners shall be:
   1. Approved by the manufacturer for exterior use in all types of treated lumber.
   2. Star drive, or approved equal.
   3. Hot dip galvanized, stainless steel, or coated with gray colored protective coating.

C. Concrete anchors: Shall be hot-dip galvanized, or approved equal, and approved by the manufacturer for use in exterior concrete.

D. The fastener product used for each type of connection shall be consistent and the same across the entire project.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verification of Conditions: Prior to beginning installation of the boardwalk:
   1. Obtain inspection and approval of soil restoration, grading, slope stabilization, and other elements of the work that must be performed before boardwalk installation.
   2. Verify boardwalk foundations and abutments are installed correctly and in the correct location.
   3. Verify boardwalk foundations and abutments are ready to accept live and dead loads.

3.02 PREPARATION

A. Protection of In-Place Conditions: Protect completed work and existing features during boardwalk installation.

3.03 INSTALLATION

A. Installation and construction practices for foundations and boardwalk system shall be performed in accordance with local codes and industry standards.

B. Install boardwalk in accordance with manufacturer's written instructions and recommendations.

C. Obtain required field inspections prior to beginning installation of boardwalk.

D. Coordinate installation with completion of on grade walkways and other adjoining work.

E. Frames and Structural Components:
   1. Layout and locate boardwalk in accordance with the drawings and approved shop drawings. Boardwalk shall align with adjacent on grade walkways.
   2. Sloped and level frame segments shall be installed true to elevations and slopes indicated on the drawings.
   3. Adjoining frame segments shall meet flush and be installed in accordance with fabricator specified tolerances.
   4. Fasten utilizing fabricator provided fasteners and applicable torque specifications.
   5. Install concrete anchors in accordance with manufacturer's instructions.

F. Decking:

1. Shall be installed with adjoining panels and boards meeting flush at the edges with a consistent gap between all deck boards.
2. Miter deck boards at landings and other directional changes to provide a uniform symmetrical deck board pattern across the entire project.
3. Boardwalk surfaces shall be meet the requirements of the Architectural Barriers Act Accessibility Standards (ABAAS) for facilities for visitors and employees.
4. Countersink all wood fasteners flush with board surface. Do not over drive.
5. Treat all cut ends with preservative ensuring that the visible deck surface is not discolored or stained

G. Guardrails and toe rails:
1. Shall be installed with adjoining segments and boards meeting flush.
2. Miter adjoining boards to provide symmetrical joinery at landings and other directional changes. Align joints in guardrails and toe rails with joints in decking panels below.
3. Sand field cut lumber smooth.
4. Countersink all wood fasteners flush with board surface. Do not over drive.
5. Wire mesh panels shall not protrude beyond wood framing.
6. Field cuts to wire mesh shall be made with methods that do not generate heat or otherwise damage the wire finish. Ensure cuts are smooth and free of sharp edges. Paint all cut ends with two coats of color matched exterior spray paint.

3.04 CLEANING

A. Upon completion of the work provide final cleaning of the boardwalk structure to remove dirt, soil, debris, and any other foreign materials or stains.

3.05 PROTECTION

A. Protect installed boardwalk from subsequent construction operations.

B. Do not permit vehicle traffic over unprotected boardwalk surface.

C. Do not exceed load limits for installed boardwalk.

D. Protective measures shall not be screwed or otherwise fastened directly to exposed boardwalk deck or other visible surfaces.

E. Remove all temporary construction measures including, but not limited, to shoring, ground protection, and boardwalk surface protection upon completion of the work, or when they are no longer required to complete the work.

END OF SECTION

SECTION 32 91 19
LANDSCAPE GRADING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Preparation of subsoil.

B. Topsoil placement.

C. Finish grading.

D. Permanent Slope Stabilization Measures

1.02 RELATED REQUIREMENTS

A. Section 31 11 00 - Clearing and Grubbing

B. Section 31 23 00 - Earthwork

C. Section 31 25 00 - Erosion and Sedimentation Controls

D. Section 32 92 19 - Seeding.

1.03 REFERENCE STANDARDS

A. ASTM D5141 - Standard Test Method for Determining Filtering Efficiency and Flow Rate of the Filtration Component of a Sediment Retention Device; 2023

B. ASTM D6459 - Standard Test Method for Determination of Rolled Erosion Control Product (RECP) Performance in Protecting Hillslopes from Rainfall-Induced Erosion; 2019

C. ASTM D6460 - Standard Test Method for Determination of Rolled Erosion Control Product (RECP) Performance in Protecting Earthen Channels from Stormwater-Induced Erosion; 2024

D. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System); 2017, with Editorial Revision (2020).

E. ASTM D5268 - Standard Specification for Topsoil Used for Landscaping and Construction Purposes; 2023.

1.04 SUBMITTALS

A. See Section 01 10 00 - Division 1 Short Form General Requirements for Submittal procedures.

B. Product Data:
   1. Submit product information, test reports, and sources for all imported soil and fill materials.
   2. Submit manufacturer product data sheets, performance capabilities, biodegradability certificates, and installation instructions for erosion blanket, sediment logs, and other slope stabilization products

C. Installer Qualification Statement: Provide written documentation verifying all Installer Qualifications are met.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in earthwork and landscape construction with three years documented experience. The installer’s crew shall be experienced in the installation of soil, grading, slope stabilization measures, and interpretation of grading plans.

1.06 FIELD CONDITIONS

A. Perform the work during dry weather and unfrozen conditions.

B. Ambient Conditions: Terminate work during hazardous environmental conditions in accordance with 29 CFR 1910.266.

PART 2 PRODUCTS

2.01 TOPSOIL

A. Topsoil: Comply with ASTM D5268. Imported topsoil is strictly prohibited on this project

B. Topsoil: Salvaged Site Topsoil:
   1. O or A horizon soil, typical for the site and locality; free of, subsoil, contaminants, weeds, trash, and other human made materials. May contain forest duff, plant parts, woody debris, and other organic materials as noted on the Drawings.

2.02 EROSION BLANKET

A. Blanket: 100% Biodegradable slope cover material designed to reduce slope erosion and enhance revegetation.
   1. Blanket shall consist of naturally seed free Great Lakes Aspen curled wood excelsior with 80% of the fiber ≥ 6 inches in length; covered on top and bottom with continuous 100% biodegradable jute netting.
   2. Thickness shall be consistent, with fibers evenly distributed throughout the entire area of the blanket.
   3. Blanket shall be certified by the manufacturer meeting the following performance requirements:
      a. Slope Suitability: ≤ 1.5H:1V
      b. Soil Loss Ratio C Factor: 0.22
      c. Shear Stress: 2.25 lb/ft^2
      d. Functional Longevity: up to 24 months
   4. Color: Natural Aspen
   5. Erosion control blanket shall not be defective or damaged. Damaged or defective materials shall be replaced at no additional cost to the Government.
   6. Blankets shall be manufactured in the U.S.A. by company with QA/QC processes implemented and managed by the manufacturer. Field fabricated products and products made by anyone other than the manufacturer shall not be accepted.

B. Staples: 100% Biodegradable staples approved by the erosion blanket manufacturer for use in the specified blanket, with a minimum length of 6 inches.

2.03 SEDIMENT LOGS

A. Logs: 100% biodegradable excelsior fiber logs with biodegradable exterior containment fabric designed to provide continuous e contact with the soil and prevent blowout and undermining, while allowing water to flow through the excelsior matrix, minimizing overtopping, slowing high flow water velocities, and intercepting soil movement.
   1. Log shall consist of of naturally seed free Great Lakes Aspen wood excelsior with 80% of the fiber ≥ 6 inches in length, inside a 100% biodegradable, durable, flexible containment material.
   2. Size: As indicated on the Drawings
   3. Density (+/- 10%): 6 inch log - 2.44 lb/ft^3; 9 inch log - 2.26 lb/ft^3; 12 inch log - 2.54 lb/ft^3
   4. Logs shall be certified by the manufacturer meeting the following performance requirements:
      a. Flow Rate: ≥ 35 GPM/ft^2
      b. Slope Soil Loss Reduction: ≥ 70%
      c. Functional Longevity: up to 24 months
   5. Logs shall be manufactured in the U.S.A. by company with QA/QC processes implemented and managed by the manufacturer. Field fabricated products and products made by anyone other than the manufacturer shall not be accepted.
   6. Sediment log shall be free of defects and voids that would interfere with proper installation or impair performance.

B. Stakes: Solid hardwood stakes, 1 1/8 inch wide x 1 1/8 inch thick. 36 inch minimum length for 6 inch or 9 inch logs. 48 inch minimum length for 12 inch logs.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that required work, including foundations, abutments, walls, and paving are installed, in proper location, and ready for use prior to beginning the work.

B. Verify grading and intended elevations are as indicated on drawings.

C. Obtain approval of prepared subgrade prior to placement of topsoil.

D. Obtain approval of grading and finish elevations prior to installing permanent slope stabilization measures.

E. Verify absence of standing or ponding water.

F. Verify that no unsuitable foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, or other foreign substances have been deposited in or on soil.

G. Proceed with the work only after unsatisfactory conditions have been corrected.

3.02 SUBSOIL GRADING AND PREPARATION

A. Protect all site features to remain, including but not limited to bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs.

B. Protect tree critical root zones, trees, plants, lawns, rock outcroppings, and other features to remain.

C. Grade subgrade to proposed elevations and contours indicated on drawings. Ensure subgrade elevations will allow placement of specified depth of topsoil. Make changes in grade gradual and blend slopes utilizing smooth transitions.

D. Remove debris, trash, and other foreign materials prior to preparing subgrade.

E. Till subgrade surface to depth indicated on the drawings. Ensure uniform and complete loosening of soil. Maintain proposed grades, profiles and contours.

F. Prohibit vehicle traffic and limit pedestrian traffic on prepared subgrade except as required to place topsoil.

3.03 TOPSOIL PLACEMENT

A. Place topsoil in all areas indicated on Drawings. If the volume of salvaged topsoil is not sufficient to cover all areas indicated on the Drawings, request direction from the COR on priorities for placement location and depth.

B. Ensure subgrade elevations will allow placement of specified topsoil depth.

C. Uniformly distribute and spread topsoil to the depths indicated on the drawings.

D. Settled Topsoil Depth: Depth as indicated on drawings; tolerance 1/2 inch plus/minus.

E. Limit vehicle traffic on prepared subgrade to maximum extent feasible.

F. Prohibit vehicle traffic on placed topsoil.

G. Limit pedestrian traffic on topsoil except as required to complete finish grading and planting.

3.04 FINISH GRADING

A. Maintain proposed elevations and contours. Make changes in finish grade gradual and blend slopes utilizing smooth transitions.

B. In lawn areas, remove roots, weeds, rocks, and foreign material while finish grading

C. In non-lawn areas with erosion blankets, remove roots, plant parts, rocks, and woody debris while finish grading as required to ensure continuous contact between the soil surface and erosion blanket.

D. In non-lawn areas without erosion blankets, do not remove roots, plant parts, rocks, and woody debris while finish grading.

E. Maintain uniform topsoil thickness.

F. Lawn areas to be graded smooth by hand raking, or approved equal, with a vertical tolerance of 1/2 inch plus/minus.

G. Non-Lawn areas with erosion blanket to be graded smooth by hand raking or approved equal, with a vertical tolerance of 1 inch plus/minus

H. Non-lawn areas without erosion blanket to be graded rough with a vertical tolerance of 2 inches plus/minus.

I. Maintain stability of topsoil during inclement weather. Replace eroded topsoil.

J. Prohibit vehicle traffic on placed topsoils

K. Limit pedestrian traffic on topsoils except as required to complete finish grading and planting.

3.05 EROSION BLANKET

A. Before placing erosion blanket and sediment logs: Verify that finish grade has been properly compacted, graded smooth, has no depressions, voids, soft or uncompacted areas, is free from obstructions such as tree roots, protruding stones or other foreign matter, and is seeded and fertilized according to project specifications where applicable.

B. Fine grade soils and hand dress where necessary to remove any irregularities that may prevent continuous contact between the finished soil surface and the blanket.

C. Install blankets as shown on the Drawings and in accordance with manufacturer's installation guidelines.

D. Where feasible, it is recommended that blankets be installed parallel to the flow of water.

E. Erosion blanke shall remain in place upon completion of the work and allowed to naturally decompose.

3.06 SEDIMENT LOGS

A. Install logs as shown on the Drawings and in accordance with manufacturer's installation guidelines.

B. Stakes shall be intertwined with the outer mesh of the sediment log only and driven into the ground a minimum of 16 inches on the downhill side of the log.

C. Logs shall be installed with continuous and firm soil contact along entire length.

D. Sediment logs shall remain in place upon completion of the work and allowed to naturally decompose.

3.07 CLEANING

A. Remove surplus and waste materials, including excess subsoil, unsuitable materials, trash, and debris, and legally dispose of them off of the Owner’s property.

B. Clean and restore all staging and stockpile areas.

3.08 PROTECTION

A. Protect work area from erosion and subsequent construction operations.

B. Repair or replace finish graded soils and slope stabilization measures damaged by subsequent construction operations or erosion at no additional cost to the government, until Final Acceptance

C. Protect areas of completed installation from additional compaction, disturbance, and contamination until Final Acceptance. Prohibit the following practices within these areas:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Vehicle traffic.
4. Foot traffic.
5. Erection of sheds or structures.
6. Impoundment of water.
7. Excavation and other disturbances, unless otherwise approved.

END OF SECTION

SECTION 32 92 19
SEEDING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Lawn Hydroseeding

1.02 RELATED REQUIREMENTS

A. Section 32 91 19 - Landscape Grading: Grading and preparation of subsoil, topsoil placement and finish grading.

1.03 DEFINITIONS

A. Weeds: Include Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Bermuda Grass, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Will, Bindweed, Bent Grass, Wild Garlic, Perennial Sorrel, and Brome Grass, and all non-native or invasive plant species.

1.04 SUBMITTALS

A. See Section 01 10 00 - Division 1 Short Form General Requiremtns for Submitttal procedures.

B. Product Data: Submit product information for each seed product. Include supplier information, species composition, pure live seed certification, weed seed content, germination rate, and other relevant information.

C. Product Data: Submit product data for hydro mulching material. Include weed free certification.

1.05 QUALITY ASSURANCE

A. Lawn Installer Qualifications: Company specializing in installation, seeding, and establishment of turf grass, with three years documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver seed mixtures in sealed containers. Seed in damaged packaging is not acceptable. Deliver seed mixture in containers showing percentage of seed mix, year of production, net weight, date of packaging, and location of packaging.

1.07 FIELD CONDITIONS

A. Planting Season:
   1. Lawn Seed Mix: May 1 to June 15 or August 15 to September 15, unless approved otherwise.

B. Install seed during favorable weather when existing and forecasted conditions permit the work to be performed with beneficial and optimum results. Do not seed during or immediately following heavy rainfall, when ground is too dry, during windy periods, or other detrimental weather conditions.

C. Do not install seed on frozen soil or when freezing temperatures are forecasted.

PART 2 PRODUCTS

2.01 SEED MIXTURE

A. Lawn Seed Mixture: Tall fescue seed blend adapted to local growing conditions formulated for high traffic and drought tolerance and suitable for full sun to partial shade; or approved equal.

2.02 ACCESSORIES

A. Hydro Mulching Material: Thermally refined wood fiber with tackifier; nontoxic, free of growth or germination inhibiting ingredients.

B. Water: Clean, fresh and free of substances or matter that could inhibit vigorous growth of grass.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that prepared soil base is ready to receive the work of this Section.

B. Obtain inspection and approval of topsoil placement and landscape grading prior to beginning seeding.

3.02 HYDROSEEDING

A. Apply lawn seed slurry with a hydraulic seeder in accordance with seed manufacturer's suggested rate. Apply evenly in two intersecting directions.

B. Apply water with a fine spray immediately after each area has been seeded. Saturate top 4 inches of soil.

C. Remove overspray from sidewalks, curbs, furnishings, trees, and other adjacent surfaces.

D. Following germination, immediately re-seed lawn areas without germinated seeds that are larger than 6 by 6 inches.

3.03 PROTECTION

A. Identify and enclose all seeded areas with wood stakes and twine around area periphery; or approved equal.

B. Protect work area from erosion and subsequent construction operations.

C. Protect areas of completed installation from additional compaction, disturbance, and contamination until Final Acceptance. Prohibit the following practices within these areas:
   1. Storage of construction materials, debris, or excavated material.
   2. Parking vehicles or equipment.
   3. Vehicle traffic.
   4. Foot traffic.
   5. Erection of sheds or structures.
   6. Impoundment of water.
   7. Excavation and other disturbances, unless otherwise approved.

3.04 MAINTENANCE

A. Maintain all seeded areas until Final Acceptance.

B. Provide maintenance at no extra cost to the Government.

C. Water all seeded areas regularly to prevent soil from drying out. Ensure watering schedule does not result in over watering or saturated soil conditions.

D. Mow lawn areas at regular intervals to maintain at a height of 3". Do not cut more than 1/3 of grass blade at any one mowing.

E. Neatly trim lawn edges and hand clip where necessary.

F. Do not mow lawn areas when soils or plants are wet.

G. Immediately reseed areas that show bare spots, or damage from ongoing construction and maintenance operations.

H. Maintain seed protection measures.

END OF SECTION

DIVISION 33

Utilities

SECTION 33 42 13
STORMWATER CULVERTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Removal and installation of storm water culverts and natural stone headwalls.

1.02 RELATED SECTIONS

A. The following is a list of Specifications which may be related to this section.
   1. Section 31 23 00 – Earthwork
   2. Section 31 37 00 - Riprap

1.03 REFERENCES

A. The following is a list of Specifications which may be related to this section.
   1. ASTM International (ASTM):
      a. ASTM F 2306, Standard Specification for 12 to 60 in. [300 to 1500 mm] Annular Corrugated Profile-Wall Polyethylene (PE) Pipe and Fittings for Gravity-Flow Storm Sewer and Subsurface Drainage Applications

1.04 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic structures, pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle precast concrete manholes, HDPE catch basins and other structures according to manufacturer’s written rigging instructions.

1.05 PROJECT CONDITIONS

A. Obtain approval of pipe location and alignment before excavation.

1.06 SUBMITTALS

A. Product Data: For the following:
   1. HDPE Pipe
   2. Fittings

B. Field quality-control test reports.

PART 2 – PRODUCTS

2.01 PIPES AND FITTINGS

A. Corrugated High Density Polyethylene Pipe (CPP) piping according to ASTM F 2306.

PART 3 – EXECUTION

3.01 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Section 31 23 00 "Earthwork.".

B. Backfill shall be comprised of well graded crushed aggregate compacted to 95% of the Standard Proctor surrounding and overtop of the culvert.

3.02 PIPING INSTALLATION

A. General Locations and Arrangements: Drawings and details indicate general location and arrangement of stormwater culverts. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

C. Contractor shall install pipe with any visible markings down so that no writing or stripes are visible to pedestrians on the trails

D. Install gravity-flow, non-pressure drainage piping according to the following:

E. Install Corrugated High Density Polyethylene Pipe (CPP) piping according to ASTM F 2306.

F. Culverts shall be installed with an unobstructed inlet and outlet flow.

3.03 NATURAL STONE HEADWALL INSTALLATION

A. Contractor shall install natural stone headwall on all new proposed culverts to facilitate a smooth transition to adjacent grade, and protect pipe end.

B. Headwall stone shall match stone specified under Section 32 32 53 Stone Retaining Walls.

3.04 PIPE OUTLETS

A. If directed by Contracting Officer's Representative (COR), place riprap pad at pipe outlet. Do not disturb additional vegetation to place riprap unless directed to do so by COR. Max size of rip rap pad 6 square feet. Riprap material per Section 31 37 00.

3.05 FIELD QUALITY CONTROL

A. Material certifications and product data sheets shall be collected and submitted as part of the close out documents for the pipe and backfill materials.

3.06 CLEANING AND FLUSHING OF NEW AND EXISTING PIPES

A. Clean interior of piping of dirt and superfluous materials.
   1. In large, accessible piping, brushes and brooms may be used for cleaning.
   2. Flush piping with water to remove collected debris.

END OF SECTION

APPENDIX A

Geotechnical Reports

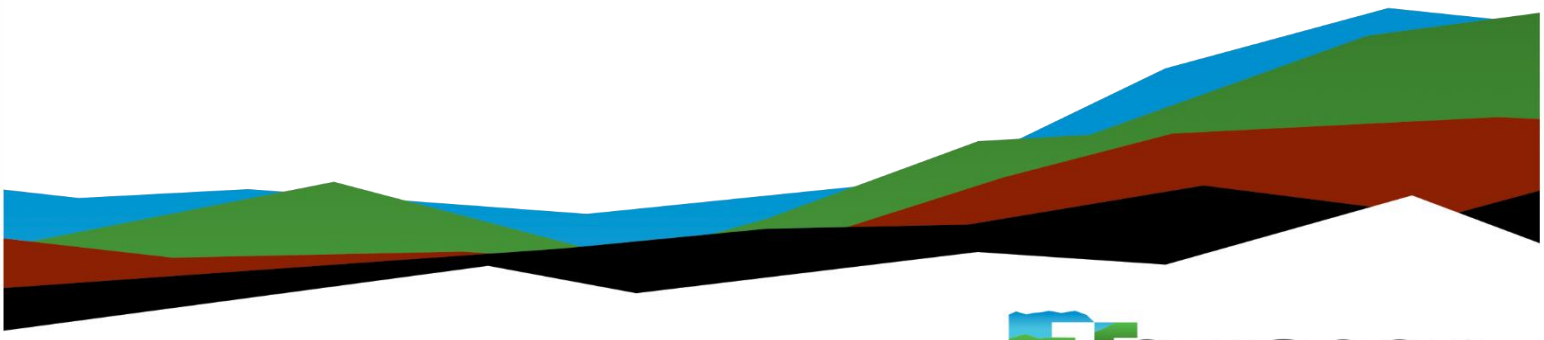
Munising Falls Trail Rehabilitation

Geotechnical Engineering Report

November 17, 2023 | Terracon Project No. N6235258

Prepared for:

Strata Architects + Preservation
1701 Oak Street, Suite 100
Kansas City, Missouri



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November 17, 2023

Strata Architects + Preservation
1701 Oak Street, Suite 100
Kansas City, Missouri

Attn: Angie Geist Gaebler
P: (816) 474-0900
E: angie@strata-arch.com

Re: Geotechnical Engineering Report
Munising Falls Trail Rehabilitation
1505 Sand Point Road
Munising, Alger County, Michigan
Terracon Project No. N6235258

Dear Ms. Gaebler:

We have completed the scope of Geotechnical Engineering services for the above referenced project in general accordance with Terracon Proposal No. PN6235258 dated Revised October 5, 2023. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of retaining walls and pavements for the proposed project.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,

Terracon Consultants-MI, Inc.

Richard Sullivan, P.E.
Engineer – Geotechnical Services

Chett A. Siefring, P.E.
Manager – Geotechnical Services

STATE OF MICHIGAN
CHETT ANTHONY SIEFRING
ENGINEER
No. 6201062297
LICENSED PROFESSIONAL ENGINEER

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Note: This report was originally delivered in a web-based format. **Blue Bold** text in the report indicates a referenced section heading. The PDF version also includes hyperlinks which direct the reader to that section and clicking on the Terracon logo will bring you back to this page. For more interactive features, please view your project online at **client.terracon.com**.

Refer to each individual Attachment for a listing of contents.

Introduction

This report presents the results of our subsurface exploration and Geotechnical Engineering services performed for the proposed trail rehabilitation to be located close to 1505 Sand Point Road in Munising, Alger County, Michigan. The purpose of these services was to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil and rock conditions
- Groundwater conditions
- Seismic site classification per IBC
- Site preparation and earthwork
- Demolition considerations
- Foundation design and construction
- Lateral earth pressure
- Pavement design and construction

The geotechnical engineering Scope of Services for this project included the advancement of 2 test borings and 4 hand augers to depths ranging from 2 to 26 feet, laboratory testing, engineering analysis, and preparation of this report.

Drawings showing the site and boring locations are shown on the **Site Location** and **Exploration Plan**, respectively. The results of the laboratory testing performed on soil samples obtained from the site during our field exploration are included on the boring logs and/or as separate graphs in the **Exploration Results** section.

Project Description

Our understanding of the project conditions is as follows:

Item	Description
Information Provided	A request for proposal that included the following was provided to Terracon via email from Chris Mueller of Quinn Evans on August 22, 2023: ■ Aerial image of the site ■ Scope of work document ■ Photos of the site ■ Google Maps link to the site During a call with Quinn Evans on October 4, 2023, additional project information clarifications were provided.

Item	Description
Project Description	The project includes the rehabilitation of the existing walking trail, including a new retaining wall and pedestrian bridge at the existing wood support portion of the trail.
Grading/Slopes	It was indicated that the rehabilitated trail will have a final grade within approximately 2 feet of existing grade except at the area where the existing wood retaining wall is located, which may be lowered up to 4 feet from existing grade. Approximately 2 feet of cut and 2 feet of fill will be required to develop final grades, except at the wood retaining wall area, where up to 4 feet of cut may be required to develop final grades, excluding remedial grading requirements.
Free-Standing Retaining Walls	A new retaining wall is planned at the site. The type and height of the retaining wall is undetermined at the time of preparing this proposal.
Trail Pavements	Portions of the existing path are asphalt pavement. It is anticipated that these sections will be rehabilitated with asphalt pavement.

Terracon should be notified if any of the above information is inconsistent with the planned construction, especially the grading limits, as modifications to our recommendations may be necessary.

Site Conditions

The following description of site conditions is derived from our site visit in association with the field exploration and our review of publicly available geologic and topographic maps.

Item	Description
Parcel Information	The project is located at 1505 Sand Point Road in Munising, Alger County, Michigan. Latitude: 46.4237 / Longitude: -86.6235 (approximate) See **Site Location**
Existing Improvements	Existing walking path.
Current Ground Cover	Asphalt pavement, wood path, earthen and trees.

Item	Description
Existing Topography	Based on Google Earth™ imagery, it appears that existing site grades range from approximately 664 feet, MSL near the start of the trail to approximately 685 feet near the end of the project site.

We also collected photographs at the time of our field exploration program. Representative photos are provided in our **Photography Log**.

Geotechnical Characterization

We have developed a general characterization of the subsurface conditions based upon our review of the subsurface exploration, laboratory data, geologic setting and our understanding of the project. This characterization, termed GeoModel, forms the basis of our geotechnical calculations and evaluation of the site. Conditions observed at each exploration point are indicated on the individual logs. The individual logs can be found in the **Exploration Results** and the GeoModel can be found in the **Figures** attachment of this report.

As part of our analyses, we identified the following model layers within the subsurface profile. For a more detailed view of the model layer depths at each boring location, refer to the GeoModel.

Model Layer	Layer Name	General Description
1	**Surface Cover**	Topsoil – 1-inch
2	**Granular Soil**	Loose to very dense sand
3	**Bedrock**	Moderately weathered, weak sandstone

The borings were advanced in the dry using the hollow-stem augers drilling technique that allows short term groundwater observations to be made while drilling. Groundwater conditions may be different at the time of construction than those encountered during completion of our field exploration. Mapping by the Natural Resources Conservation Service (NRCS) indicates a seasonal high groundwater level within 12 inches of ground surface. Groundwater conditions may change because of seasonal variations in rainfall, runoff, and other conditions not apparent at the time of drilling. Perched water may be present at the site within the soil bedrock interface. Long-term groundwater monitoring was outside the scope of services for this project.

Seismic Site Class

The seismic design requirements for buildings and other structures are based on Seismic Design Category. Site Classification is required to determine the Seismic Design Category for a structure. The Site Classification is based on the upper 100 feet of the site profile defined by a weighted average value of either shear wave velocity, standard penetration resistance, or undrained shear strength in accordance with Section 20.4 of ASCE 7 and the International Building Code (IBC). Based on the soil/bedrock properties observed at the site and as described on the exploration logs and results, our professional opinion is that a **Seismic Site Classification of C** be considered for the project. Subsurface explorations at this site were extended to a maximum depth of 26 feet. The site properties below the boring depth to 100 feet were estimated based on our experience and knowledge of geologic conditions of the general area. Additional deeper borings or geophysical testing may be performed to confirm the conditions below the current boring depth.

Geotechnical Overview

The site appears suitable for the proposed construction based upon geotechnical conditions encountered in the test borings, provided that the recommendations provided in this report are implemented in the design and construction phases of this project.

Site preparation recommendations, including subgrade improvement and fill placement, are provided in the **Earthwork** section.

The **Shallow Foundations** and the **Shallow Drilled Pier Foundations** sections addresses support of the foundations.

The **Pavements** section includes our recommended parameters for subgrade support for surfacing design by others.

The recommendations contained in this report are based upon the results of field and laboratory testing (presented in the **Exploration Results**), engineering analyses, and our current understanding of the proposed project. The **General Comments** section provides an understanding of the report limitations.

Earthwork

Earthwork is anticipated to include demolition, clearing and grubbing, excavations, and engineered fill placement. The following sections provide recommendations for use in the preparation of specifications for the work. Recommendations include critical quality criteria, as necessary, to render the site in the state considered in our geotechnical engineering evaluation for foundations and pavements.

Demolition

After any necessary demolition has taken place, it is recommended that all remnants encountered within the proposed development area be removed in their entirety. Historical evidence indicates that new structures placed over the remnants of previous construction or poorly compacted backfill often result in the new structure performing poorly.

Site Preparation

Prior to placing fill, existing vegetation, topsoil, and root mats should be removed. Complete stripping of the topsoil should be performed in the proposed building and parking/driveway areas.

Subgrade Preparation

The subgrade should be proofrolled with an adequately loaded vehicle. Typically, a fully-loaded (minimum 20 ton gross vehicle weight) tandem-axle dump truck. However, given the limited width of the development other vehicles, as approved by the Getechnical Engineer, may suffice. The proofrolling should be performed under the observation of the Geotechnical Engineer or representative. Areas excessively deflecting under the proofroll should be delineated and subsequently addressed by the Geotechnical Engineer. Such areas should be removed and replaced with properly placed and compacted engineered fill. Excessively wet or dry material should either be moisture conditioned and recompacted or removed and replaced with properly placed and compacted engineered fill.

Where the subgrade has passed a proofroll, compacted engineered fill soils should be placed to the proposed design grade and the moisture content and compaction of subgrade soils should be maintained until foundation, slab or pavement construction.

Based upon the subsurface conditions determined from the geotechnical exploration, subgrade soils exposed during construction are anticipated to be relatively workable; however, the workability of the subgrade may be affected by precipitation, repetitive construction traffic or other factors. If unworkable conditions develop, workability may be improved by scarifying and drying.

Excavation

We anticipate that excavations for the proposed construction can be accomplished with conventional earthmoving equipment. The bottom of excavations should be thoroughly cleaned of loose soils and disturbed materials prior to backfill placement and/or construction.

Fill Material Types

Fill required to achieve design grade should be classified as engineered fill. Engineered fill is material used below, or within 10 feet of structures, pavements or constructed slopes.

Reuse of On-Site Soil: Excavated on-site soil may be selectively reused as Engineered Fill.

Material property requirements for on-site soil for use as engineered fill are noted in the table below:

Property	Engineered Fill
Composition	Free of deleterious material
Maximum Particle Size	3 inches
Fines Content of Granular Soils	Less than 15% Passing No. 200 sieve
Liquid Limit of Cohesive Soils	Maximum liquid limit of 50
GeoModel Layer Expected to be Suitable[1]	2

1. It may be possible to reuse the fill materials of GeoModel Layer 3 providing that they are processed to a soil like state and that they are approved by the Geotechnical Engineer.

Imported Fill Materials: Imported fill materials should meet the following material property requirements. Regardless of its source, compacted fill should consist of approved materials that are free of organic matter and debris. Frozen material should not be used, and fill should not be placed on a frozen subgrade.

Soil Type [1]	USCS Classification	Acceptable Parameters (for Engineered Fill)
Low Plasticity Cohesive	CL, CL-ML	All locations and elevations
Granular	GW, GM, GC, SW, SM, SC	All locations and elevations

1. A sample of each material type should be submitted to the Geotechnical Engineer for evaluation prior to use on this site. Additional geotechnical consultation should be provided prior to use of uniformly graded gravel on the site.

Fill Placement and Compaction Requirements

Engineered fill should meet the following compaction requirements.

Item	Engineered Fill
Maximum Lift Thickness	8 inches or less in loose thickness when heavy (minimum 8 tons), self-propelled compaction equipment is used 6 inches in loose thickness when hand-guided equipment (i.e. jumping jack or plate compactor) is used
Minimum Compaction Requirements [1,2]	98% of the material's maximum dry density
Water Content Range [1]	Low plasticity cohesive: -2% to +3% of optimum moisture Granular: -3% to +3% of optimum moisture or at suitable level to provide sufficient compaction without the material pumping or rutting when proofrolled

1. Maximum density and optimum water content as determined by the standard Proctor test (ASTM D 698).
2. If the granular material is a coarse sand or gravel, or of a uniform size, or has a low fines content, compaction comparison to relative density may be more appropriate. In this case, granular materials should be compacted to at least 70% relative density (ASTM D 4253 and D 4254). Materials not amenable to density testing should be placed and compacted to a stable condition observed by the Geotechnical Engineer or representative.

Earthwork Construction Considerations

Shallow excavations for the proposed structure are anticipated to be accomplished with conventional construction equipment. Upon completion of filling and grading, care should be taken to maintain the subgrade water content prior to construction of grade-supported improvements such as floor slabs and pavements. Construction traffic over the completed subgrades should be avoided. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. Water collecting over or adjacent to construction areas should be removed. If the subgrade freezes, desiccates, saturates, or is disturbed, the affected material should be removed, or the materials should be scarified, moisture conditioned, and recompacted prior to floor slab construction.

As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, "Excavations" and its appendices, and in accordance with any applicable local and/or state regulations.

Construction site safety is the sole responsibility of the contractor who controls the means, methods, and sequencing of construction operations. Under no circumstances shall the information provided herein be interpreted to mean Terracon is assuming responsibility for construction site safety or the contractor's activities; such responsibility shall neither be implied nor inferred.

Excavations or other activities resulting in ground disturbance have the potential to affect adjoining properties and structures. Our scope of services does not include review of available final grading information or consider potential temporary grading performed by the contractor for potential effects such as ground movement beyond the project limits. A preconstruction/ precondition survey should be conducted to document nearby property/infrastructure prior to any site development activity. Excavation or ground disturbance activities adjacent or near property lines should be monitored or instrumented for potential ground movements that could negatively affect adjoining property and/or structures.

Construction Observation and Testing

The earthwork efforts should be observed by the Geotechnical Engineer (or others under their direction). Observation should include documentation of adequate removal of surficial materials (vegetation, topsoil, and pavements), evaluation and remediation of existing fill materials, as well as proofrolling and mitigation of unsuitable areas delineated by the proofroll.

Each lift of compacted fill should be tested, evaluated, and reworked, as necessary, as recommended by the Geotechnical Engineer prior to placement of additional lifts. Each lift of fill should be tested for density and water content at a frequency of at least 3 tests per lift, and 5,000 square feet in pavement areas.

In areas of foundation excavations, the bearing subgrade should be evaluated by the Geotechnical Engineer. If unanticipated conditions are observed, the Geotechnical Engineer should prescribe mitigation options.

In addition to the documentation of the essential parameters necessary for construction, the continuation of the Geotechnical Engineer into the construction phase of the project provides the continuity to maintain the Geotechnical Engineer's evaluation of subsurface conditions, including assessing variations and associated design changes.

Shallow Foundations

If the site has been prepared in accordance with the requirements noted in **Earthwork**, the following design parameters are applicable for shallow foundations.

Design Parameters – Compressive Loads

Item	Description	
	GeoModel Layer 2	2,500 psf

Item	Description	
Maximum Net Allowable Bearing Pressure [1, 2]	GeoModel Layer 3	10,000 psf
Required Bearing Stratum [3]	GeoModel Layer 2	Medium dense or better granular soils or engineered soils bearing upon these soils.
	GeoModel Layer 3	Bedrock
Minimum Foundation Dimensions	Columns	30 inches
	Continuous	16 inches
Sliding Resistance [4]	Granular Materials	0.35 allowable coefficient of friction
Minimum Embedment below Finished Grade [5]	Exterior footings in unheated areas:	42 inches
Estimated Total Settlement from Structural Loads [2]	Less than about 1 inch	

1. The maximum net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. A factor of safety of 3 has been applied.
2. Values provided are for maximum loads noted in **Project Description**. Additional geotechnical consultation will be necessary if higher loads are anticipated.
3. Unsuitable or soft soils should be overexcavated and replaced per the recommendations presented in **Earthwork**. Subgrade soils should be compacted until they reach a medium dense or better relative density.
4. Can be used to compute sliding resistance where foundations are placed on suitable soil/materials. Frictional resistance for granular materials is dependent on the bearing pressure which may vary due to load combinations. For fine-grained materials, lateral resistance using cohesion should not exceed ½ the dead load.
5. Embedment necessary to minimize the effects of frost and/or seasonal water content variations. For sloping ground, maintain depth below the lowest adjacent exterior grade within 5 horizontal feet of the structure.

Design Parameters – Overturning and Uplift Loads

Shallow foundations subjected to overturning loads should be proportioned such that the resultant eccentricity is maintained in the center-third of the foundation (e.g., e < b/6, where b is the foundation width). This requirement is intended to keep the entire foundation area in compression during the extreme lateral/overturning load event. Foundation oversizing may be required to satisfy this condition.

Uplift resistance of spread footings can be developed from the effective weight of the footing and the overlying soils with consideration to the IBC basic load combinations.

Item	Description
Soil Moist Unit Weight	120 pcf
Soil Effective Unit Weight[1]	60 pcf
Soil weight included in uplift resistance	Soil included within the prism extending up from the top perimeter of the footing at an angle of 20 degrees from vertical to ground surface

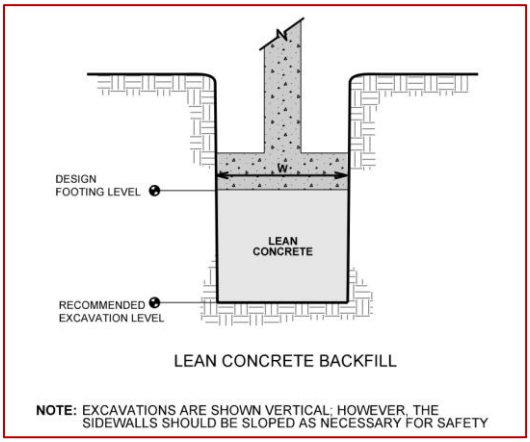
1. Effective (or buoyant) unit weight should be used for soil above the foundation level and below a water level. The high groundwater level should be used in uplift design as applicable.

Foundation Construction Considerations

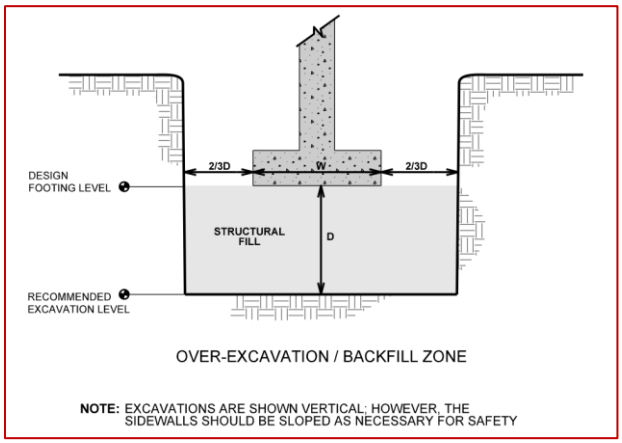
As noted in **Earthwork**, the footing excavations should be evaluated under the observation of the Geotechnical Engineer. The base of all foundation excavations should be free of water and loose soil, prior to placing concrete. Concrete should be placed soon after excavating to reduce bearing soil disturbance. Care should be taken to prevent wetting or drying of the bearing materials during construction. Excessively wet or dry material or any loose/disturbed material in the bottom of the footing excavations should be removed/reconditioned before foundation concrete is placed.

Sensitive soils exposed at the surface of footing excavations may require surficial compaction with hand-held dynamic compaction equipment prior to placing engineered fill, steel, and/or concrete. Should surficial compaction not be adequate, construction of a working surface consisting of either crushed stone or a lean concrete mud mat may be required prior to the placement of reinforcing steel and construction of foundations.

If unsuitable bearing soils are observed at the base of the planned footing excavation, the excavation should be extended deeper to suitable soils, and the footings could bear directly on these soils at the lower level or on lean concrete backfill placed in the excavations. The lean concrete replacement zone is illustrated on the sketch below.



Overexcavation for engineered fill placement below footings should be conducted as shown below. The overexcavation should be backfilled up to the footing base elevation, with approved engineered fill that is placed and compacted, as recommended in the **Earthwork** section.



Drilled Pier Foundations

Drilled Shaft Vertical Design Parameters

Soil design parameters are provided below in the **Drilled Shaft Design Summary** table for the design of drilled shaft foundations. The values presented for allowable side friction and end bearing include a factor of safety.

Drilled Shaft Design Summary [1]

Stratigraphy [2]		Allowable Skin Friction (psf) [3]	Allowable End Bearing Pressure (psf) [4]
Layer No.	Material		
2	Granular Soil	500	2,500
3	Bedrock	1,000	10,000

1. Design capacities are dependent upon the method of installation and quality control parameters. The values provided are estimates and should be verified when installation protocol have been finalized.
2. See Subsurface Profile in **Geotechnical Characterization** for more details on stratigraphy.
3. Skin friction design is not applicable for shallow drilled piers. The skin friction value provided can be used in uplift load resistance design of the drilled shafts. Effective weight of the pier can be added to uplift load resistance to the extent permitted by IBC.
4. Shafts should extend at least one diameter into the bearing stratum (or to a depth equal to the bell diameter for belled shafts) for end bearing to be considered.

Piers should be adequately reinforced as designed by the Structural Engineer for both tension and shear to sufficient depths. Buoyant unit weights of the soil and concrete should be used in the calculations below the highest anticipated groundwater elevation.

A minimum shaft diameter of 18 inches should be used. Drilled shafts should have a minimum length of 4 feet and should extend into the bearing strata at least one shaft/pile/bell diameter for the allowable end-bearing pressures listed in the above table.

Post-construction settlements of drilled shafts designed and constructed as described in this report are estimated to range from about ½ to ¾ inch. Differential settlement between individual shafts is expected to be ½ to ⅔ of the total settlement.

Drilled Shaft Lateral Loading

The following table lists input values for use in LPILE analyses. versions of LPILE provide estimated default values of kh and E50 based on strength and are recommended for the project. Since deflection or a service limit criterion will most likely control lateral capacity design, no safety/resistance factor is included with the parameters.

Soil Inputs								
Stratigraphy[1]		L-Pile Soil Model	S_u (psf)[2]	ϕ[2]	γ' (pcf)[2]	ε_{50}	K (pci)	
Layer No.	Material						Static	Cyclic
2	Granular Soil	Sand (Reese)	---	35°	125	Use Default Value		

1. See Subsurface Profile in **Geotechnical Characterization** for more details on Stratigraphy.
2. Definition of Terms:
   S_u: Undrained shear strength
   ϕ: Internal friction angle
   γ': Effective unit weight

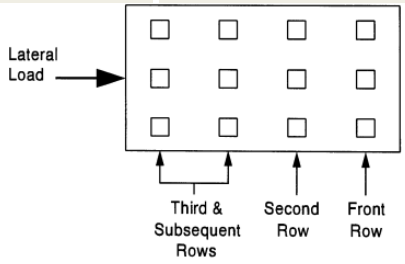
Rock Inputs							
Stratigraphy[1]		L-Pile Soil Model	γ' (pcf)[2]	K rm[2]	UCS (psi)[2]	Ei (psi)[2]	RQD (%)
Layer No.	Material						
3	Use Default Value	Weak Rock (Reese)	150	0.0005	750	68,000	0

1. See Subsurface Profile in **Geotechnical Characterization** for more details on Stratigraphy.
2. Definition of Terms:
   γ': Effective unit weight
   K rm: Strain Factor
   UCS: Uniaxial Compressive Strength (psi)
   Ei: Initial Modulus of Rock Mass (psi)
   RQD: Rock Quality Designation (%)

When shafts are used in groups, the When shafts are used in groups, the lateral capacities of the shafts in the second, third, and subsequent rows of the group should be reduced as compared to the capacity of a single, independent shaft. Guidance for applying p-multiplier factors to the p values in the p-y curves for each row of pile foundations within a pile group are as follows:

Center to Center Pile Spacing [1,2]	P-Multiplier, P_m [3]		
	Front Row	Second Row	Third and Subsequent Rows
3B	0.8	0.4	0.3
4B	0.9	0.65	0.5
5B	1.0	0.85	0.7
6B	1.0	1.0	1.0

1. Spacing in the direction of loading. B = pile diameter
2. For the case of a single row of piles supporting a laterally loaded grade beam, group action for lateral resistance of piles would need be considered when spacing is less than three pile diameters (measured center-to-center).
3. See adjacent figure for definition of front, second and third rows.



Spacing closer than 3D (where D is the diameter of the shaft) is not recommended without additional geotechnical consultation due to potential for the installation of a new shaft disturbing an adjacent installed shaft likely resulting in axial capacity reduction.

Drilled Shaft Construction Considerations

The drilling contractor should be experienced in the subsurface conditions observed at the site, and the excavations should be performed with equipment capable of providing a clean bearing surface. The drilled straight-shaft foundation system should be installed in general accordance with the procedures presented in "Standard Specification for the Construction of Drilled Piers", ACI Publication No. 336.1-01.

The contractor is generally expected to use conventional "dry" techniques for installation of the drilled shaft. Subsurface water was not encountered in boring during the drilling activities. Subsurface water levels are influenced by seasonal and climatic conditions, which result in fluctuations in subsurface water elevations. Additionally, it is common for water to be present after periods of significant rainfall. Casing or slurry drilling procedures could be required in soils zones of higher sand content (such as was observed in GeoModel Layer 3) to reduce the potential for excavation sidewall collapse.

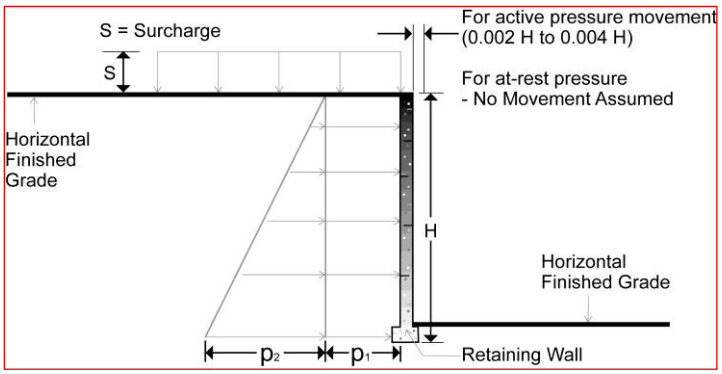
The drilling contractor should remove all soft and disturbed soils from the base of the drilled pier prior to placing concrete. The drilled shaft installation process should be performed under the observation of the Geotechnical Engineer. The Geotechnical Engineer should document the shaft installation process including soil/rock and groundwater

conditions observed, consistency with expected conditions, and details of the installed shaft.

Lateral Earth Pressures

Design Parameters

Structures with unbalanced backfill levels on opposite sides should be designed for earth pressures at least equal to values indicated in the following table. Earth pressures will be influenced by structural design of the walls, conditions of wall restraint, methods of construction, and/or compaction and the strength of the materials being restrained. Two wall restraint conditions are shown in the diagram below. Active earth pressure is commonly used for design of free-standing cantilever retaining walls and assumes wall movement. The "at-rest" condition assumes no wall movement and is commonly used for basement walls, loading dock walls, or other walls restrained at the top. The recommended design lateral earth pressures do not include a factor of safety and do not provide for possible hydrostatic pressure on the walls (unless stated).



Lateral Earth Pressure Design Parameters

Earth Pressure Condition [1]	Coefficient for Backfill Type [2]	Surcharge Pressure [3] p_1 (psf)	Equivalent Fluid Pressures (psf) [2,4]	
			Unsaturated [5]	Submerged [5]
Active (Ka)	Granular - 0.33 Fine Grained - 0.41	(0.33)S (0.41)S	(40)H (50)H	(80)H (85)H
At-Rest (Ko)	Granular - 0.50 Fine Grained - 0.58	(0.50)S (0.58)S	(60)H (70)H	(90)H (95)H

1. For active earth pressure, wall must rotate about base, with top lateral movements 0.002 H to 0.004 H, where H is wall height. For passive earth pressure, wall must

Lateral Earth Pressure Design Parameters

Earth Pressure Condition [1]	Coefficient for Backfill Type [2]	Surcharge Pressure [3] p_1 (psf)	Equivalent Fluid Pressures (psf) [2,4]	
			Unsaturated [5]	Submerged [5]

move horizontally to mobilize resistance. Fat clay or other expansive soils should not be used as backfill behind the wall.

2. Uniform, horizontal backfill, with a maximum unit weight of 120pcf for cohesive soils and 120pcf for granular soils.
3. Uniform surcharge, where S is surcharge pressure.
4. Loading from heavy compaction equipment is not included.
5. To achieve "Unsaturated" conditions, follow guidelines in **Subsurface Drainage for Below-Grade Walls** below. "Submerged" conditions are recommended when drainage behind walls is not incorporated into the design.

Backfill placed against structures should consist of granular soils or low plasticity cohesive soils. For the granular values to be valid, the granular backfill must extend out and up from the base of the wall at an angle of at least 45 degrees from vertical for the active case.

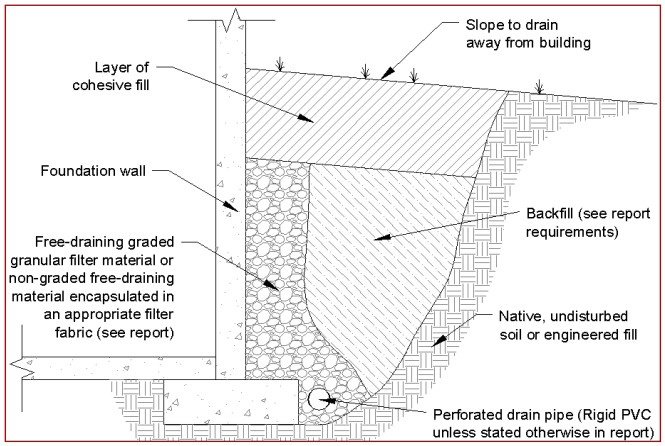
Footings, floor slabs or other loads bearing on backfill behind walls may have a significant influence on the lateral earth pressure. Placing footings within wall backfill and in the zone of active soil influence on the wall should be avoided unless structural analyses indicate the wall can safely withstand the increased pressure.

The lateral earth pressure recommendations given in this section are applicable to the design of rigid retaining walls subject to slight rotation, such as cantilever, or gravity type concrete walls. These recommendations are not applicable to the design of modular block - geogrid reinforced backfill walls (also termed MSE walls). Recommendations covering these types of wall systems are beyond the scope of services for this assignment. However, we would be pleased to develop a proposal for evaluation and design of such wall systems upon request.

Subsurface Drainage for Below-Grade Walls

A perforated rigid plastic drain line installed behind the base of walls and extending below adjacent grade is recommended to prevent hydrostatic loading on the walls. The invert of a drain line around a below-grade building area or exterior retaining wall should be placed near foundation bearing level. The drain line should be sloped to provide positive gravity drainage to daylight or to a sump pit and pump. The drain line should be surrounded by clean, free-draining granular material having less than 5% passing the No. 200 sieve, such as No. 57 aggregate. The free-draining aggregate should be encapsulated in a filter fabric.

The granular fill should extend to within 2 feet of final grade, where it should be capped with compacted cohesive fill to reduce infiltration of surface water into the drain system.



As an alternative to free-draining granular fill, a prefabricated drainage structure may be used. A prefabricated drainage structure is a plastic drainage core or mesh which is covered with filter fabric to prevent soil intrusion and is fastened to the wall prior to placing backfill.

Pavements

Pavement Subgrade Support Characteristics

For pavement design by others, we recommend that a subgrade California Bearing Ratio, CBR, of 10 be used for the asphaltic concrete pavement designs. We recommend that a modulus of subgrade reaction of 200 pci be used for the portland cement concrete pavement designs. These values were empirically derived based upon our experience with the subgrade soils identified at the site and our expectation of the quality of the subgrade as prescribed by the **Site Preparation** conditions as outlined in **Earthwork**.

Slope Stability

A slope stability analyses was not undertaken as part of this analysis for this project and as such we have not commented upon the stability of the slopes surrounding the project area.

It should be expected that during construction, disturbance to the surround soils should be kept to a minimum. Disturbance to surrounding soils may result in sloughing of surface soils, which may lead to a larger sliding failure of the surface soils.

General Comments

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Variations will occur between exploration point locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained as the Geotechnical Engineer, where noted in this report, to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Our Scope of Services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third-party beneficiaries intended. Any third-party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly effect excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety and cost estimating including excavation support and dewatering requirements/design are the responsibility of others. Construction and site development have the potential to affect adjacent properties. Such impacts can include damages due to vibration, modification of groundwater/surface water flow during construction, foundation movement due to undermining or subsidence from excavation, as well as noise or air quality concerns. Evaluation of these items on nearby properties are commonly associated with contractor means and methods and are not addressed in this report. The owner and contractor should consider a preconstruction/precondition survey of surrounding development. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

Figures

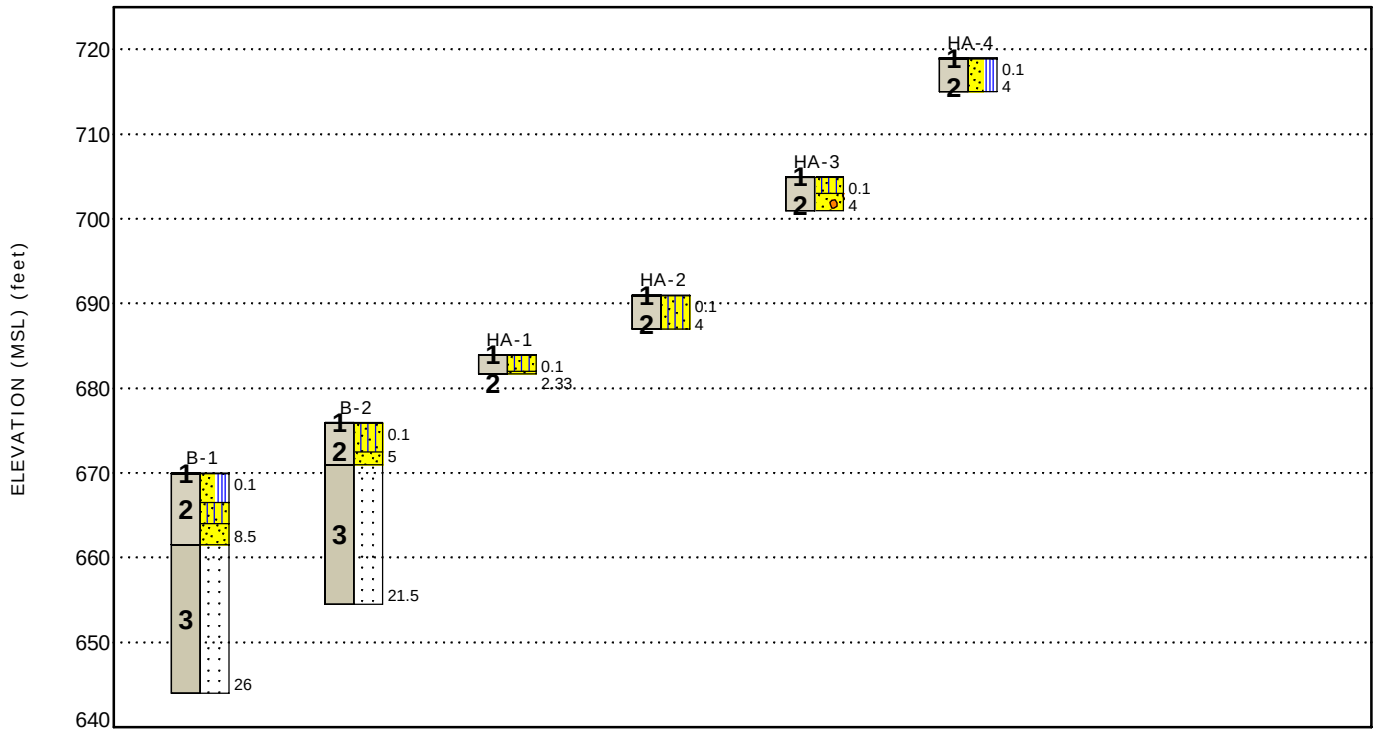
Contents:

GeoModel

Munising Falls Trail Rehabilitation
1505 Sand Point Road | Munising, MI
Terracon Project No. N6235258

Terracon
12460 Plaza Dr
Parma, OH

GeoModel



This is not a cross section. This is intended to display the Geotechnical Model only. See individual logs for more detailed conditions.

Model Layer	Layer Name	General Description
1	Surface Cover	Topsoil - 1 inch
2	Granular Soil	Loose to very dense sand
3	Bedrock	Moderately weathered, weak sandstone

Legend	
Topsoil	Poorly-graded Sand with Silt
Silty Sand	Poorly-graded Sand
Sandstone	Poorly-graded Sand with Gravel

NOTES:
Layering shown on this figure has been developed by the geotechnical engineer for purposes of modeling the subsurface conditions as required for the subsequent geotechnical engineering for this project.
Numbers adjacent to soil column indicate depth below ground surface.

Attachments

Exploration and Testing Procedures

Field Exploration

Number of Borings	Approximate Boring Depth (feet)	Location
2	21.5 to 26.0	Trail area
4	2.3 to 4.0	Trail area

Boring Layout and Elevations: Terracon personnel provided the boring layout using recreational handheld GPS equipment (estimated horizontal accuracy of 10± feet) and referencing existing site features. Approximate ground surface elevations were obtained by interpolation from Google Earth. If elevations and a more precise boring layout are desired, we recommend borings be surveyed.

Subsurface Exploration Procedures: We advanced the deeper borings with a track-mounted, rotary drill rig using continuous flight augers (solid stem and/or hollow stem, as necessary, depending on soil conditions). Four samples were obtained in the upper 10 feet of each boring and at intervals of 5 feet thereafter. In the split-barrel sampling procedure, a standard 2-inch outer diameter split-barrel sampling spoon was driven into the ground by a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring logs at the test depths.

We advanced the shallower borings with direct-push handheld sampling equipment.

We observed and recorded groundwater levels during drilling and sampling. For safety purposes, all borings were backfilled with auger cuttings after their completion. Pavements were patched with cold-mix asphalt and/or pre-mixed concrete, as appropriate.

The sampling depths, penetration distances, and other sampling information was recorded on the field boring logs. The samples were placed in appropriate containers and taken to our soil laboratory for testing and classification by a Geotechnical Engineer. Our exploration team prepared field boring logs as part of the drilling operations. These field logs included visual classifications of the materials observed during drilling and our interpretation of the subsurface conditions between samples. Final boring logs were prepared from the field logs. The final boring logs represent the Geotechnical Engineer's interpretation of the field logs and include modifications based on observations and tests of the samples in our laboratory.

Laboratory Testing

The laboratory testing program often included classification of soil samples by an engineer or geologist. Based on the results of our field and laboratory programs, we described and classified the soil samples in accordance with the Unified Soil Classification System.

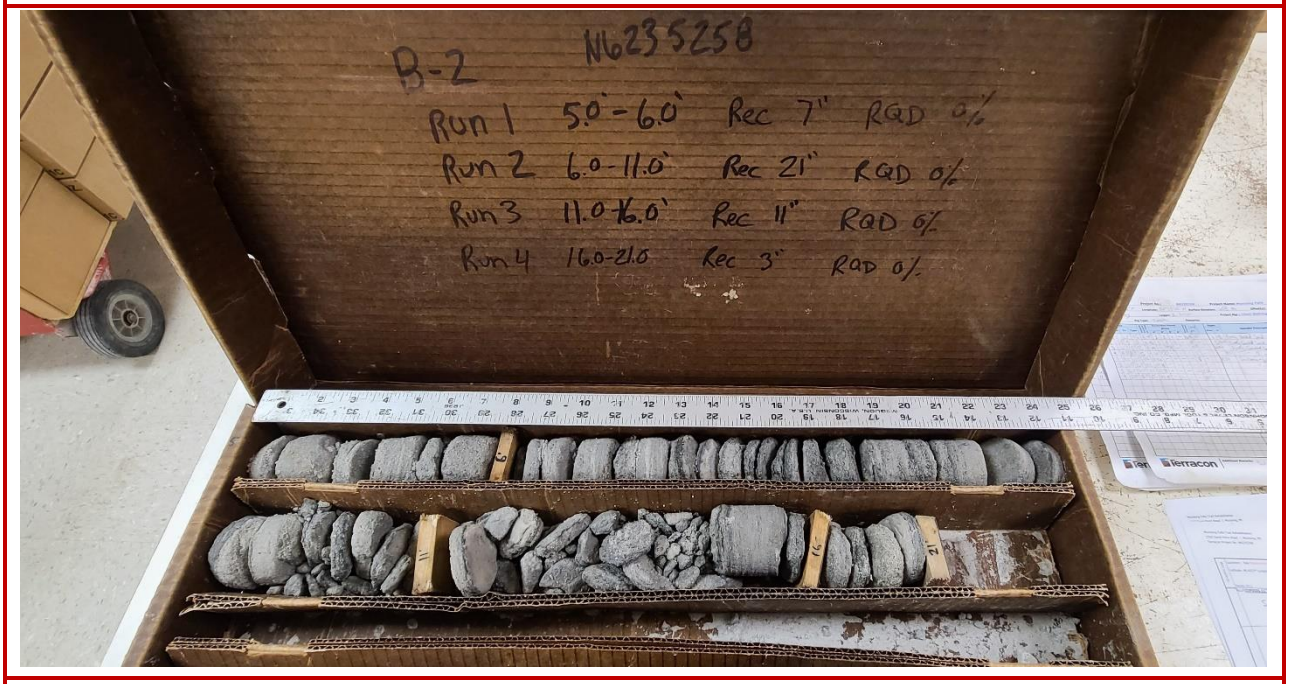
The project engineer reviewed the field data and assigned laboratory tests. The laboratory testing program included the following types of tests:

- Grain Size Distribution

Rock classification was conducted using locally accepted practices for engineering purposes; petrographic analysis may reveal other rock types. Rock core samples typically provide an improved specimen for this classification. Boring log rock classification was determined using the Description of Rock Properties.

Photography Log

B-1: 8.5-26.0'



B-2: 5.0-21.0'

Site Location and Exploration Plans

Contents:

Site Location
Exploration Plan

Note: All attachments are one page unless noted above.

Site Location

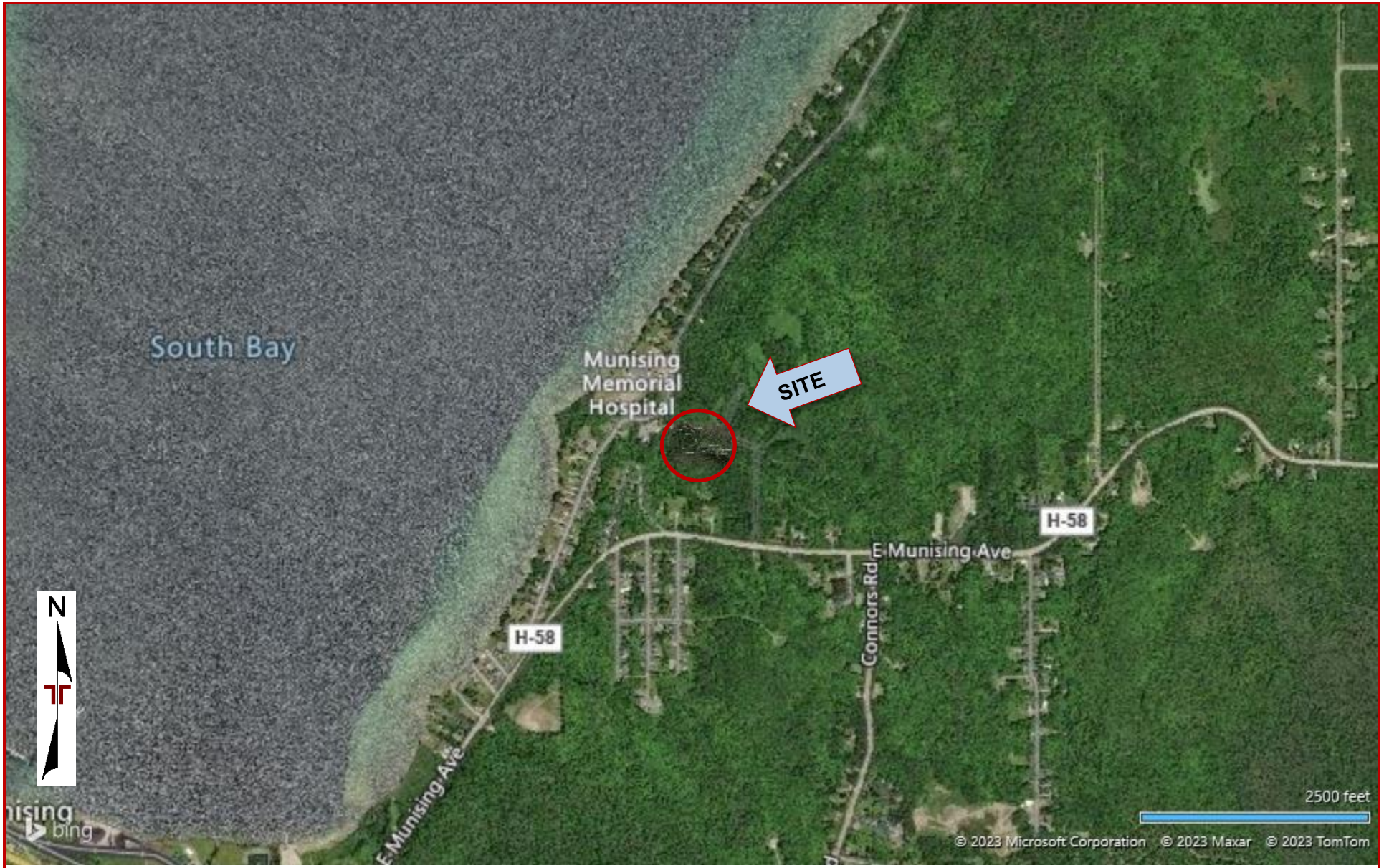


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

Exploration Plan

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

Exploration and Laboratory Results

Contents:

Boring Logs (B-1 and B-2 and HA-1 through HA-4)
Grain Size Distribution
Geophysical Exploration Report

Note: All attachments are one page unless noted above.

Munising Falls Trail Rehabilitation
1505 Sand Point Road | Munising, MI
Terracon Project No. N6235258

Terracon
12460 Plaza Dr
Parma, OH

Boring Log No. B-1

Location: 20' East

Latitude: 46.4237° Longitude: -86.6236°

Model Layer	Depth (Ft.)	Elevation: 670 (Ft.) +/-	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results
1	0.1	TOPSOIL (1") 669.9					
		POORLY GRADED SAND WITH SILT (SP-SM), fine to medium grained, brown, loose				16	2-2-1 N=3
	3.5	666.5					
2		SILTY SAND (SM), yellowish brown, dense				18	5-8-18 N=26
	6.0	664	5				
		POORLY GRADED SAND (SP), fine to medium grained, gray, very dense				10	43-50/4"
	8.5	661.5				3	50/3"
3		SANDSTONE, gray, very close fracture spacing, laminated bedding, moderately weathered, weak rock	10			11	RQD = 0%
						21	RQD = 0%
			15				
						25	RQD = 0%
			20				
						38	RQD = 0%
			25				
	26.0	644					
		Boring Terminated at 26 Feet					

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered

Notes
Elevation Reference: Elevations estimated from Google Earth.

Advancement Method
3.25" ID HSA

Abandonment Method
Boring backfilled with auger cuttings and sand upon completion.

Drill Rig
B57

Hammer Type
Automatic

Driller
A. Fay

Logged by
K. Miller

Boring Started
10-17-2023

Boring Completed
10-17-2023

Munising Falls Trail Rehabilitation
1505 Sand Point Road | Munising, MI
Terracon Project No. N6235258

Terracon
12460 Plaza Dr
Parma, OH

Boring Log No. B-2

Location: See Exploration Plan

Latitude: 46.4237° Longitude: -86.6234°

Model Layer	Depth (Ft.)	Elevation: 676 (Ft.) +/-	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results
1	0.1	TOPSOIL (1")	675.9				
2		SILTY SAND (SM), brown, very dense				16	4-11-35 N=46
	3.5		672.5				
		POORLY GRADED SAND (SP), fine grained, gray, very dense				3	50/3"
	5.0		671			2	50/2"
3		SANDSTONE, gray, very close fracture spacing, laminated bedding, moderately weathered, weak rock	5			7	RQD = 0%
						21	RQD = 0%
			10				
						11	RQD = 0%
			15				
						3	RQD = 0%
			20				
	21.5		654.5			4	50/4"
		Boring Terminated at 21.5 Feet					

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered

Notes
Elevation Reference: Elevations estimated from Google Earth.

Advancement Method
3.25" ID HSA

Abandonment Method
Boring backfilled with auger cuttings and sand upon completion.

Drill Rig
B57

Hammer Type
Automatic

Driller
A. Fay

Logged by
K. Miller

Boring Started
10-17-2023

Boring Completed
10-17-2023

Munising Falls Trail Rehabilitation
1505 Sand Point Road | Munising, MI
Terracon Project No. N6235258

Terracon
12460 Plaza Dr
Parma, OH

Boring Log No. HA-1

Location: See Exploration Plan

Latitude: 46.4236° Longitude: -86.6232°

Model Layer	Depth (Ft.)	Elevation: 684 (Ft.) +/-	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)
1	0.1	TOPSOIL (1")	683.9			
2		SILTY SAND (SM), brown				11
	2.0		682			
	2.3	POORLY GRADED SAND (SP), fine to medium grained, gray	681.67			4
		Boring Terminated at 2.33 Feet				

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered

Drill Rig
B57

Hammer Type
Automatic

Driller
A. Fay

Logged by
K. Miller

Boring Started
10-17-2023

Boring Completed
10-17-2023

Notes
Elevation Reference: Elevations estimated from Google Earth.

Advancement Method
Hand Advanced Direct Push

Abandonment Method
Boring backfilled with auger cuttings and sand upon completion.

Munising Falls Trail Rehabilitation
1505 Sand Point Road | Munising, MI
Terracon Project No. N6235258

Terracon
12460 Plaza Dr
Parma, OH

Boring Log No. HA-2

Location: See Exploration Plan

Latitude: 46.4235° Longitude: -86.6229°

Model Layer	Graphic Log	Depth (Ft.)	Elevation: 691 (Ft.) +/-	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)
1		0.1	TOPSOIL (1") 690.9				
2			SILTY SAND (SM), brown				10
							10
		4.0	687				
			Boring Terminated at 4 Feet				

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered

Notes
Elevation Reference: Elevations estimated from Google Earth.

Advancement Method
Hand Advanced Direct Push

Abandonment Method
Boring backfilled with auger cuttings and sand upon completion.

Drill Rig
B57

Hammer Type
Automatic

Driller
A. Fay

Logged by
K. Miller

Boring Started
10-17-2023

Boring Completed
10-17-2023

Munising Falls Trail Rehabilitation
1505 Sand Point Road | Munising, MI
Terracon Project No. N6235258

Terracon
12460 Plaza Dr
Parma, OH

Boring Log No. HA-3

Location: See Exploration Plan

Latitude: 46.4234° Longitude: -86.6228°

Model Layer	Graphic Log	Depth (Ft.)	Elevation: 705 (Ft.) +/-	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)
1		0.1	TOPSOIL (1") 704.9				
			SILTY SAND (SM), brown, contains wood fragments				6
2		2.0	703				
			POORLY GRADED SAND WITH GRAVEL (SP), fine to medium grained, brown				10
		4.0	701				
			Boring Terminated at 4 Feet				

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered

Drill Rig
B57

Hammer Type
Automatic

Driller
A. Fay

Logged by
K. Miller

Boring Started
10-17-2023

Boring Completed
10-17-2023

Notes
Elevation Reference: Elevations estimated from Google Earth.

Advancement Method
Hand Advanced Direct Push

Abandonment Method
Boring backfilled with auger cuttings and sand upon completion.

Munising Falls Trail Rehabilitation
1505 Sand Point Road | Munising, MI
Terracon Project No. N6235258

Terracon
12460 Plaza Dr
Parma, OH

Boring Log No. HA-4

Location: See Exploration Plan

Latitude: 46.4231° Longitude: -86.6227°

Model Layer	Graphic Log	Depth (Ft.)	Elevation: 719 (Ft.) +/-	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)
1		0.1	TOPSOIL (1") 718.9				
2			POORLY GRADED SAND WITH SILT (SP-SM), fine grained, brown				10
							18
		4.0	715				
			Boring Terminated at 4 Feet				

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered

Notes
Elevation Reference: Elevations estimated from Google Earth.

Advancement Method
Hand Advanced Direct Push

Abandonment Method
Boring backfilled with auger cuttings and sand upon completion.

Drill Rig
B57

Hammer Type
Automatic

Driller
A. Fay

Logged by
K. Miller

Boring Started
10-17-2023

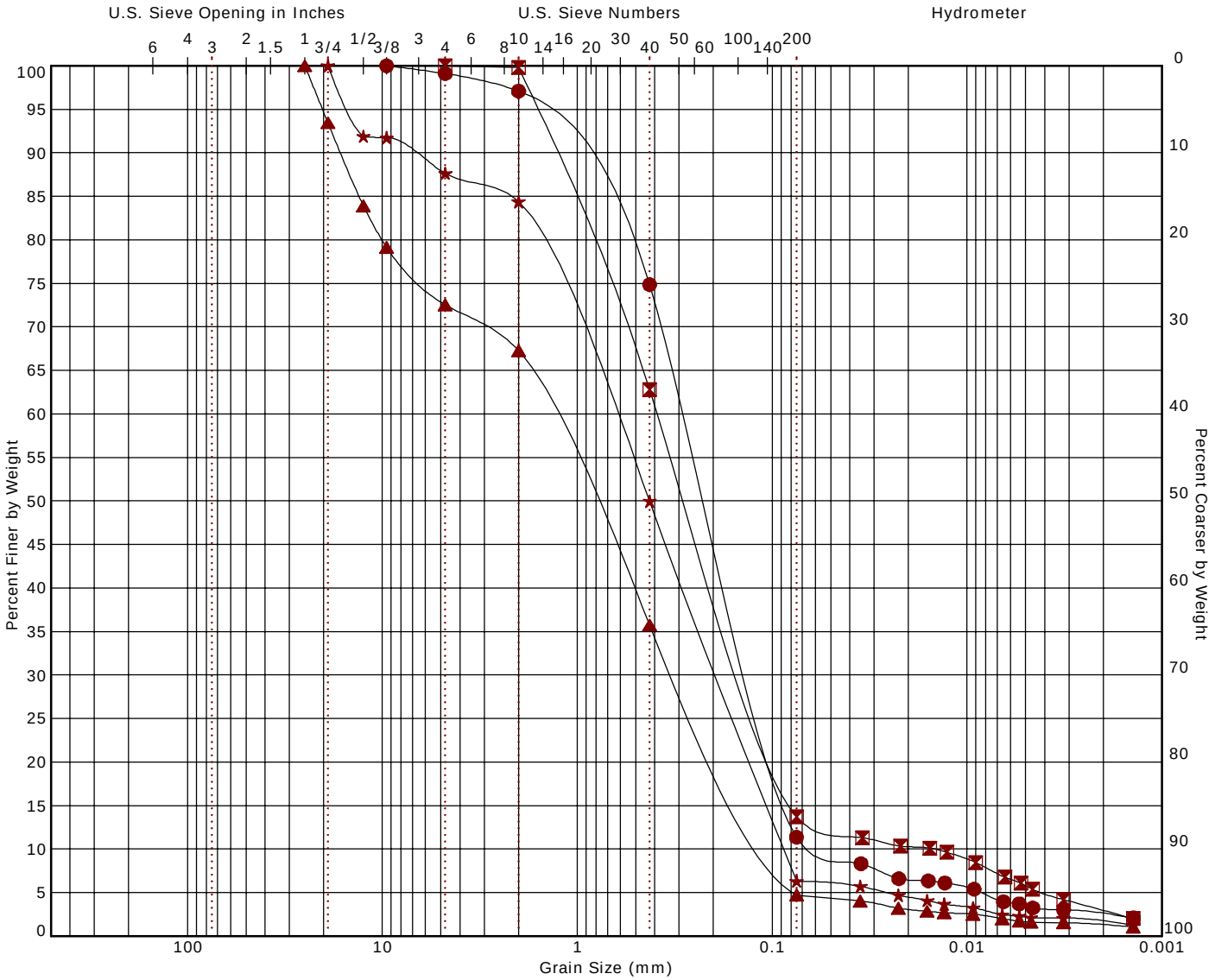
Boring Completed
10-17-2023

Munising Falls Trail Rehabilitation
1505 Sand Point Road | Munising, MI
Terracon Project No. N6235258

Terracon
12460 Plaza Dr
Parma, OH

Grain Size Distribution

ASTM D422 / ASTM C136



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Boring ID		Depth (Ft)	Description		LL	PL	PI	Cc	Cu
●	B-1	1 - 2.5	POORLY GRADED SAND WITH SILT					1.03	5.32
⊠	B-2	1 - 2.5	SILTY SAND					3.14	26.14
▲	HA-3	2 - 4	POORLY GRADED SAND WITH GRAVEL					0.67	13.89
★	HA-4	0 - 2	POORLY GRADED SAND WITH SILT					0.64	7.69

Boring ID		Depth (Ft)	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
●	B-1	1 - 2.5	9.5	0.283	0.125	0.053	0.0	0.9	87.7		7.9	3.5
⊠	B-2	1 - 2.5	4.75	0.385	0.133	0.015	0.0	0.0	86.3		7.9	5.8
▲	HA-3	2 - 4	25	1.4	0.308	0.101	0.0	27.5	67.8		3.1	1.6
★	HA-4	0 - 2	19	0.667	0.192	0.087	0.0	12.4	81.3		4.1	2.2

Laboratory tests are not valid if separated from original report.

November 16, 2023

STRATA Architecture + Preservation
1701 Oak Street, Suite 100
Kansas City, MO 64108

Attn: Angie Geist Gaebler
P: (816) 474-0900
E: angie@srjarch.com

RE: Report of Geophysical Exploration Services
Munising Falls Trail Rehabilitation
1505 Sand Point Road
Munising, Michigan
Terracon Project No. N6235258

Dear Ms. Geist Gaebler:

Terracon has completed their geophysical exploration scope of services for the proposed Munising Falls Trail Rehabilitation. Our geophysical exploration scope of services, as presented herein, was performed consistent with our proposal scope of work.

Terracon performed surface geophysical exploration services consisting of a ground penetrating radar (GPR) and multichannel analysis of surface waves (MASW) survey on October 19, 2023. The survey location is displayed on Figure 1. The primary goal of this survey was to map depth to bedrock and to identify tiebacks and structural components below the paved Munising Falls Trail within the area of interest.

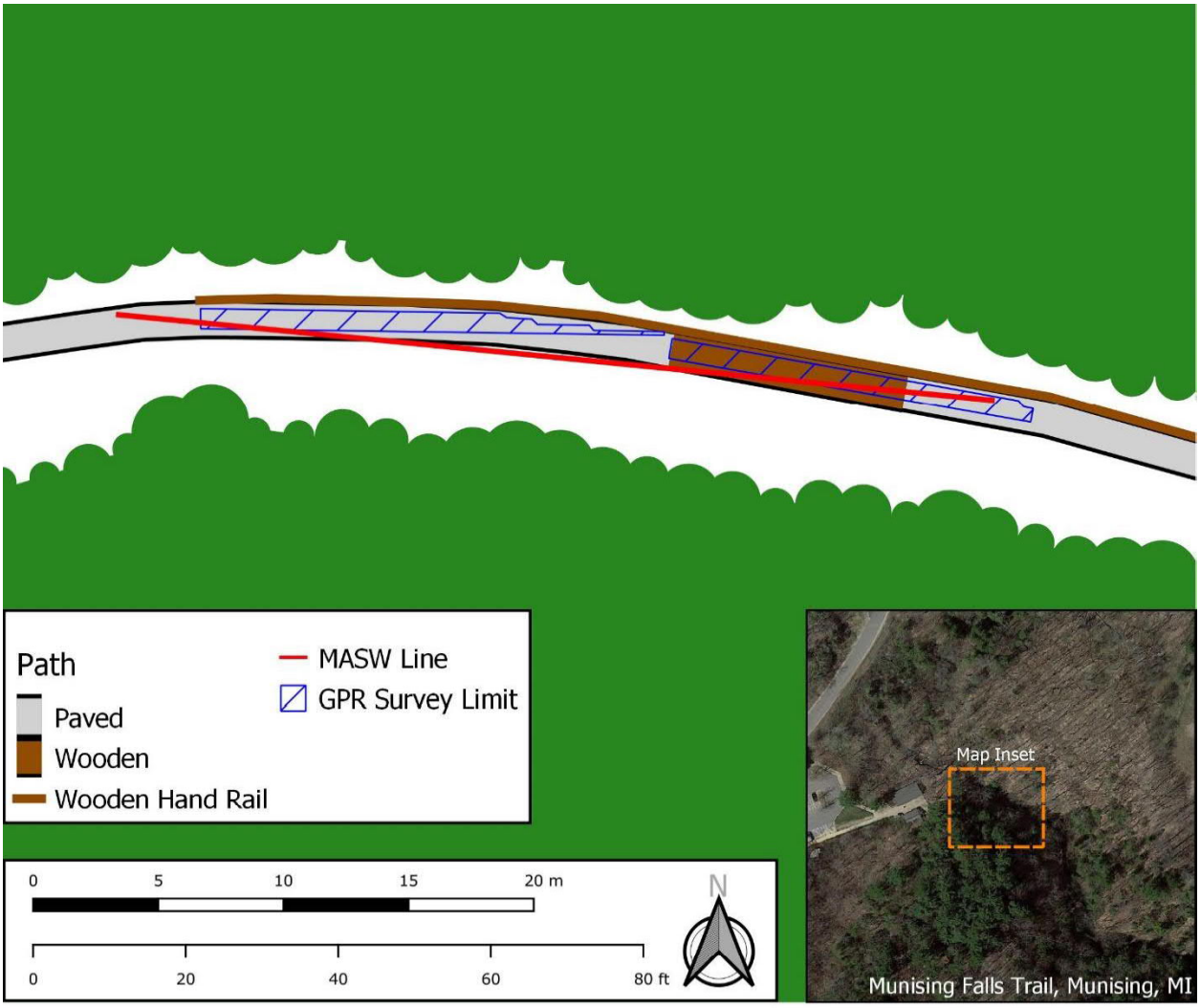


Figure 1- Geophysical Survey Limit Sketch and Google aerial image of Project Area

SURVEY METHODOLOGY

Ground Penetrating Radar – Ground penetrating radar survey was split into two areas to accommodate the curvature of the paved path and to ensure coverage. Our method of investigation used a 250 MHz GPR system pushed along parallel transects spaced 6 inches apart. The data was then processed using GPR processing software (Geolitix) where the data was processed, georeferenced, velocity corrected, and depth-sliced.

MASW - Our method of investigation used a seismograph and a linear array of twenty-four (24) 4.5Hz geophones to collect MASW data. One array was placed on the project site in a straight line, with geophones inserted into the ground or placed on paved surfaces. The

geophones were spaced 5 feet apart, for a total line length of 115 feet. Seismic source shots were taken using a 10 lb. sledgehammer and metal plate. Ambient seismic noise (e.g., vehicular traffic, walking along the line, nearby equipment) were also recorded.

The data was then processed using dispersion analysis software (SurfSeis, engineered by the Kansas Geological Survey) that extracts the fundamental-mode dispersion curve(s). The curves were inverted and modeled to yield a 2D shear-wave velocity profile along the array.

FINDINGS

The GPR was successful in identifying potential structures along the path (Figure 2, 3, 4) and a potential void below the wooden portion of the walking path. The structures represent two distinct depths of horizontal anomalies which extent roughly north to south beneath the walking path. The first set of anomalies were detected at approximately 0.75 ft below surface. The second, deeper set of linear anomalies were detected at approximately 1.5 ft below surface. Both of these sets of anomalies likely correspond with tiebacks associated with the retaining wall to the north of the path. Though intermittent, the GPR detected a horizon which is likely associated with bedrock at approximately 16 ft below surface. The GPR detected responses consistent with tiebacks below the wooden portion of the trail at approximately 1.5 ft below surface at 4 ft intervals.

The MASW data was successful in identifying depth to bedrock between 10 and 17 ft below surface (Figure 5). It additionally identified an anomaly which is spatially consisting with the potential void identified in the GPR survey.

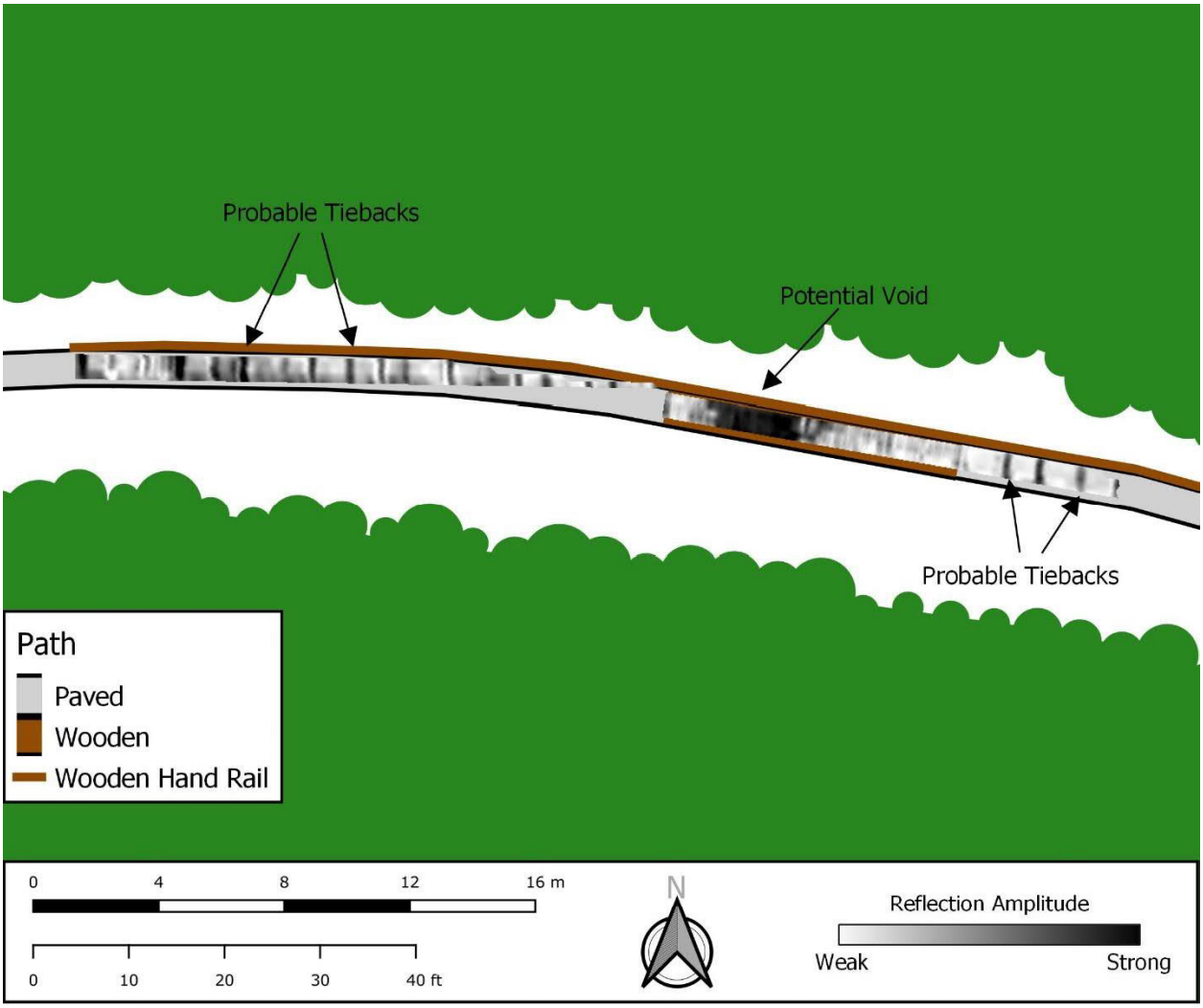


Figure 2 GPR Depth slices from areas 1 and 2 at 0.65 ft below surface.

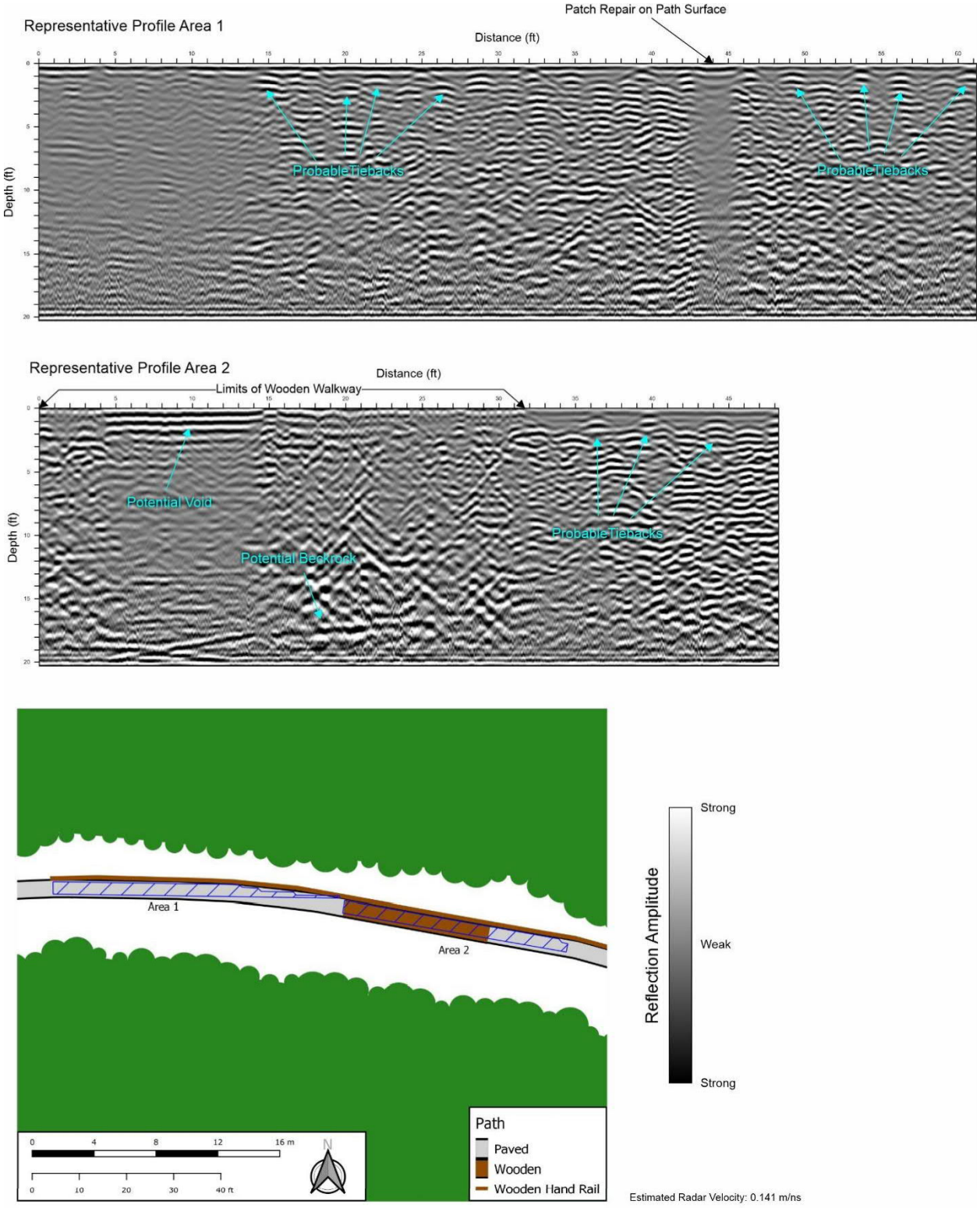


Figure 3 Example Radargrams from Areas 1 and 2.

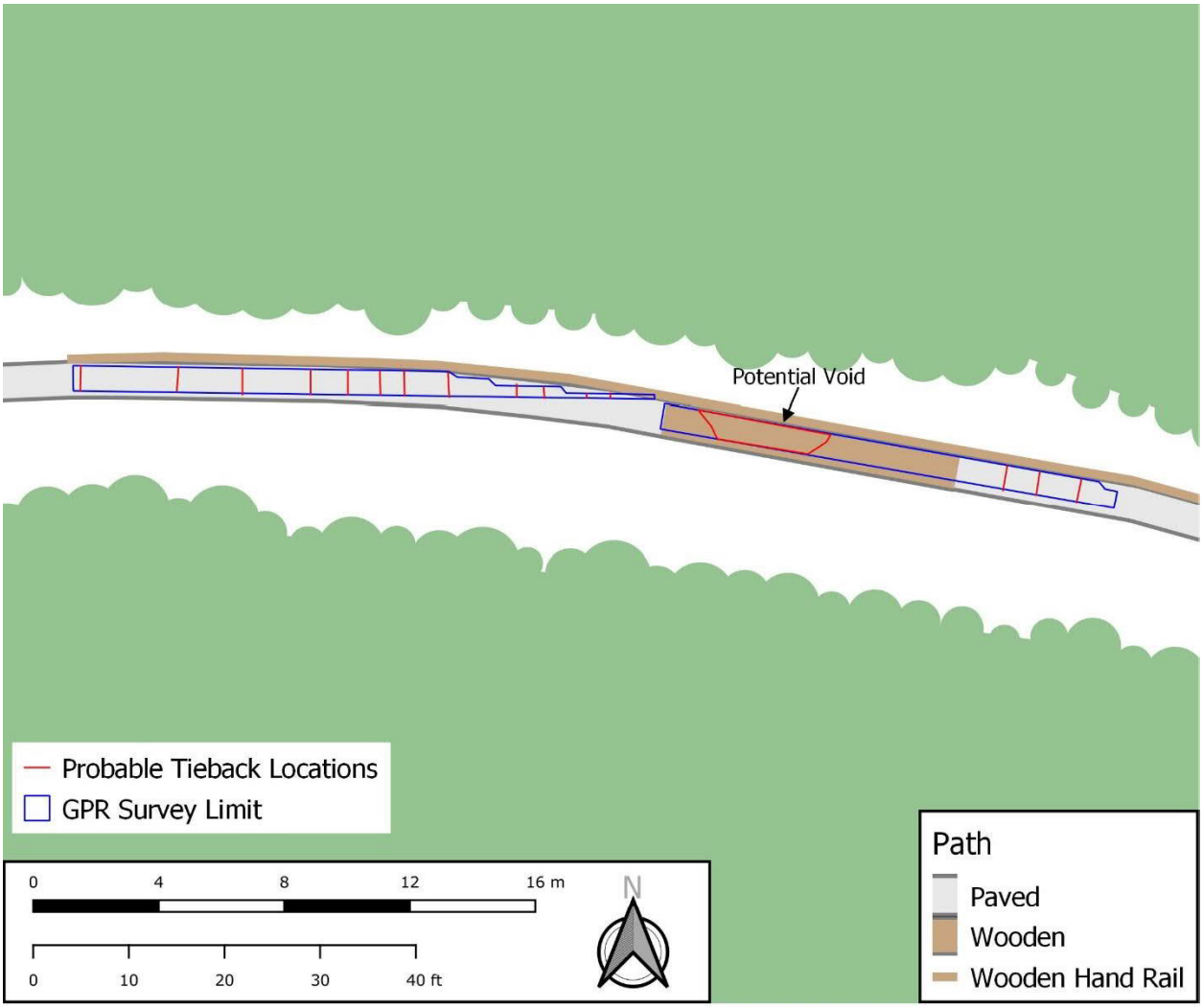


Figure 4 GPR Interpretation on Sketchmap.

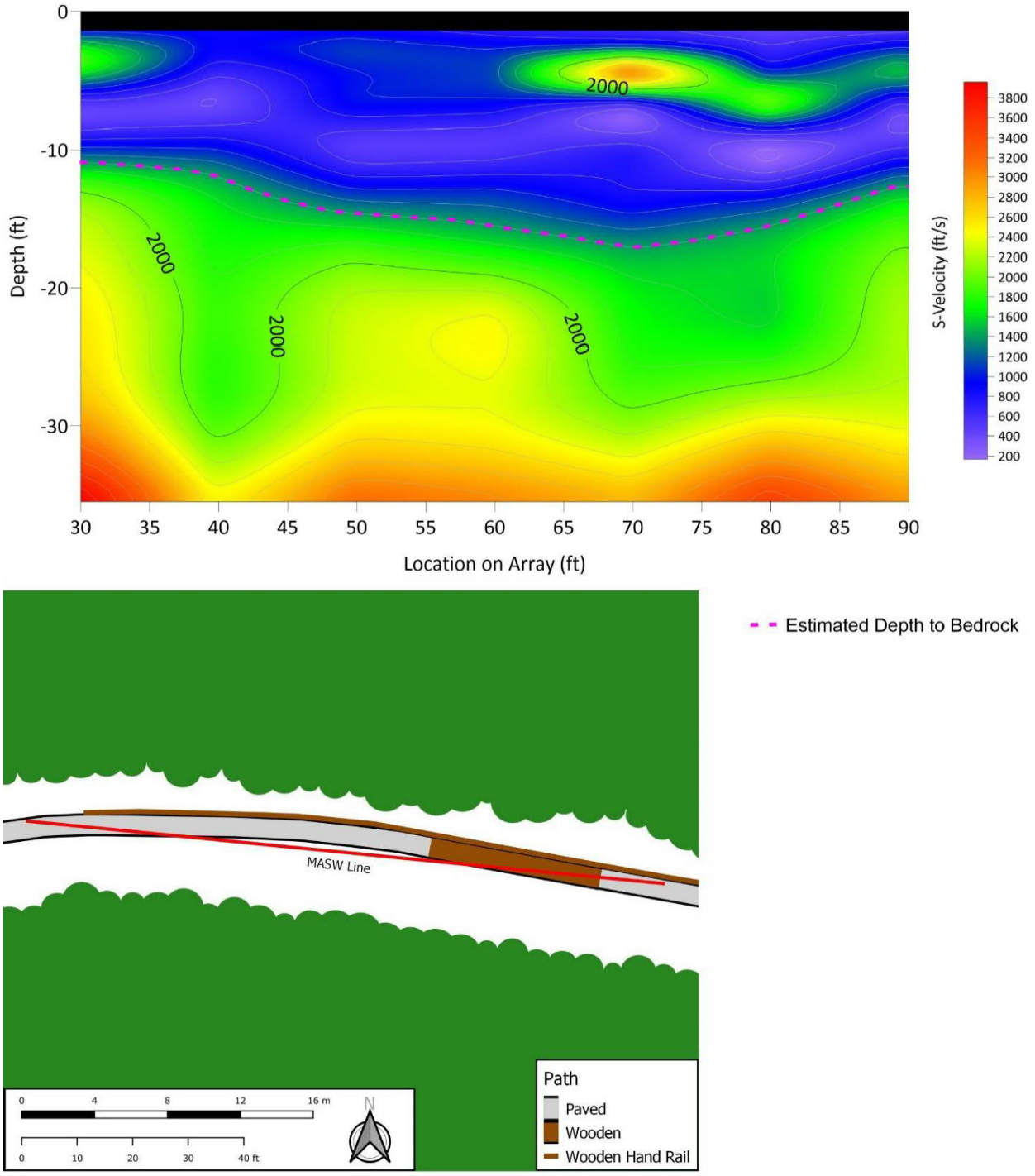


Figure 5 Showing MASW Data and Survey Location on Sketch Map.

LIMITATIONS

All geophysical testing methods rely on instrument signals to indicate physical conditions in the field. Signal information can be affected by on-site conditions beyond the control of the operator, such as, but not limited to, cultural features, standing water, high subsurface moisture content, and other buried objects. Interpretation of those signals is based on a combination of known factors combined with the experience of the operator and geophysical scientist evaluating the results.

This report has been prepared for the application discussed and in accordance with generally accepted geophysical practices. No warranties, expressed or implied, are intended or made. The findings presented in this report are based upon the data obtained from the geophysical surveys and from other information discussed in this report. This report does not reflect variations that may occur in areas not tested or inaccessible to the geophysical equipment, across the site, or due to the modifying effects of construction or weather.

CLOSING

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,
Terracon Consultants, Inc.

Alexander C. Corkum II, PhD
Project Geophysicist

Chett A. Siefring
Manager | Geotechnical Services

Supporting Information

Contents:

General Notes
Unified Soil Classification System
Description of Rock Properties

Note: All attachments are one page unless noted above.

Terracon
12460 Plaza Dr
Parma, OH

General Notes

Sampling

Rock Core

Standard Penetration Test

Water Level

Water Initially Encountered

Water Level After a Specified Period of Time

Water Level After a Specified Period of Time

Cave In Encountered

Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.

Field Tests

N	Standard Penetration Test Resistance (Blows/Ft.)
(HP)	Hand Penetrometer
(T)	Torvane
(DCP)	Dynamic Cone Penetrometer
UC	Unconfined Compressive Strength
(PID)	Photo-Ionization Detector
(OVA)	Organic Vapor Analyzer

Descriptive Soil Classification

Soil classification as noted on the soil boring logs is based Unified Soil Classification System. Where sufficient laboratory data exist to classify the soils consistent with ASTM D2487 "Classification of Soils for Engineering Purposes" this procedure is used. ASTM D2488 "Description and Identification of Soils (Visual-Manual Procedure)" is also used to classify the soils, particularly where insufficient laboratory data exist to classify the soils in accordance with ASTM D2487. In addition to USCS classification, coarse grained soils are classified on the basis of their in-place relative density, and fine-grained soils are classified on the basis of their consistency. See "Strength Terms" table below for details. The ASTM standards noted above are for reference to methodology in general. In some cases, variations to methods are applied as a result of local practice or professional judgment.

Location And Elevation Notes

Exploration point locations as shown on the Exploration Plan and as noted on the soil boring logs in the form of Latitude and Longitude are approximate. See Exploration and Testing Procedures in the report for the methods used to locate the exploration points for this project. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

Strength Terms

Relative Density of Coarse-Grained Soils
(More than 50% retained on No. 200 sieve.)
Density determined by Standard Penetration Resistance

Relative Density	Standard Penetration or N-Value (Blows/Ft.)
Very Loose	0 - 3
Loose	4 - 9
Medium Dense	10 - 29
Dense	30 - 50
Very Dense	> 50

Consistency of Fine-Grained Soils
(50% or more passing the No. 200 sieve.)
Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance

Consistency	Unconfined Compressive Strength Qu (tsf)	Standard Penetration or N-Value (Blows/Ft.)
Very Soft	less than 0.25	0 - 1
Soft	0.25 to 0.50	2 - 4
Medium Stiff	0.50 to 1.00	4 - 8
Stiff	1.00 to 2.00	8 - 15
Very Stiff	2.00 to 4.00	15 - 30
Hard	> 4.00	> 30

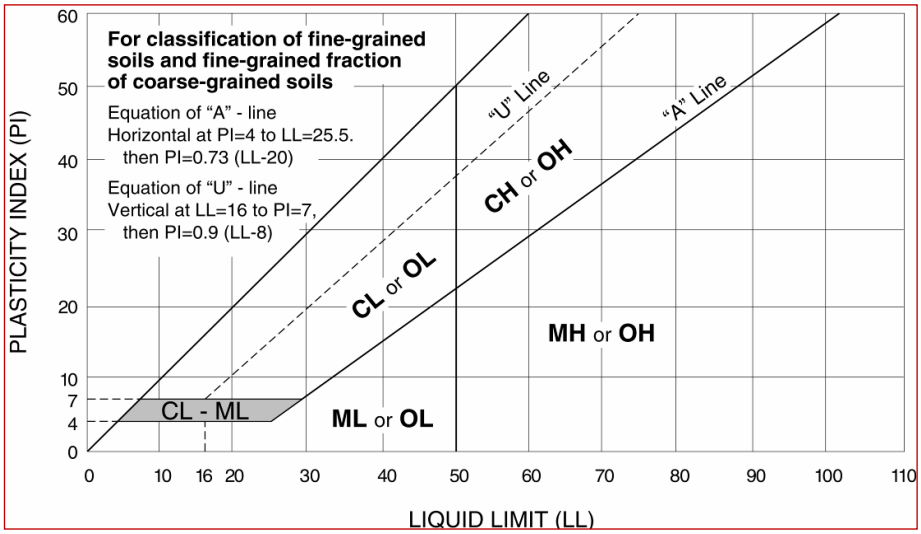
Relevance of Exploration and Laboratory Test Results

Exploration/field results and/or laboratory test data contained within this document are intended for application to the project as described in this document. Use of such exploration/field results and/or laboratory test data should not be used independently of this document.

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. 4 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	Cu≥4 and 1≤Cc≤3 [E]	GW	Well-graded gravel [F]
			Cu<4 and/or [Cc<1 or Cc>3.0] [E]	GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH	GM	Silty gravel [F, G, H]
			Fines classify as CL or CH	GC	Clayey gravel [F, G, H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	Cu≥6 and 1≤Cc≤3 [E]	SW	Well-graded sand [I]
			Cu<6 and/or [Cc<1 or Cc>3.0] [E]	SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH	SM	Silty sand [G, H, I]
			Fines classify as CL or CH	SC	Clayey sand [G, H, 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 above "A" line [J]	CL	Lean clay [K, L, M]
			PI < 4 or plots below "A" line [J]	ML	Silt [K, L, M]
		Organic:	$\frac{LL\ oven\ dried}{LL\ not\ dried} < 0.75$	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:	$\frac{LL\ oven\ dried}{LL\ not\ dried} < 0.75$	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] 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.
[E] $Cu = D_{60}/D_{10}$ $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$
[F] If soil contains ≥ 15% sand, add "with sand" to group name.
[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.
[H] If fines are organic, add "with organic fines" to group name.
[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.
[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.
[K] If soil contains 15 to 29% 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.



Rock Classification Notes

WEATHERING	
Term	**Description**
Fresh	Mineral crystals appear bright; show no discoloration. Features show little or now staining on surfaces. Discoloration does not extend into intact rock.
Slightly weathered	Rock generally fresh except along fractures. Some fractures stained and discoloration may extend <0.5 inches into rock.
Moderately weathered	Significant portions of rock are dull and discolored. Rock may be significantly weaker than in fresh state near fractures. Soil zones of limited extent may occur along some fractures.
Highly weathered	Rock dull and discolored throughout. Majority of rock mass is significantly weaker and has decomposed and/or disintegrated; isolated zones of stronger rock and/or soil may occur throughout.
Completely weathered	All rock material is decomposed and/or disintegrated to soil. The rock mass or fabric is still evident and largely intact. Isolated zones of stronger rock may occur locally.

STRENGTH OR HARDNESS		
Description	**Field Identification**	**Uniaxial Compressive Strength, psi**
Extremely strong	Can only be chipped with geological hammer. Rock rings on hammer blows. Cannot be scratched with a sharp pick. Hand specimens require several hard hammer blows to break.	>36,000
Very strong	Several blows of a geological hammer to fracture. Cannot be scratched with a 20d common steel nail. Can be scratched with a geologist's pick only with difficulty.	15,000-36,000
Strong	More than one blow of a geological hammer needed to fracture. Can be scratched with a 20d nail or geologist's pick. Gouges or grooves to ¼ inch deep can be excavated by a hard blow of a geologist's pick. Hand specimens can be detached by a moderate blow.	7,500-15,000
Medium strong	One blow of geological hammer needed to fracture. Can be distinctly scratched with 20d nail. Can be grooved or gouged 1/16 in. deep by firm pressure with a geologist's pick point. Can be fractured with single firm blow of geological hammer. Can be excavated in small chips (about 1-in. maximum size) by hard blows of the point of a geologist's pick;	3,500-7,500
Weak	Shallow indent by firm blow with geological hammer point. Can be gouged or grooved readily with geologist's pick point. Can be excavated in pieces several inches in size by moderate blows of a pick point. Small thin pieces can be broken by finger pressure.	700-3,500
Very weak	Crumbles under firm blow with geological hammer point. Can be excavated readily with the point of a geologist's pick. Pieces 1-in. or more in thickness can be broken with finger pressure. Can be scratched readily by fingernail.	150-700

DISCONTINUITY DESCRIPTION			
Fracture Spacing (Joints, Faults, Other Fractures)		**Bedding Spacing (May Include Foliation or Banding)**	
Description	**Spacing**	**Description**	**Spacing**
Intensely fractured	< 2.5 inches	**Laminated**	< ½-inch
Highly fractured	2.5 – 8 inches	**Very thin**	½ – 2 inches
Moderately fractured	8 inches to 2 feet	**Thin**	2 inches – 1 foot
Slightly fractured	2 to 6.5 feet	**Medium**	1 – 3 feet
Very slightly fractured	> 6.5 feet	**Thick**	3 – 10 feet
		Massive	> 10 feet

ROCK QUALITY DESIGNATION (RQD) [1]	
Description	**RQD Value (%)**
Very Poor	0 - 25
Poor	25 – 50
Fair	50 – 75
Good	75 – 90
Excellent	90 - 100

1. The combined length of all sound and intact core segments equal to or greater than 4 inches in length, expressed as a percentage of the total core run length.

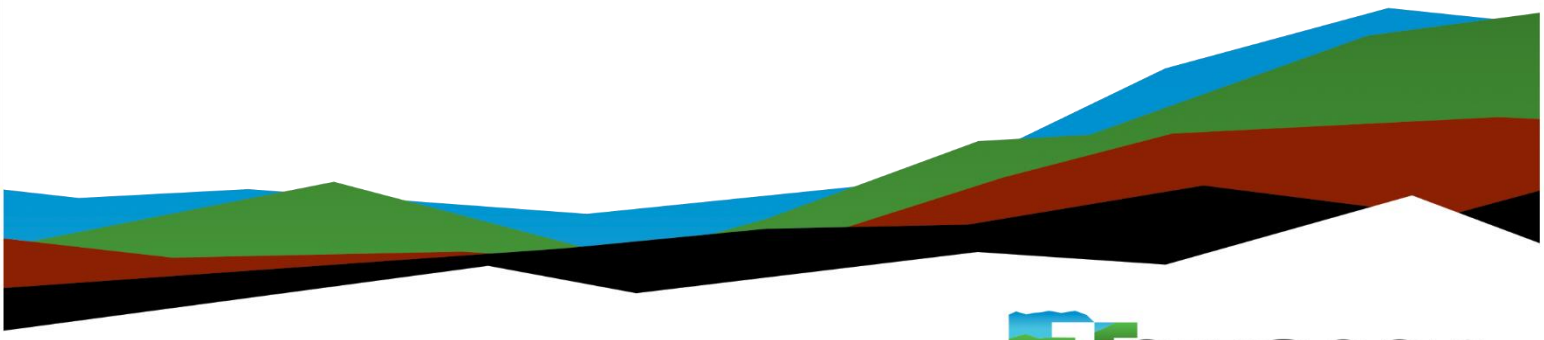
Munising Falls Trail Rehabilitation

Geotechnical Engineering Report

January 18, 2024 | Terracon Project No. N6235258

Prepared for:

Strata Architects + Preservation
1701 Oak Street, Suite 100
Kansas City, Missouri



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November 17,2023
Revised January 18, 2024

Strata Architects + Preservation
1701 Oak Street, Suite 100
Kansas City, Missouri

Attn: Angie Geist Gaebler
P: (816) 474-0900
E: angie@strata-arch.com

Re: Geotechnical Engineering Report
Munising Falls Trail Rehabilitation
1505 Sand Point Road
Munising, Alger County, Michigan
Terracon Project No. N6235258

Dear Ms. Gaebler:

We have completed the scope of Geotechnical Engineering services for the above referenced project in general accordance with Terracon Proposal No. PN6235258 dated Revised October 5, 2023. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of retaining walls and pavements for the proposed project.

This report was revised to accommodate the revision of the trail section from a retaining wall to an elevated walkway.

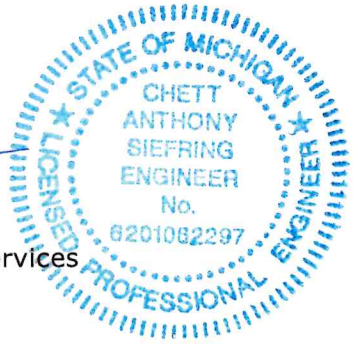
We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,

Terracon Consultants-MI, Inc.

Richard Sullivan, P.E.
Engineer – Geotechnical Services

Chett A. Siefring, P.E.
Manager – Geotechnical Services



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Exploration and Testing Procedures
Photography Log
Site Location and Exploration Plans
Exploration and Laboratory Results
Supporting Information

Note: This report was originally delivered in a web-based format. **Blue Bold** text in the report indicates a referenced section heading. The PDF version also includes hyperlinks which direct the reader to that section and clicking on the Terracon logo will bring you back to this page. For more interactive features, please view your project online at **client.terracon.com**.

Refer to each individual Attachment for a listing of contents.

Introduction

This report presents the results of our subsurface exploration and Geotechnical Engineering services performed for the proposed trail rehabilitation to be located close to 1505 Sand Point Road in Munising, Alger County, Michigan. The purpose of these services was to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil and rock conditions
- Groundwater conditions
- Seismic site classification per IBC
- Site preparation and earthwork
- Demolition considerations
- Foundation design and construction
- Lateral earth pressure
- Pavement design and construction

The geotechnical engineering Scope of Services for this project included the advancement of 2 test borings and 4 hand augers to depths ranging from 2 to 26 feet, laboratory testing, engineering analysis, and preparation of this report.

Drawings showing the site and boring locations are shown on the **Site Location** and **Exploration Plan**, respectively. The results of the laboratory testing performed on soil samples obtained from the site during our field exploration are included on the boring logs and/or as separate graphs in the **Exploration Results** section.

Project Description

Our understanding of the project conditions is as follows:

Item	Description
Information Provided	A request for proposal that included the following was provided to Terracon via email from Chris Mueller of Quinn Evans on August 22, 2023: ▪ Aerial image of the site ▪ Scope of work document ▪ Photos of the site ▪ Google Maps link to the site During a call with Quinn Evans on October 4, 2023, additional project information clarifications were provided.

Item	Description
Project Description	The project includes the rehabilitation of the existing walking trail, including a new elevated walkway at the existing wood support portion of the trail.
Grading/Slopes	It was indicated that the rehabilitated trail will have a final grade within approximately 2 feet of existing grade except at the area where the existing wood retaining wall is located, which may be lowered up to 4 feet from existing grade. Approximately 2 feet of cut and 2 feet of fill will be required to develop final grades, except at the wood retaining wall area, where up to 4 feet of cut may be required to develop final grades, excluding remedial grading requirements.
Free-Standing Retaining Walls	A new elevated walkway is planned at the site. The type and height of the walkway is undetermined at the time of preparing this proposal.
Trail Pavements	Portions of the existing path are asphalt pavement. It is anticipated that these sections will be rehabilitated with asphalt pavement.

Terracon should be notified if any of the above information is inconsistent with the planned construction, especially the grading limits, as modifications to our recommendations may be necessary.

Site Conditions

The following description of site conditions is derived from our site visit in association with the field exploration and our review of publicly available geologic and topographic maps.

Item	Description
Parcel Information	The project is located at 1505 Sand Point Road in Munising, Alger County, Michigan. Latitude: 46.4237 / Longitude: -86.6235 (approximate) See **Site Location**
Existing Improvements	Existing walking path.
Current Ground Cover	Asphalt pavement, wood path, earthen and trees.

Item	Description
Existing Topography	Based on Google Earth™ imagery, it appears that existing site grades range from approximately 664 feet, MSL near the start of the trail to approximately 685 feet near the end of the project site.

We also collected photographs at the time of our field exploration program. Representative photos are provided in our **Photography Log**.

Geotechnical Characterization

We have developed a general characterization of the subsurface conditions based upon our review of the subsurface exploration, laboratory data, geologic setting and our understanding of the project. This characterization, termed GeoModel, forms the basis of our geotechnical calculations and evaluation of the site. Conditions observed at each exploration point are indicated on the individual logs. The individual logs can be found in the **Exploration Results** and the GeoModel can be found in the **Figures** attachment of this report.

As part of our analyses, we identified the following model layers within the subsurface profile. For a more detailed view of the model layer depths at each boring location, refer to the GeoModel.

Model Layer	Layer Name	General Description
1	**Surface Cover**	Topsoil – 1-inch
2	**Granular Soil**	Loose to very dense sand
3	**Bedrock**	Moderately weathered, weak sandstone

The borings were advanced in the dry using the hollow-stem augers drilling technique that allows short term groundwater observations to be made while drilling. Groundwater conditions may be different at the time of construction than those encountered during completion of our field exploration. Mapping by the Natural Resources Conservation Service (NRCS) indicates a seasonal high groundwater level within 12 inches of ground surface. Groundwater conditions may change because of seasonal variations in rainfall, runoff, and other conditions not apparent at the time of drilling. Perched water may be present at the site within the soil bedrock interface. Long-term groundwater monitoring was outside the scope of services for this project.

Seismic Site Class

The seismic design requirements for buildings and other structures are based on Seismic Design Category. Site Classification is required to determine the Seismic Design Category for a structure. The Site Classification is based on the upper 100 feet of the site profile defined by a weighted average value of either shear wave velocity, standard penetration resistance, or undrained shear strength in accordance with Section 20.4 of ASCE 7 and the International Building Code (IBC). Based on the soil/bedrock properties observed at the site and as described on the exploration logs and results, our professional opinion is that a **Seismic Site Classification of C** be considered for the project. Subsurface explorations at this site were extended to a maximum depth of 26 feet. The site properties below the boring depth to 100 feet were estimated based on our experience and knowledge of geologic conditions of the general area. Additional deeper borings or geophysical testing may be performed to confirm the conditions below the current boring depth.

Geotechnical Overview

The site appears suitable for the proposed construction based upon geotechnical conditions encountered in the test borings, provided that the recommendations provided in this report are implemented in the design and construction phases of this project.

Site preparation recommendations, including subgrade improvement and fill placement, are provided in the **Earthwork** section.

The **Foundations** sections addresses support of the foundations while the **Slope Stability** section addresses slopes.

The **Pavements** section includes our recommended parameters for subgrade support for surfacing design by others.

The recommendations contained in this report are based upon the results of field and laboratory testing (presented in the **Exploration Results**), engineering analyses, and our current understanding of the proposed project. The **General Comments** section provides an understanding of the report limitations.

Earthwork

Earthwork is anticipated to include demolition, clearing and grubbing, excavations, and engineered fill placement. The following sections provide recommendations for use in the preparation of specifications for the work. Recommendations include critical quality criteria, as necessary, to render the site in the state considered in our geotechnical engineering evaluation for foundations and pavements.

Demolition

After any necessary demolition has taken place, it is recommended that all remnants encountered within the proposed development area be removed in their entirety. Historical evidence indicates that new structures placed over the remnants of previous construction or poorly compacted backfill often result in the new structure performing poorly.

Site Preparation

Prior to placing fill, existing vegetation, topsoil, and root mats should be removed. Complete stripping of the topsoil should be performed in the proposed building and parking/driveway areas.

Subgrade Preparation

The subgrade should be proofrolled with an adequately loaded vehicle. Typically, a fully-loaded (minimum 20 ton gross vehicle weight) tandem-axle dump truck. However, given the limited width of the development other vehicles, as approved by the Geotechnical Engineer, may suffice. The proofrolling should be performed under the observation of the Geotechnical Engineer or representative. Areas excessively deflecting under the proofroll should be delineated and subsequently addressed by the Geotechnical Engineer. Such areas should be removed and replaced with properly placed and compacted engineered fill. Excessively wet or dry material should either be moisture conditioned and recompacted or removed and replaced with properly placed and compacted engineered fill.

Where the subgrade has passed a proofroll, compacted engineered fill soils should be placed to the proposed design grade and the moisture content and compaction of subgrade soils should be maintained until foundation, slab or pavement construction.

Based upon the subsurface conditions determined from the geotechnical exploration, subgrade soils exposed during construction are anticipated to be relatively workable; however, the workability of the subgrade may be affected by precipitation, repetitive construction traffic or other factors. If unworkable conditions develop, workability may be improved by scarifying and drying.

Excavation

We anticipate that excavations for the proposed construction can be accomplished with conventional earthmoving equipment. The bottom of excavations should be thoroughly cleaned of loose soils and disturbed materials prior to backfill placement and/or construction.

Fill Material Types

Fill required to achieve design grade should be classified as engineered fill. Engineered fill is material used below, or within 10 feet of structures, pavements or constructed slopes.

Reuse of On-Site Soil: Excavated on-site soil may be selectively reused as Engineered Fill.

Material property requirements for on-site soil for use as engineered fill are noted in the table below:

Property	Engineered Fill
Composition	Free of deleterious material
Maximum Particle Size	3 inches
Fines Content of Granular Soils	Less than 15% Passing No. 200 sieve
Liquid Limit of Cohesive Soils	Maximum liquid limit of 50
GeoModel Layer Expected to be Suitable[1]	2

1. It may be possible to reuse the fill materials of GeoModel Layer 3 providing that they are processed to a soil like state and that they are approved by the Geotechnical Engineer.

Imported Fill Materials: Imported fill materials should meet the following material property requirements. Regardless of its source, compacted fill should consist of approved materials that are free of organic matter and debris. Frozen material should not be used, and fill should not be placed on a frozen subgrade.

Soil Type [1]	USCS Classification	Acceptable Parameters (for Engineered Fill)
Low Plasticity Cohesive	CL, CL-ML	All locations and elevations
Granular	GW, GM, GC, SW, SM, SC	All locations and elevations

1. A sample of each material type should be submitted to the Geotechnical Engineer for evaluation prior to use on this site. Additional geotechnical consultation should be provided prior to use of uniformly graded gravel on the site.

Fill Placement and Compaction Requirements

Engineered fill should meet the following compaction requirements.

Item	Engineered Fill
Maximum Lift Thickness	8 inches or less in loose thickness when heavy (minimum 8 tons), self-propelled compaction equipment is used 6 inches in loose thickness when hand-guided equipment (i.e. jumping jack or plate compactor) is used
Minimum Compaction Requirements [1,2]	98% of the material's maximum dry density
Water Content Range [1]	Low plasticity cohesive: -2% to +3% of optimum moisture Granular: -3% to +3% of optimum moisture or at suitable level to provide sufficient compaction without the material pumping or rutting when proofrolled

1. Maximum density and optimum water content as determined by the standard Proctor test (ASTM D 698).
2. If the granular material is a coarse sand or gravel, or of a uniform size, or has a low fines content, compaction comparison to relative density may be more appropriate. In this case, granular materials should be compacted to at least 70% relative density (ASTM D 4253 and D 4254). Materials not amenable to density testing should be placed and compacted to a stable condition observed by the Geotechnical Engineer or representative.

Earthwork Construction Considerations

Shallow excavations for the proposed structure are anticipated to be accomplished with conventional construction equipment. Upon completion of filling and grading, care should be taken to maintain the subgrade water content prior to construction of grade-supported improvements such as floor slabs and pavements. Construction traffic over the completed subgrades should be avoided. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. Water collecting over or adjacent to construction areas should be removed. If the subgrade freezes, desiccates, saturates, or is disturbed, the affected material should be removed, or the materials should be scarified, moisture conditioned, and recompacted prior to floor slab construction.

As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, "Excavations" and its appendices, and in accordance with any applicable local and/or state regulations.

Construction site safety is the sole responsibility of the contractor who controls the means, methods, and sequencing of construction operations. Under no circumstances shall the information provided herein be interpreted to mean Terracon is assuming responsibility for construction site safety or the contractor's activities; such responsibility shall neither be implied nor inferred.

Excavations or other activities resulting in ground disturbance have the potential to affect adjoining properties and structures. Our scope of services does not include review of available final grading information or consider potential temporary grading performed by the contractor for potential effects such as ground movement beyond the project limits. A preconstruction/ precondition survey should be conducted to document nearby property/infrastructure prior to any site development activity. Excavation or ground disturbance activities adjacent or near property lines should be monitored or instrumented for potential ground movements that could negatively affect adjoining property and/or structures.

Construction Observation and Testing

The earthwork efforts should be observed by the Geotechnical Engineer (or others under their direction). Observation should include documentation of adequate removal of surficial materials (vegetation, topsoil, and pavements), evaluation and remediation of existing fill materials, as well as proofrolling and mitigation of unsuitable areas delineated by the proofroll.

Each lift of compacted fill should be tested, evaluated, and reworked, as necessary, as recommended by the Geotechnical Engineer prior to placement of additional lifts. Each lift of fill should be tested for density and water content at a frequency of at least 3 tests per lift, and 5,000 square feet in pavement areas.

In areas of foundation excavations, the bearing subgrade should be evaluated by the Geotechnical Engineer. If unanticipated conditions are observed, the Geotechnical Engineer should prescribe mitigation options.

In addition to the documentation of the essential parameters necessary for construction, the continuation of the Geotechnical Engineer into the construction phase of the project provides the continuity to maintain the Geotechnical Engineer's evaluation of subsurface conditions, including assessing variations and associated design changes.

Foundations

We recommend the use of either drilled piers or helical piers to support the elevated walkway.

Helical piles are typically proprietary and are generally designed by an in-house specialty pile engineer. However, we do recommend the pile designs be submitted to project structural engineer and geotechnical engineer for review and acceptance.

To help reduce the possibility of future undercutting of the foundations from stream erosion it may prove beneficial to extend the foundations to or into bedrock. This may be

a cost-based designation on the effects of risk/reward. Similarly, in design, it may prove prudent to eliminate any axial and/or lateral soil support on account of the potential for stream erosion and subsequently only base axial and lateral support on the rock and the structural design of the elevated walkway itself.

Axial Loading

The following table is for the design of axially loaded foundations. The values presented for allowable side friction and end bearing include a factor of safety.

Axial Loading Design Summary [1]

Stratigraphy [2]		Allowable Skin Friction (psf) [3]	Allowable End Bearing Pressure (psf) [4]
Layer No.	Material		
2	Granular Soil	500	2,500
3	Bedrock	1,000	10,000

1. Design capacities are dependent upon the method of installation and quality control parameters. The values provided are estimates and should be verified when installation protocol have been finalized.
2. See Subsurface Profile in **Geotechnical Characterization** for more details on stratigraphy.
3. Skin friction design is not applicable for shallow drilled piers. The skin friction value provided can be used in uplift load resistance design of the drilled shafts. Effective weight of the pier can be added to uplift load resistance to the extent permitted by IBC.
4. Shafts should extend at least one diameter into the bearing stratum for end bearing to be considered.

Lateral Loading

The following table lists input values for use in LPILE analyses. versions of LPILE provide estimated default values of kh and E50 based on strength and are recommended for the project. Since deflection or a service limit criterion will most likely control lateral capacity design, no safety/resistance factor is included with the parameters.

Soil Inputs								
Stratigraphy[1]		L-Pile Soil Model	S_u (psf)[2]	ϕ[2]	γ' (pcf)[2]	ε_{50}	K (pci)	
Layer No.	Material						Static	Cyclic
2	Granular Soil	Sand (Reese)	---	35°	125	Use Default Value		

1. See Subsurface Profile in **Geotechnical Characterization** for more details on Stratigraphy.
2. Definition of Terms:
   S_u: Undrained shear strength
   ϕ: Internal friction angle
   γ': Effective unit weight

Rock Inputs							
Stratigraphy[1]		L-Pile Soil Model	γ' (pcf)[2]	K rm[2]	UCS (psi)[2]	Ei (psi)[2]	RQD (%)
Layer No.	Material						
3	Use Default Value	Weak Rock (Reese)	150	0.0005	750	68,000	0

1. See Subsurface Profile in **Geotechnical Characterization** for more details on Stratigraphy.
2. Definition of Terms:
   γ': Effective unit weight
   K rm: Strain Factor
   UCS: Uniaxial Compressive Strength (psi)
   Ei: Initial Modulus of Rock Mass (psi)
   RQD: Rock Quality Designation (%)

We do not recommend using vertically installed helical piles to resist lateral loads without approved lateral load test data, as these types of foundations are typically designed to resist axial loads. Helical piles installed at a batter may be better used to resist lateral loads. Typically, helical piles can be installed to a batter of up to 45 degrees from the horizontal. Only the horizontal component of the allowable axial load should be considered to resist the lateral loading and only in the direction of the batter.

Per IBC, all piles shall be laterally braced. This is especially important for slender piles such as helical piles, small diameter drilled shafts, pipe piles, and micropiles. Lateral bracing can be achieved by arranging three or more piles under an isolated column or arranging two piles spaced one on each side of a wall or grade beam.

Drilled Shaft Construction Considerations

The drilling contractor should be experienced in the subsurface conditions observed at the site, and the excavations should be performed with equipment capable of providing a clean bearing surface. The drilled straight-shaft foundation system should be installed in general accordance with the procedures presented in "Standard Specification for the Construction of Drilled Piers", ACI Publication No. 336.1-01.

The contractor is generally expected to use conventional "dry" techniques for installation of the drilled shaft. Subsurface water was not encountered in boring during the drilling activities. Subsurface water levels are influenced by seasonal and climatic conditions, which result in fluctuations in subsurface water elevations. Additionally, it is common for water to be present after periods of significant rainfall. Casing or slurry drilling procedures could be required in soils zones of higher sand content (such as was observed in GeoModel Layer 3) to reduce the potential for excavation sidewall collapse.

The drilling contractor should remove all soft and disturbed soils from the base of the drilled pier prior to placing concrete. The drilled shaft installation process should be performed under the observation of the Geotechnical Engineer. The Geotechnical Engineer should document the shaft installation process including soil/rock and groundwater conditions observed, consistency with expected conditions, and details of the installed shaft.

Helical Pile Construction Considerations

An experienced helical pile contractor should review the data from this report to assess the equipment required to achieve the minimum length and capacity. We recommend a minimum of one load test be conducted at the site to confirm anticipated capacities and to finalize design information.

We should be consulted to review load test data, and a representative of the geotechnical engineer should be present to observe test and production helical pile installation to verify that piles have been installed to the recommended torque and/or minimum depth and to confirm pile capacity

Pavements

Pavement Subgrade Support Characteristics

For pavement design by others, we recommend that a subgrade California Bearing Ratio, CBR, of 10 be used for the asphaltic concrete pavement designs. We recommend that a modulus of subgrade reaction of 200 pci be used for the portland cement concrete

pavement designs. These values were empirically derived based upon our experience with the subgrade soils identified at the site and our expectation of the quality of the subgrade as prescribed by the **Site Preparation** conditions as outlined in **Earthwork**.

Slope Stability

A slope stability analyses was not undertaken as part of this analysis for this project and as such we have not commented upon the stability of the slopes surrounding the project area.

It is understood that the utilizing an elevated walkway will permit the existing slopes to return to a natural state of sloping downwards towards the creek.

Since a slope stability analysis was not within the scope, we cannot comment upon a stable slope geometry. However, we would suggest using the existing unaltered slopes as a gauge for future permanent slope geometry.

We do not recommend armoring nor surficial stabilization measures if the slopes are intended to return to their natural state as this may potentially result in larger slope failures than the localized sloughing expected from unarmored/unstabilized slopes.

For temporary slopes we recommend that the slopes have a geometry of 2:1 (H:V). Benches should not exceed 4 feet in height and should be spaced no less than twice the bench height so that, for example a 2-foot-high bench would be separated from the next bench by a distance of 4 feet. In lieu of benching, temporary shoring may be used, and the parameters identified in the lateral loading section may be used in their design.

It should be expected that during construction, disturbance to the surround soils should be kept to a minimum. Disturbance to surrounding soils may result in sloughing of surface soils, which may lead to a larger sliding failure of the surface soils.

General Comments

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Variations will occur between exploration point locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained as the Geotechnical Engineer, where noted in this report, to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation

and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Our Scope of Services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third-party beneficiaries intended. Any third-party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly effect excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety and cost estimating including excavation support and dewatering requirements/design are the responsibility of others. Construction and site development have the potential to affect adjacent properties. Such impacts can include damages due to vibration, modification of groundwater/surface water flow during construction, foundation movement due to undermining or subsidence from excavation, as well as noise or air quality concerns. Evaluation of these items on nearby properties are commonly associated with contractor means and methods and are not addressed in this report. The owner and contractor should consider a preconstruction/precondition survey of surrounding development. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

Figures

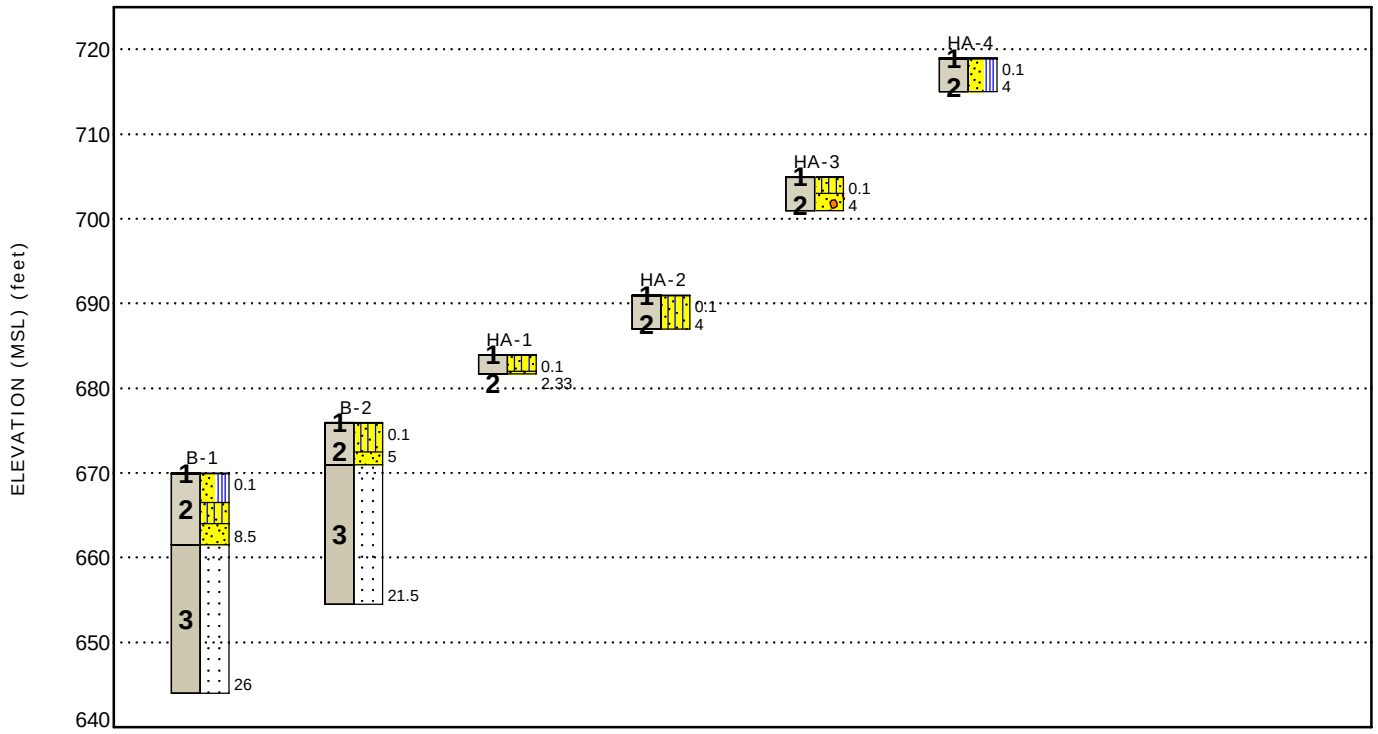
Contents:

GeoModel

Munising Falls Trail Rehabilitation
1505 Sand Point Road | Munising, MI
Terracon Project No. N6235258

Terracon
12460 Plaza Dr
Parma, OH

GeoModel



This is not a cross section. This is intended to display the Geotechnical Model only. See individual logs for more detailed conditions.

Model Layer	Layer Name	General Description
1	Surface Cover	Topsoil - 1 inch
2	Granular Soil	Loose to very dense sand
3	Bedrock	Moderately weathered, weak sandstone

Legend	
Topsoil	Poorly-graded Sand with Silt
Silty Sand	Poorly-graded Sand
Sandstone	Poorly-graded Sand with Gravel

NOTES:
Layering shown on this figure has been developed by the geotechnical engineer for purposes of modeling the subsurface conditions as required for the subsequent geotechnical engineering for this project.
Numbers adjacent to soil column indicate depth below ground surface.

Attachments

Exploration and Testing Procedures

Field Exploration

Number of Borings	Approximate Boring Depth (feet)	Location
2	21.5 to 26.0	Trail area
4	2.3 to 4.0	Trail area

Boring Layout and Elevations: Terracon personnel provided the boring layout using recreational handheld GPS equipment (estimated horizontal accuracy of 10± feet) and referencing existing site features. Approximate ground surface elevations were obtained by interpolation from Google Earth. If elevations and a more precise boring layout are desired, we recommend borings be surveyed.

Subsurface Exploration Procedures: We advanced the deeper borings with a track-mounted, rotary drill rig using continuous flight augers (solid stem and/or hollow stem, as necessary, depending on soil conditions). Four samples were obtained in the upper 10 feet of each boring and at intervals of 5 feet thereafter. In the split-barrel sampling procedure, a standard 2-inch outer diameter split-barrel sampling spoon was driven into the ground by a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring logs at the test depths.

We advanced the shallower borings with direct-push handheld sampling equipment.

We observed and recorded groundwater levels during drilling and sampling. For safety purposes, all borings were backfilled with auger cuttings after their completion. Pavements were patched with cold-mix asphalt and/or pre-mixed concrete, as appropriate.

The sampling depths, penetration distances, and other sampling information was recorded on the field boring logs. The samples were placed in appropriate containers and taken to our soil laboratory for testing and classification by a Geotechnical Engineer. Our exploration team prepared field boring logs as part of the drilling operations. These field logs included visual classifications of the materials observed during drilling and our interpretation of the subsurface conditions between samples. Final boring logs were prepared from the field logs. The final boring logs represent the Geotechnical Engineer's interpretation of the field logs and include modifications based on observations and tests of the samples in our laboratory.

Laboratory Testing

The laboratory testing program often included classification of soil samples by an engineer or geologist. Based on the results of our field and laboratory programs, we described and classified the soil samples in accordance with the Unified Soil Classification System.

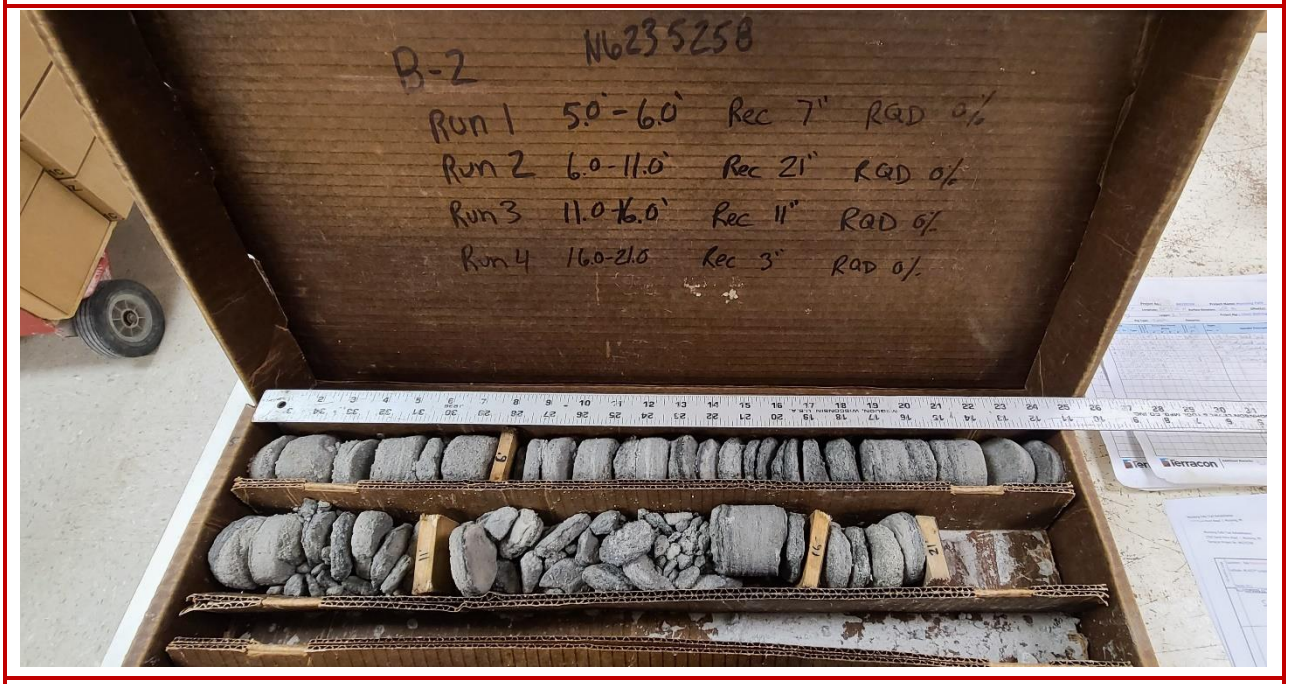
The project engineer reviewed the field data and assigned laboratory tests. The laboratory testing program included the following types of tests:

- Grain Size Distribution

Rock classification was conducted using locally accepted practices for engineering purposes; petrographic analysis may reveal other rock types. Rock core samples typically provide an improved specimen for this classification. Boring log rock classification was determined using the Description of Rock Properties.

Photography Log

B-1: 8.5-26.0'



B-2: 5.0-21.0'

Site Location and Exploration Plans

Contents:

Site Location
Exploration Plan

Note: All attachments are one page unless noted above.

Site Location

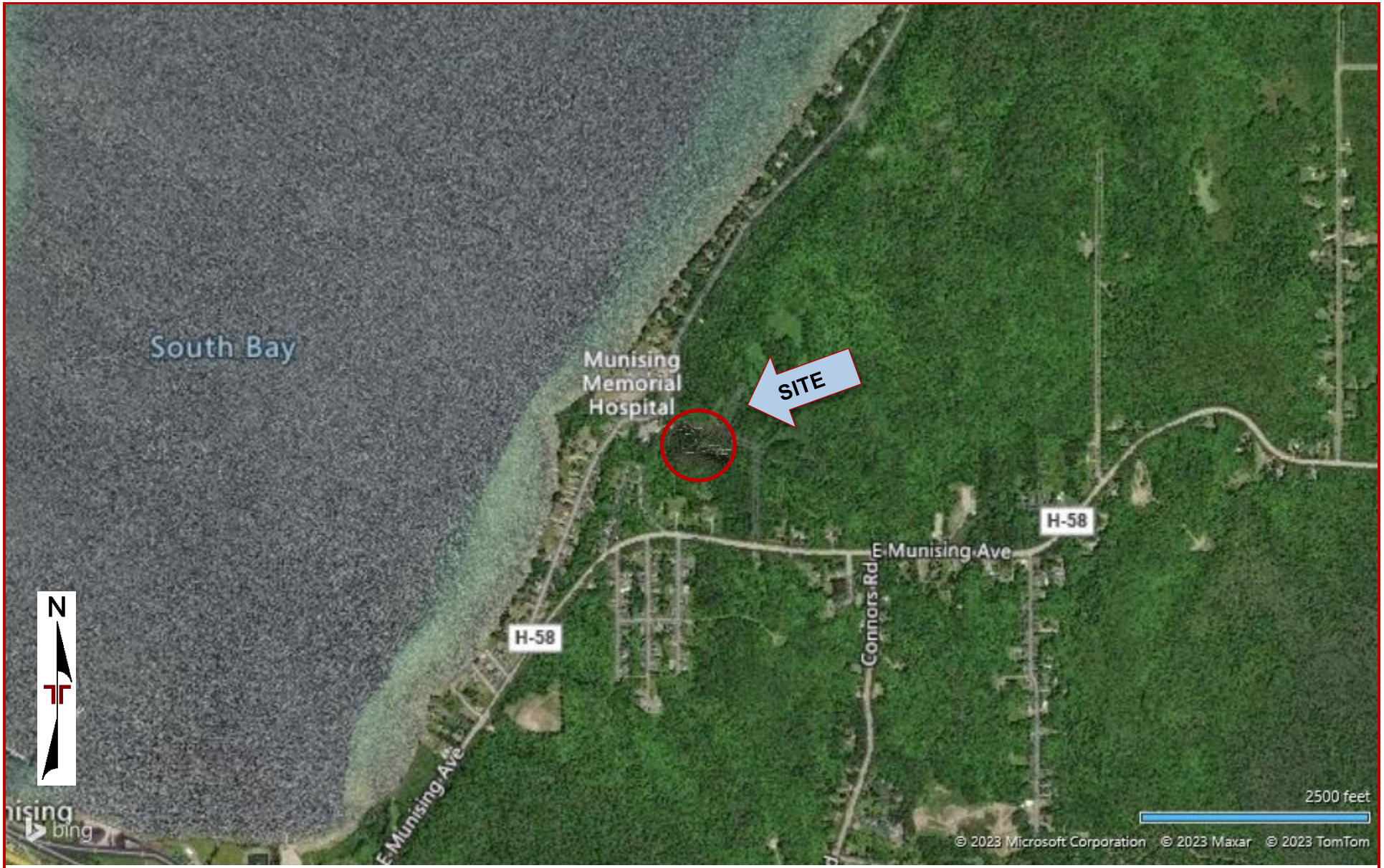


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

Exploration Plan

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

Exploration and Laboratory Results

Contents:

Boring Logs (B-1 and B-2 and HA-1 through HA-4)
Grain Size Distribution
Geophysical Exploration Report
Bedrock Depths

Note: All attachments are one page unless noted above.

Munising Falls Trail Rehabilitation
1505 Sand Point Road | Munising, MI
Terracon Project No. N6235258

Terracon
12460 Plaza Dr
Parma, OH

Boring Log No. B-1

Location: 20' East

Latitude: 46.4237° Longitude: -86.6236°

Model Layer	Depth (Ft.)	Elevation: 670 (Ft.) +/-	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results
1	0.1	TOPSOIL (1") 669.9					
		POORLY GRADED SAND WITH SILT (SP-SM), fine to medium grained, brown, loose				16	2-2-1 N=3
	3.5	666.5					
2		SILTY SAND (SM), yellowish brown, dense				18	5-8-18 N=26
	6.0	664	5				
		POORLY GRADED SAND (SP), fine to medium grained, gray, very dense				10	43-50/4"
	8.5	661.5				3	50/3"
3		SANDSTONE, gray, very close fracture spacing, laminated bedding, moderately weathered, weak rock	10			11	RQD = 0%
						21	RQD = 0%
			15				
						25	RQD = 0%
			20				
						38	RQD = 0%
			25				
	26.0	644					
		Boring Terminated at 26 Feet					

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered

Notes
Elevation Reference: Elevations estimated from Google Earth.

Advancement Method
3.25" ID HSA

Abandonment Method
Boring backfilled with auger cuttings and sand upon completion.

Drill Rig
B57

Hammer Type
Automatic

Driller
A. Fay

Logged by
K. Miller

Boring Started
10-17-2023

Boring Completed
10-17-2023

Munising Falls Trail Rehabilitation
1505 Sand Point Road | Munising, MI
Terracon Project No. N6235258

Terracon
12460 Plaza Dr
Parma, OH

Boring Log No. HA-1

Location: See Exploration Plan

Latitude: 46.4236° Longitude: -86.6232°

Model Layer	Depth (Ft.)	Elevation: 684 (Ft.) +/-	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)
1	0.1	TOPSOIL (1")	683.9			
2		SILTY SAND (SM), brown				11
	2.0		682			
	2.3	POORLY GRADED SAND (SP), fine to medium grained, gray	681.67			4
		Boring Terminated at 2.33 Feet				

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered

Drill Rig
B57

Hammer Type
Automatic

Driller
A. Fay

Logged by
K. Miller

Boring Started
10-17-2023

Boring Completed
10-17-2023

Notes
Elevation Reference: Elevations estimated from Google Earth.

Advancement Method
Hand Advanced Direct Push

Abandonment Method
Boring backfilled with auger cuttings and sand upon completion.

Munising Falls Trail Rehabilitation
1505 Sand Point Road | Munising, MI
Terracon Project No. N6235258

Terracon
12460 Plaza Dr
Parma, OH

Boring Log No. HA-2

Location: See Exploration Plan

Latitude: 46.4235° Longitude: -86.6229°

Model Layer	Graphic Log	Depth (Ft.)	Elevation: 691 (Ft.) +/-	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)
1		0.1	TOPSOIL (1") 690.9				
2			SILTY SAND (SM), brown				10
							10
		4.0	687				
			Boring Terminated at 4 Feet				

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered

Notes
Elevation Reference: Elevations estimated from Google Earth.

Advancement Method
Hand Advanced Direct Push

Abandonment Method
Boring backfilled with auger cuttings and sand upon completion.

Drill Rig
B57

Hammer Type
Automatic

Driller
A. Fay

Logged by
K. Miller

Boring Started
10-17-2023

Boring Completed
10-17-2023

Munising Falls Trail Rehabilitation
1505 Sand Point Road | Munising, MI
Terracon Project No. N6235258

Terracon
12460 Plaza Dr
Parma, OH

Boring Log No. HA-3

Location: See Exploration Plan

Latitude: 46.4234° Longitude: -86.6228°

Model Layer	Graphic Log	Depth (Ft.)	Elevation: 705 (Ft.) +/-	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)
1		0.1	TOPSOIL (1") 704.9				
			SILTY SAND (SM), brown, contains wood fragments				6
2		2.0	703				
			POORLY GRADED SAND WITH GRAVEL (SP), fine to medium grained, brown				10
		4.0	701				
			Boring Terminated at 4 Feet				

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered

Drill Rig
B57

Hammer Type
Automatic

Driller
A. Fay

Logged by
K. Miller

Boring Started
10-17-2023

Boring Completed
10-17-2023

Notes
Elevation Reference: Elevations estimated from Google Earth.

Advancement Method
Hand Advanced Direct Push

Abandonment Method
Boring backfilled with auger cuttings and sand upon completion.

Munising Falls Trail Rehabilitation
1505 Sand Point Road | Munising, MI
Terracon Project No. N6235258

Terracon
12460 Plaza Dr
Parma, OH

Boring Log No. HA-4

Location: See Exploration Plan

Latitude: 46.4231° Longitude: -86.6227°

Model Layer	Graphic Log	Depth (Ft.)	Elevation: 719 (Ft.) +/-	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)
1		0.1	TOPSOIL (1") 718.9				
2			POORLY GRADED SAND WITH SILT (SP-SM), fine grained, brown				10
							18
		4.0	715				
			Boring Terminated at 4 Feet				

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered

Notes
Elevation Reference: Elevations estimated from Google Earth.

Advancement Method
Hand Advanced Direct Push

Abandonment Method
Boring backfilled with auger cuttings and sand upon completion.

Drill Rig
B57

Hammer Type
Automatic

Driller
A. Fay

Logged by
K. Miller

Boring Started
10-17-2023

Boring Completed
10-17-2023

Munising Falls Trail Rehabilitation
1505 Sand Point Road | Munising, MI
Terracon Project No. N6235258

Terracon
12460 Plaza Dr
Parma, OH

Boring Log No. B-2

Location: See Exploration Plan

Latitude: 46.4237° Longitude: -86.6234°

Model Layer	Depth (Ft.)	Elevation: 676 (Ft.) +/-	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results
1	0.1	TOPSOIL (1")	675.9				
2		SILTY SAND (SM), brown, very dense				16	4-11-35 N=46
	3.5		672.5				
		POORLY GRADED SAND (SP), fine grained, gray, very dense				3	50/3"
	5.0		671			2	50/2"
3		SANDSTONE, gray, very close fracture spacing, laminated bedding, moderately weathered, weak rock	5			7	RQD = 0%
						21	RQD = 0%
			10				
						11	RQD = 0%
			15				
						3	RQD = 0%
			20				
	21.5		654.5			4	50/4"
		Boring Terminated at 21.5 Feet					

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered

Notes
Elevation Reference: Elevations estimated from Google Earth.

Advancement Method
3.25" ID HSA

Abandonment Method
Boring backfilled with auger cuttings and sand upon completion.

Drill Rig
B57

Hammer Type
Automatic

Driller
A. Fay

Logged by
K. Miller

Boring Started
10-17-2023

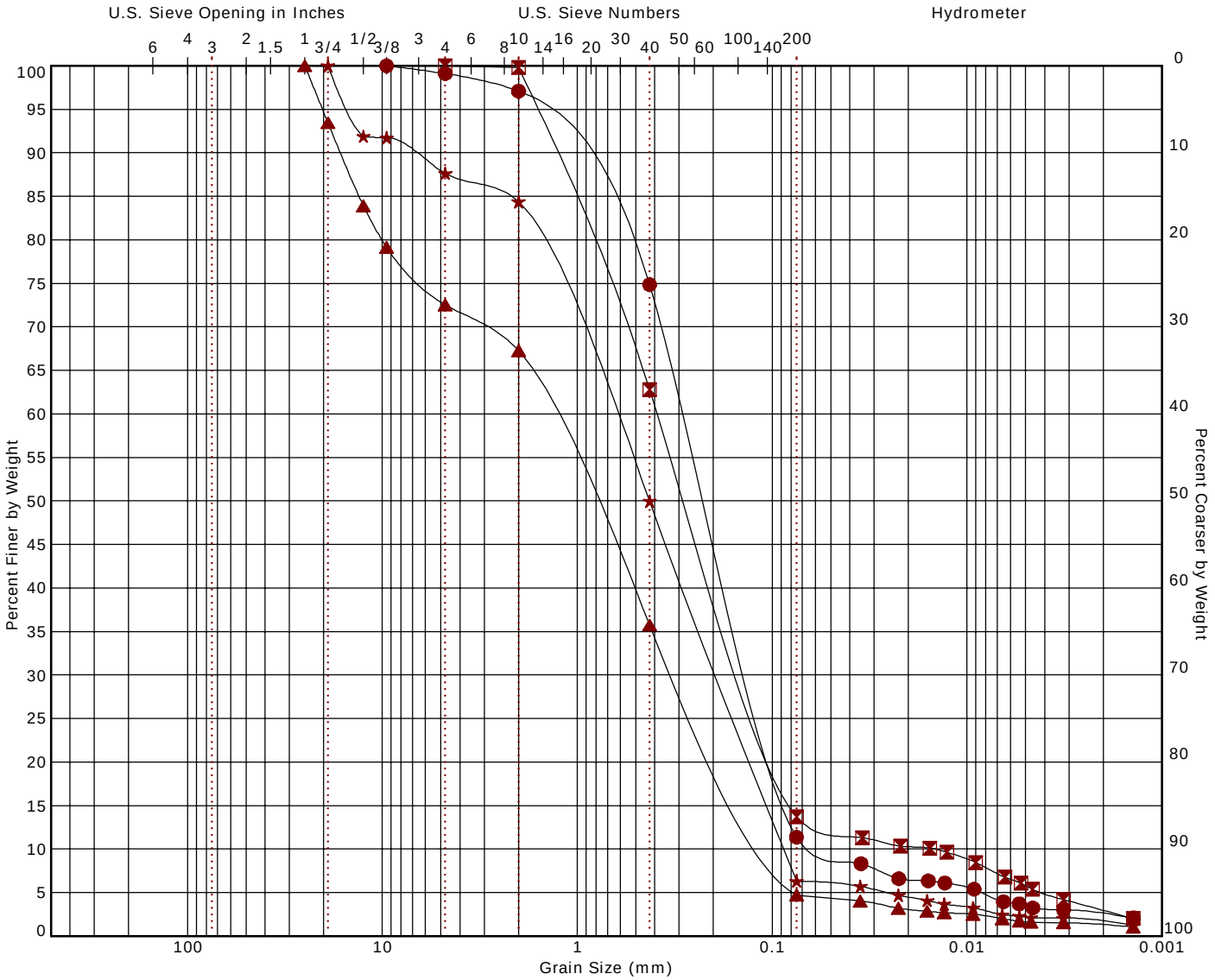
Boring Completed
10-17-2023

Munising Falls Trail Rehabilitation
1505 Sand Point Road | Munising, MI
Terracon Project No. N6235258

Terracon
12460 Plaza Dr
Parma, OH

Grain Size Distribution

ASTM D422 / ASTM C136



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Boring ID		Depth (Ft)	Description		LL	PL	PI	Cc	Cu
●	B-1	1 - 2.5	POORLY GRADED SAND WITH SILT					1.03	5.32
⊠	B-2	1 - 2.5	SILTY SAND					3.14	26.14
▲	HA-3	2 - 4	POORLY GRADED SAND WITH GRAVEL					0.67	13.89
★	HA-4	0 - 2	POORLY GRADED SAND WITH SILT					0.64	7.69

Boring ID		Depth (Ft)	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
●	B-1	1 - 2.5	9.5	0.283	0.125	0.053	0.0	0.9	87.7		7.9	3.5
⊠	B-2	1 - 2.5	4.75	0.385	0.133	0.015	0.0	0.0	86.3		7.9	5.8
▲	HA-3	2 - 4	25	1.4	0.308	0.101	0.0	27.5	67.8		3.1	1.6
★	HA-4	0 - 2	19	0.667	0.192	0.087	0.0	12.4	81.3		4.1	2.2

Laboratory tests are not valid if separated from original report.

November 16, 2023

STRATA Architecture + Preservation
1701 Oak Street, Suite 100
Kansas City, MO 64108

Attn: Angie Geist Gaebler
P: (816) 474-0900
E: angie@srjarch.com

RE: Report of Geophysical Exploration Services
Munising Falls Trail Rehabilitation
1505 Sand Point Road
Munising, Michigan
Terracon Project No. N6235258

Dear Ms. Geist Gaebler:

Terracon has completed their geophysical exploration scope of services for the proposed Munising Falls Trail Rehabilitation. Our geophysical exploration scope of services, as presented herein, was performed consistent with our proposal scope of work.

Terracon performed surface geophysical exploration services consisting of a ground penetrating radar (GPR) and multichannel analysis of surface waves (MASW) survey on October 19, 2023. The survey location is displayed on Figure 1. The primary goal of this survey was to map depth to bedrock and to identify tiebacks and structural components below the paved Munising Falls Trail within the area of interest.

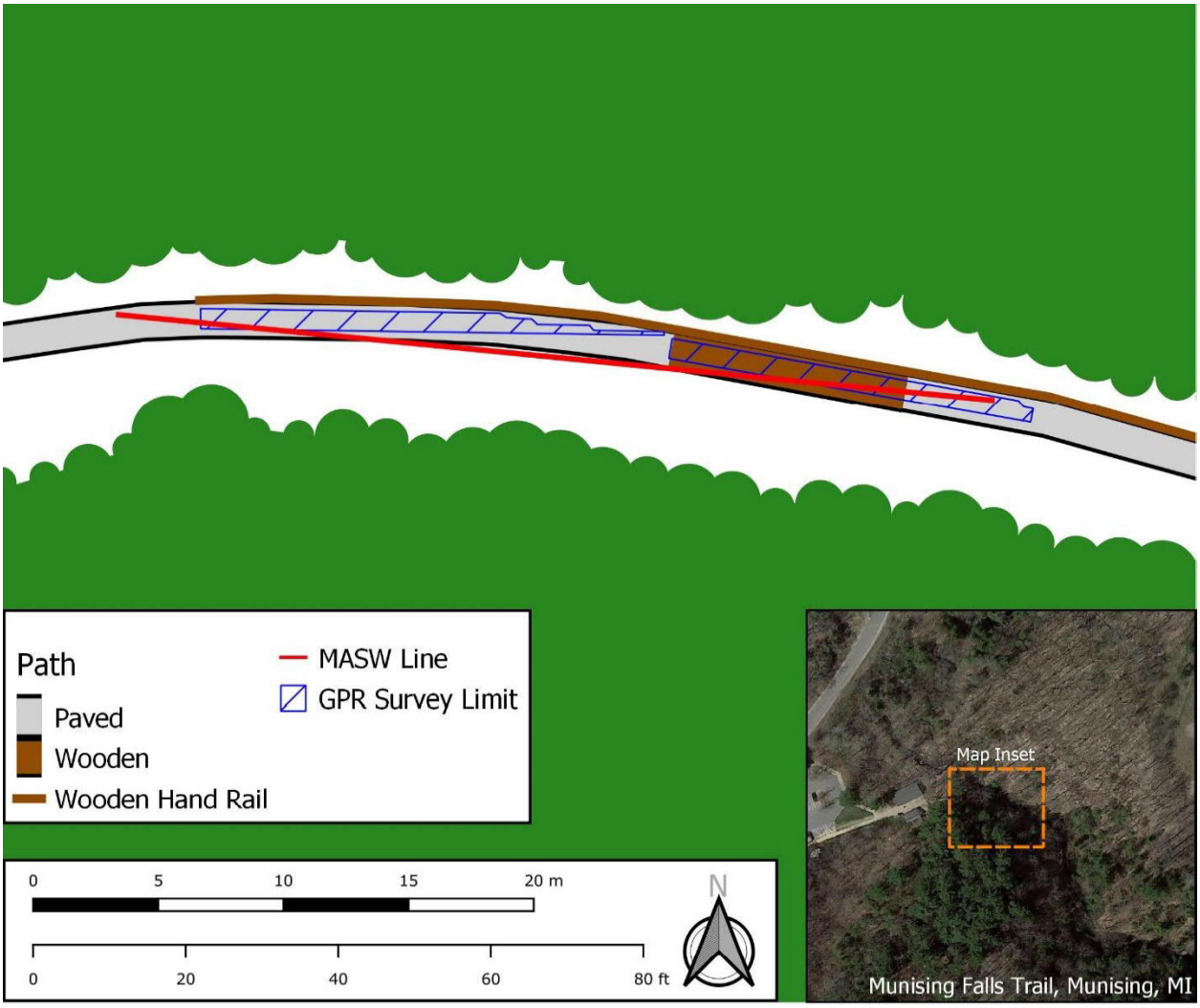


Figure 1- Geophysical Survey Limit Sketch and Google aerial image of Project Area

SURVEY METHODOLOGY

Ground Penetrating Radar – Ground penetrating radar survey was split into two areas to accommodate the curvature of the paved path and to ensure coverage. Our method of investigation used a 250 MHz GPR system pushed along parallel transects spaced 6 inches apart. The data was then processed using GPR processing software (Geolitix) where the data was processed, georeferenced, velocity corrected, and depth-sliced.

MASW - Our method of investigation used a seismograph and a linear array of twenty-four (24) 4.5Hz geophones to collect MASW data. One array was placed on the project site in a straight line, with geophones inserted into the ground or placed on paved surfaces. The

geophones were spaced 5 feet apart, for a total line length of 115 feet. Seismic source shots were taken using a 10 lb. sledgehammer and metal plate. Ambient seismic noise (e.g., vehicular traffic, walking along the line, nearby equipment) were also recorded.

The data was then processed using dispersion analysis software (SurfSeis, engineered by the Kansas Geological Survey) that extracts the fundamental-mode dispersion curve(s). The curves were inverted and modeled to yield a 2D shear-wave velocity profile along the array.

FINDINGS

The GPR was successful in identifying potential structures along the path (Figure 2, 3, 4) and a potential void below the wooden portion of the walking path. The structures represent two distinct depths of horizontal anomalies which extent roughly north to south beneath the walking path. The first set of anomalies were detected at approximately 0.75 ft below surface. The second, deeper set of linear anomalies were detected at approximately 1.5 ft below surface. Both of these sets of anomalies likely correspond with tiebacks associated with the retaining wall to the north of the path. Though intermittent, the GPR detected a horizon which is likely associated with bedrock at approximately 16 ft below surface. The GPR detected responses consistent with tiebacks below the wooden portion of the trail at approximately 1.5 ft below surface at 4 ft intervals.

The MASW data was successful in identifying depth to bedrock between 10 and 17 ft below surface (Figure 5). It additionally identified an anomaly which is spatially consisting with the potential void identified in the GPR survey.

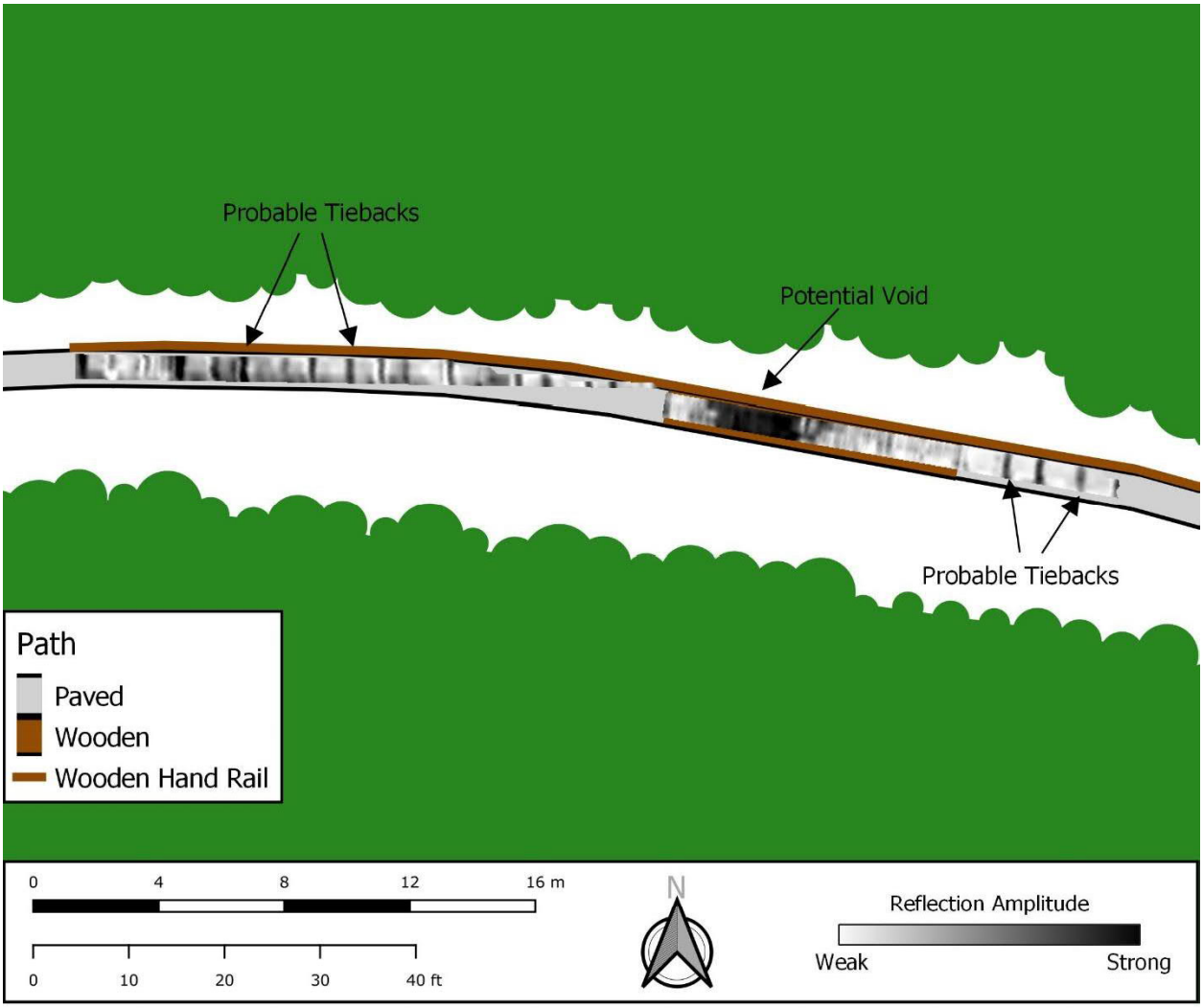


Figure 2 GPR Depth slices from areas 1 and 2 at 0.65 ft below surface.

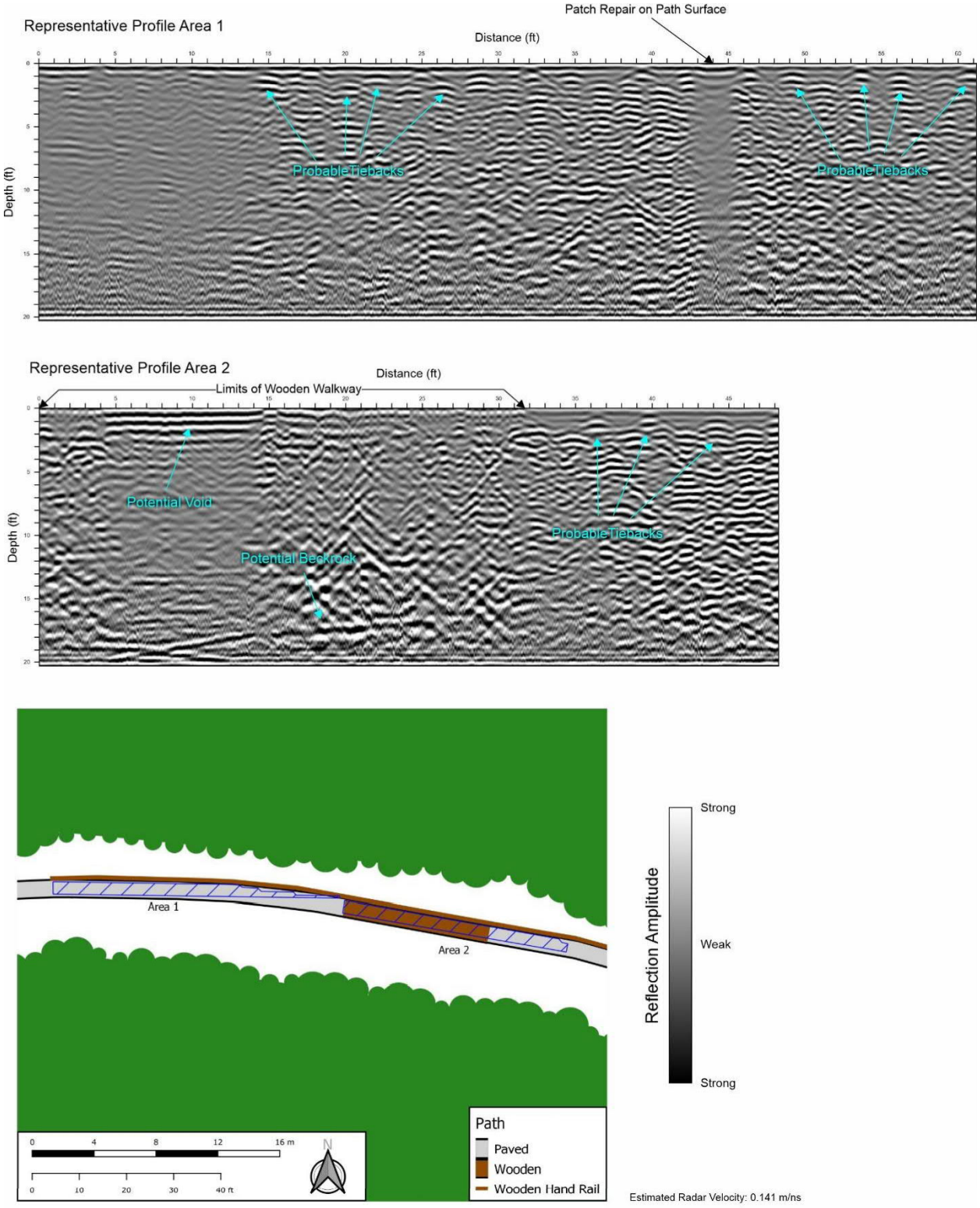


Figure 3 Example Radargrams from Areas 1 and 2.

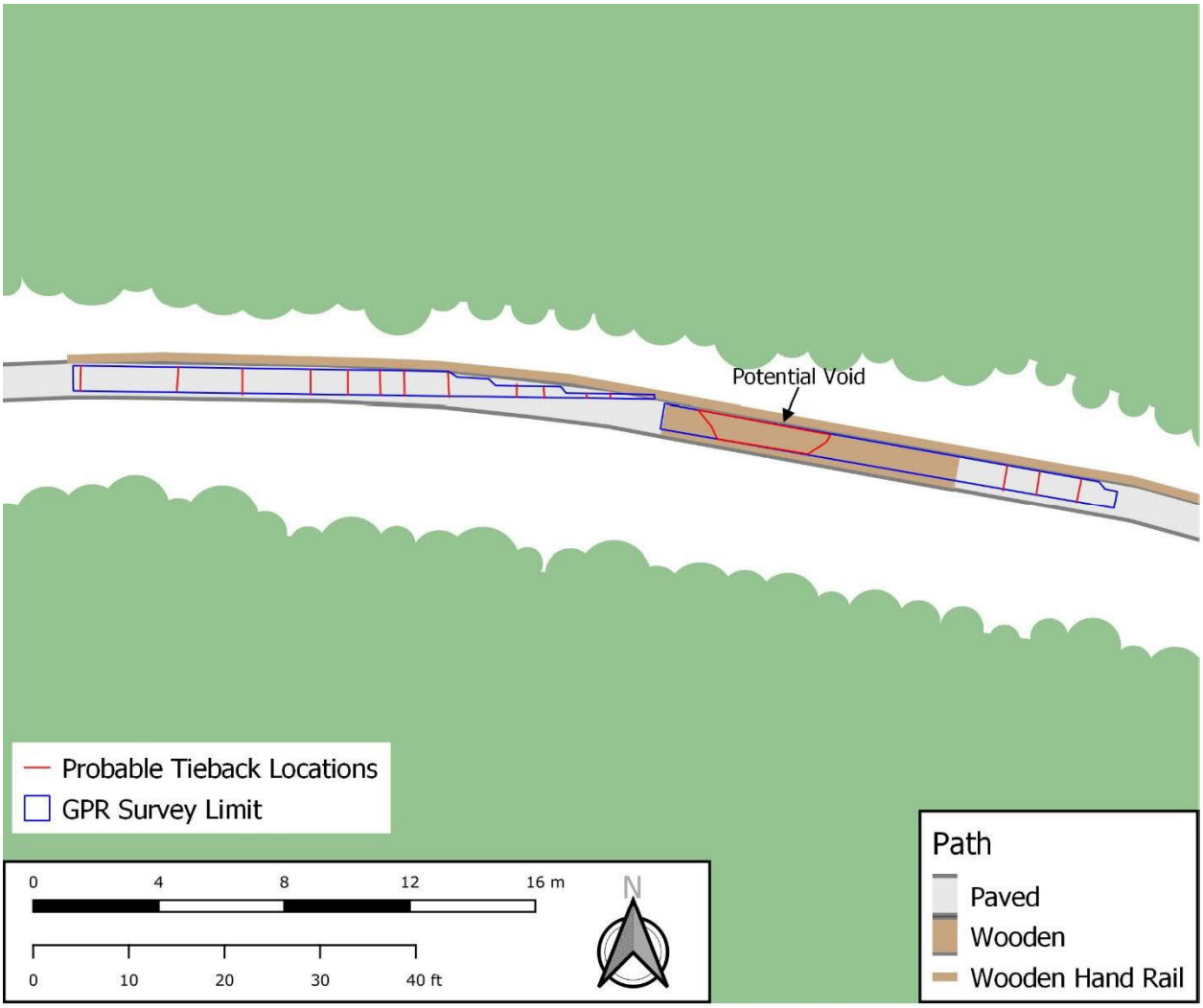


Figure 4 GPR Interpretation on Sketchmap.

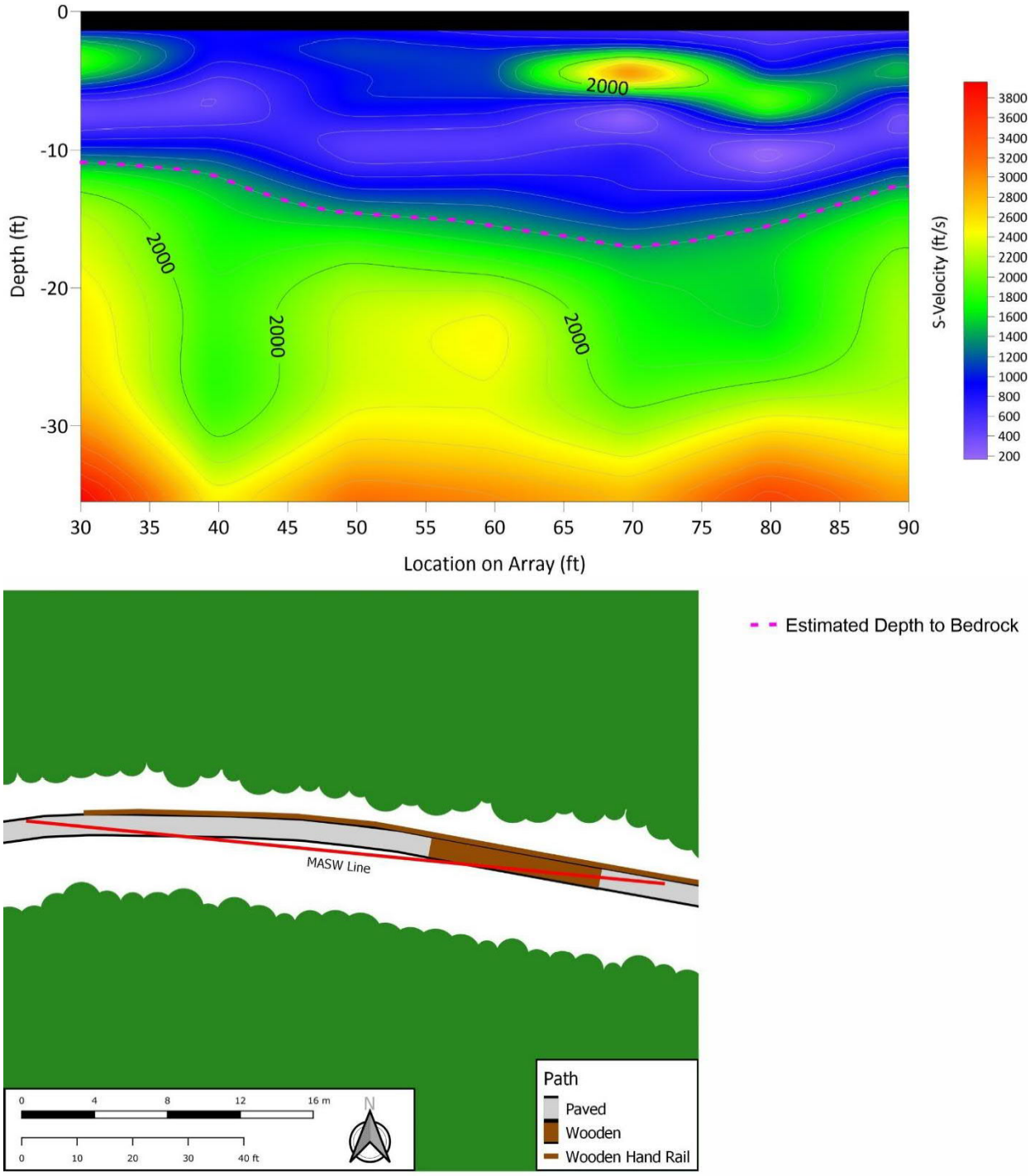


Figure 5 Showing MASW Data and Survey Location on Sketch Map.

LIMITATIONS

All geophysical testing methods rely on instrument signals to indicate physical conditions in the field. Signal information can be affected by on-site conditions beyond the control of the operator, such as, but not limited to, cultural features, standing water, high subsurface moisture content, and other buried objects. Interpretation of those signals is based on a combination of known factors combined with the experience of the operator and geophysical scientist evaluating the results.

This report has been prepared for the application discussed and in accordance with generally accepted geophysical practices. No warranties, expressed or implied, are intended or made. The findings presented in this report are based upon the data obtained from the geophysical surveys and from other information discussed in this report. This report does not reflect variations that may occur in areas not tested or inaccessible to the geophysical equipment, across the site, or due to the modifying effects of construction or weather.

CLOSING

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,
Terracon Consultants, Inc.

Alexander C. Corkum II, PhD
Project Geophysicist

Chett A. Siefring
Manager | Geotechnical Services

BEDROCK DEPTH

Local Geophone Location	N	E	Bedrock Depth (feet)
0	598384.3752	26341671.33	N/A
5	598382.7858	26341676.07	N/A
10	598381.1964	26341680.81	N/A
15	598379.607	26341685.55	N/A
20	598378.0176	26341690.29	N/A
25	598376.4282	26341695.03	N/A
30	598374.8388	26341699.78	-10.93775746
35	598373.2494	26341704.52	-11.25659079
40	598371.66	26341709.26	-12.01231354
45	598370.0706	26341714	-13.81566712
50	598368.4812	26341718.74	-14.6242659
55	598366.8918	26341723.48	-14.99087408
60	598365.3024	26341728.22	-15.55014184
65	598363.713	26341732.96	-16.33062292
70	598362.1236	26341737.7	-17.07769634
75	598360.5342	26341742.44	-16.51134711
80	598358.9447	26341747.18	-15.48535101
85	598357.3553	26341751.92	-13.9730303
90	598355.7659	26341756.66	-12.72057432
95	598354.1765	26341761.4	N/A
100	598352.5871	26341766.14	N/A
105	598350.9977	26341770.88	N/A
110	598349.4083	26341775.63	N/A
115	598347.8189	26341780.37	N/A

Supporting Information

Contents:

General Notes
Unified Soil Classification System
Description of Rock Properties

Note: All attachments are one page unless noted above.

Terracon
12460 Plaza Dr
Parma, OH

General Notes

Sampling

Rock Core

Standard Penetration Test

Water Level

Water Initially Encountered

Water Level After a Specified Period of Time

Water Level After a Specified Period of Time

Cave In Encountered

Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.

Field Tests

N	Standard Penetration Test Resistance (Blows/Ft.)
(HP)	Hand Penetrometer
(T)	Torvane
(DCP)	Dynamic Cone Penetrometer
UC	Unconfined Compressive Strength
(PID)	Photo-Ionization Detector
(OVA)	Organic Vapor Analyzer

Descriptive Soil Classification

Soil classification as noted on the soil boring logs is based Unified Soil Classification System. Where sufficient laboratory data exist to classify the soils consistent with ASTM D2487 "Classification of Soils for Engineering Purposes" this procedure is used. ASTM D2488 "Description and Identification of Soils (Visual-Manual Procedure)" is also used to classify the soils, particularly where insufficient laboratory data exist to classify the soils in accordance with ASTM D2487. In addition to USCS classification, coarse grained soils are classified on the basis of their in-place relative density, and fine-grained soils are classified on the basis of their consistency. See "Strength Terms" table below for details. The ASTM standards noted above are for reference to methodology in general. In some cases, variations to methods are applied as a result of local practice or professional judgment.

Location And Elevation Notes

Exploration point locations as shown on the Exploration Plan and as noted on the soil boring logs in the form of Latitude and Longitude are approximate. See Exploration and Testing Procedures in the report for the methods used to locate the exploration points for this project. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

Strength Terms

Relative Density of Coarse-Grained Soils
(More than 50% retained on No. 200 sieve.)
Density determined by Standard Penetration Resistance

Relative Density	Standard Penetration or N-Value (Blows/Ft.)
Very Loose	0 - 3
Loose	4 - 9
Medium Dense	10 - 29
Dense	30 - 50
Very Dense	> 50

Consistency of Fine-Grained Soils
(50% or more passing the No. 200 sieve.)
Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance

Consistency	Unconfined Compressive Strength Qu (tsf)	Standard Penetration or N-Value (Blows/Ft.)
Very Soft	less than 0.25	0 - 1
Soft	0.25 to 0.50	2 - 4
Medium Stiff	0.50 to 1.00	4 - 8
Stiff	1.00 to 2.00	8 - 15
Very Stiff	2.00 to 4.00	15 - 30
Hard	> 4.00	> 30

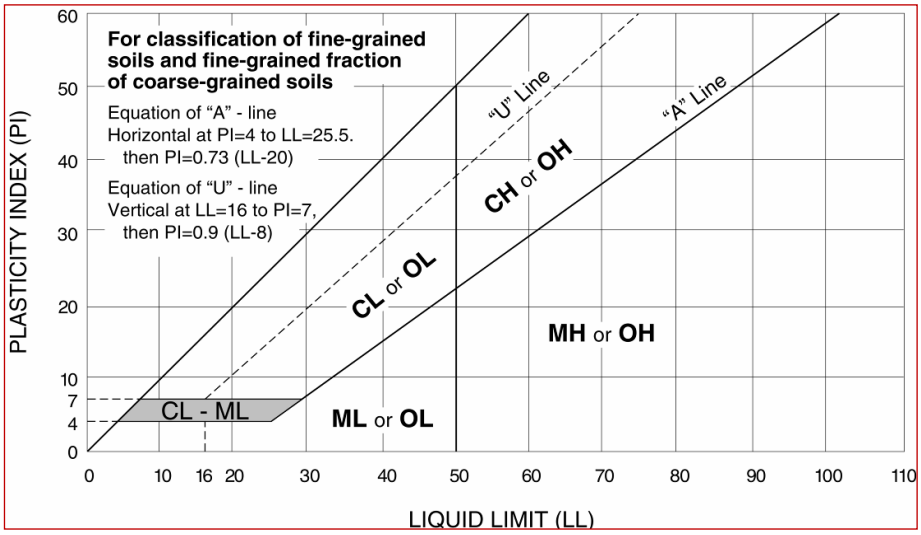
Relevance of Exploration and Laboratory Test Results

Exploration/field results and/or laboratory test data contained within this document are intended for application to the project as described in this document. Use of such exploration/field results and/or laboratory test data should not be used independently of this document.

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. 4 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	Cu≥4 and 1≤Cc≤3 [E]	GW	Well-graded gravel [F]
			Cu<4 and/or [Cc<1 or Cc>3.0] [E]	GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH	GM	Silty gravel [F, G, H]
			Fines classify as CL or CH	GC	Clayey gravel [F, G, H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	Cu≥6 and 1≤Cc≤3 [E]	SW	Well-graded sand [I]
			Cu<6 and/or [Cc<1 or Cc>3.0] [E]	SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH	SM	Silty sand [G, H, I]
			Fines classify as CL or CH	SC	Clayey sand [G, H, 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 above "A" line [J]	CL	Lean clay [K, L, M]
			PI < 4 or plots below "A" line [J]	ML	Silt [K, L, M]
		Organic:	$\frac{LL\ oven\ dried}{LL\ not\ dried} < 0.75$	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:	$\frac{LL\ oven\ dried}{LL\ not\ dried} < 0.75$	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] 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.
[E] $Cu = D_{60}/D_{10}$ $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$
[F] If soil contains ≥ 15% sand, add "with sand" to group name.
[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.
[H] If fines are organic, add "with organic fines" to group name.
[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.
[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.
[K] If soil contains 15 to 29% 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.



Rock Classification Notes

WEATHERING	
Term	**Description**
Fresh	Mineral crystals appear bright; show no discoloration. Features show little or now staining on surfaces. Discoloration does not extend into intact rock.
Slightly weathered	Rock generally fresh except along fractures. Some fractures stained and discoloration may extend <0.5 inches into rock.
Moderately weathered	Significant portions of rock are dull and discolored. Rock may be significantly weaker than in fresh state near fractures. Soil zones of limited extent may occur along some fractures.
Highly weathered	Rock dull and discolored throughout. Majority of rock mass is significantly weaker and has decomposed and/or disintegrated; isolated zones of stronger rock and/or soil may occur throughout.
Completely weathered	All rock material is decomposed and/or disintegrated to soil. The rock mass or fabric is still evident and largely intact. Isolated zones of stronger rock may occur locally.

STRENGTH OR HARDNESS		
Description	**Field Identification**	**Uniaxial Compressive Strength, psi**
Extremely strong	Can only be chipped with geological hammer. Rock rings on hammer blows. Cannot be scratched with a sharp pick. Hand specimens require several hard hammer blows to break.	>36,000
Very strong	Several blows of a geological hammer to fracture. Cannot be scratched with a 20d common steel nail. Can be scratched with a geologist's pick only with difficulty.	15,000-36,000
Strong	More than one blow of a geological hammer needed to fracture. Can be scratched with a 20d nail or geologist's pick. Gouges or grooves to ¼ inch deep can be excavated by a hard blow of a geologist's pick. Hand specimens can be detached by a moderate blow.	7,500-15,000
Medium strong	One blow of geological hammer needed to fracture. Can be distinctly scratched with 20d nail. Can be grooved or gouged 1/16 in. deep by firm pressure with a geologist's pick point. Can be fractured with single firm blow of geological hammer. Can be excavated in small chips (about 1-in. maximum size) by hard blows of the point of a geologist's pick;	3,500-7,500
Weak	Shallow indent by firm blow with geological hammer point. Can be gouged or grooved readily with geologist's pick point. Can be excavated in pieces several inches in size by moderate blows of a pick point. Small thin pieces can be broken by finger pressure.	700-3,500
Very weak	Crumbles under firm blow with geological hammer point. Can be excavated readily with the point of a geologist's pick. Pieces 1-in. or more in thickness can be broken with finger pressure. Can be scratched readily by fingernail.	150-700

DISCONTINUITY DESCRIPTION			
Fracture Spacing (Joints, Faults, Other Fractures)		**Bedding Spacing (May Include Foliation or Banding)**	
Description	**Spacing**	**Description**	**Spacing**
Intensely fractured	< 2.5 inches	**Laminated**	< ½-inch
Highly fractured	2.5 – 8 inches	**Very thin**	½ – 2 inches
Moderately fractured	8 inches to 2 feet	**Thin**	2 inches – 1 foot
Slightly fractured	2 to 6.5 feet	**Medium**	1 – 3 feet
Very slightly fractured	> 6.5 feet	**Thick**	3 – 10 feet
		Massive	> 10 feet

ROCK QUALITY DESIGNATION (RQD) [1]	
Description	**RQD Value (%)**
Very Poor	0 - 25
Poor	25 – 50
Fair	50 – 75
Good	75 – 90
Excellent	90 - 100

1. The combined length of all sound and intact core segments equal to or greater than 4 inches in length, expressed as a percentage of the total core run length.

12460 Plaza Drive
Parma, Ohio 44130
P (216) 459-8378
Terracon.com

June 21, 2024

Quinn Evans
219 ½ N. Main Street
Ann Arbor, MI 48104

Attn: Chris Mueller
P: (734) 926-0408
E: chris.mueller@quinnevans.com

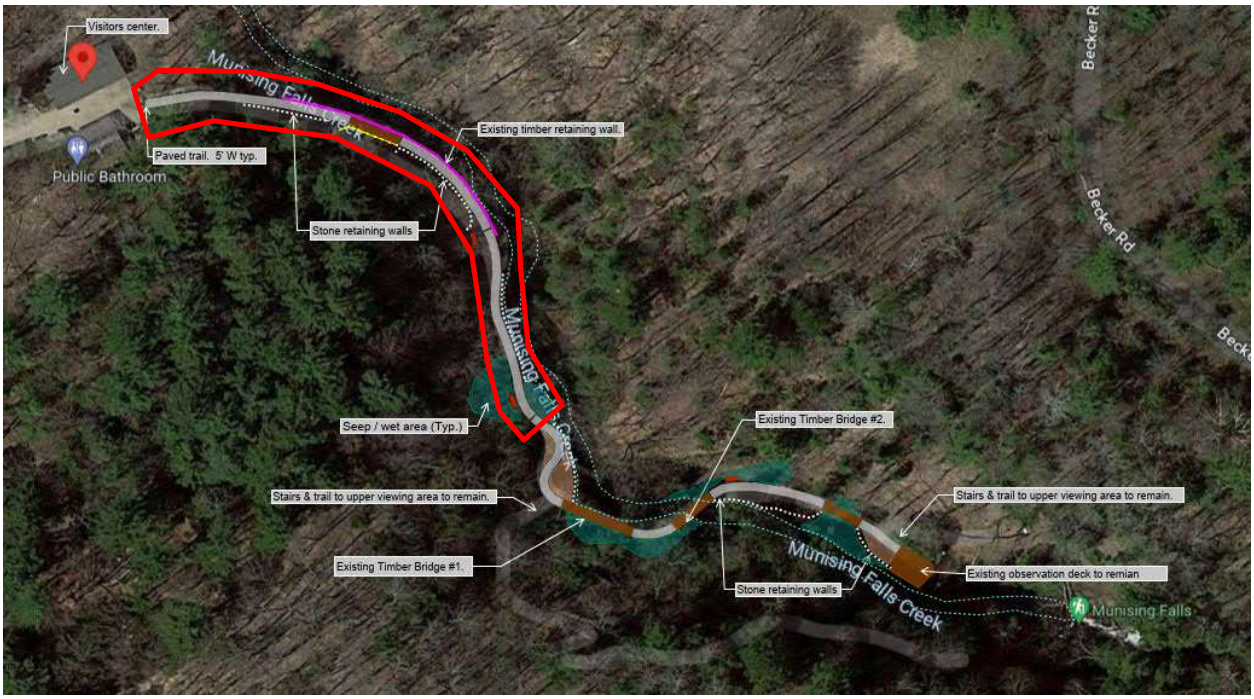
Re: Geotechnical Memorandum
Munising Falls Trail Rehabilitation
1505 Sand Point Road
Munising, Alger County, Michigan
Terracon Project No. N6235258

Dear Mr. Mueller:

We have reviewed the data collected and information presented in our original and revised Geotechnical Engineering Reports prepared for this project, dated November 17, 2023, and January 18, 2024 respectively. This memorandum addresses applicability of the information presented in these reports with respect to modifications made to the overall project.

Project Information

The scope of our geotechnical study included providing recommendations for the rehabilitation/replacement of the existing Munising Falls Trail, starting at the existing Visitor's Center and extending east to a point approximately halfway between the Visitor's Center and Observation Deck, as shown in the boxed area of the graphic below:



This section of the trail improvements was initially expected to include a new retaining wall and replacement of a pedestrian bridge. To address this, geotechnical recommendations for design and construction of the retaining wall and bridge foundations were provided in our report dated November 17, 2023.

Rehabilitation plans were modified to eliminate the retaining wall and pedestrian bridge in favor of a continuous, elevated walkway. Terracon's revised report dated January 18, 2024 incorporated this design change, removing report sections addressing retaining wall and bridge foundation design and construction and including recommendations for helical pile support of the elevated walkway.

Reportedly, the project now includes rehabilitation of the remainder of the trail to the Observation Deck. Due to cost and site access constraints, no additional geotechnical exploration has been conducted within the expanded area of the project.

Within the additional area of the project, rehabilitation/replacement of existing timber bridges and stone retaining walls may be necessary.

Geotechnical Overview

Subsurface conditions evidenced within soil borings and hand augers completed at the site indicated relatively uniform conditions along the original section of trail explored. These conditions include approximately 5 to 10 feet of native, loose to very dense,

coarse-grained deposits of poorly graded sand over moderately weathered, weak, sandstone bedrock.

The results of geophysical exploration, including both ground penetrating radar (GPR) and multi-channel analysis of surface waves (MASW), conducted along the original study area of the trail, east of the completed boring locations, indicated the depth to bedrock between approximately 10 and 17 feet below current surface grades.

While no geotechnical or geophysical exploration has been completed within the remaining portion of the trail, available mapping developed by the National Resources Conservation Service (NRCS), the United States Geological Society (USGS) and the State of Michigan all indicate conditions along this portion of the trail consistent with area explored.

As such, consideration can be given to employing the geotechnical recommendations originally provided for retaining wall and bridge foundation construction to the improvements planned along the entire trail. These recommendations have been provided in this memo for reference only. This information should be used only in conjunction with full Geotechnical Engineering Reports.

It should be noted, however, that without actual data and analysis of the conditions present within the expanded project area, there is inherent risk in using these recommendations. Regardless of the extent of exploration conducted, variations will occur and should be expected. The nature and extent of such variations may not become evident until during or after construction. Use of the following recommendations in design can be done only if the user is willing to accept these risks.

Shallow Foundations

If the site has been prepared in accordance with the requirements noted in **Earthwork**, the following design parameters are applicable for shallow foundations.

Design Parameters – Compressive Loads

Item	Description	
Maximum Net Allowable Bearing Pressure [1, 2]	GeoModel Layer 2	2,500psf
	GeoModel Layer 3	10,000psf
Required Bearing Stratum [3]	GeoModel Layer 2	Medium dense or better granular soils or engineered soils

Item	Description	
		bearing upon these soils.
	GeoModel Layer 3	Bedrock
Minimum Foundation Dimensions	Columns	30 inches
	Continuous	16 inches
Sliding Resistance [4]	Granular Materials	0.35 allowable coefficient of friction
Minimum Embedment below Finished Grade [5]	Exterior footings in unheated areas:	42 inches
Estimated Total Settlement from Structural Loads [2]	Less than about 1 inch	

1. The maximum net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. A factor of safety of 3 has been applied.
2. Values provided are for maximum loads noted in **Project Description**. Additional geotechnical consultation will be necessary if higher loads are anticipated.
3. Unsuitable or soft soils should be overexcavated and replaced per the recommendations presented in **Earthwork**. Subgrade soils should be compacted until they reach a medium dense or better relative density.
4. Can be used to compute sliding resistance where foundations are placed on suitable soil/materials. Frictional resistance for granular materials is dependent on the bearing pressure which may vary due to load combinations. For fine-grained materials, lateral resistance using cohesion should not exceed ½ the dead load.
5. Embedment necessary to minimize the effects of frost and/or seasonal water content variations. For sloping ground, maintain depth below the lowest adjacent exterior grade within 5 horizontal feet of the structure.

Design Parameters – Overturning and Uplift Loads

Shallow foundations subjected to overturning loads should be proportioned such that the resultant eccentricity is maintained in the center-third of the foundation (e.g., $e < b/6$, where b is the foundation width). This requirement is intended to keep the entire foundation area in compression during the extreme lateral/overturning load event. Foundation oversizing may be required to satisfy this condition.

Uplift resistance of spread footings can be developed from the effective weight of the footing and the overlying soils with consideration to the IBC basic load combinations.

Item	Description
Soil Moist Unit Weight	120pcf
Soil Effective Unit Weight[1]	60pcf
Soil weight included in uplift resistance	Soil included within the prism extending up from the top perimeter of the footing at an angle of 20 degrees from vertical to ground surface

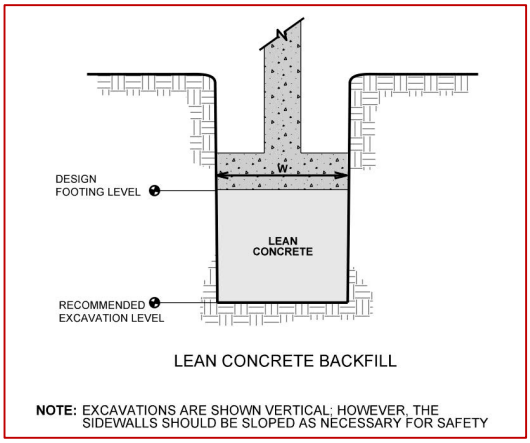
1. Effective (or buoyant) unit weight should be used for soil above the foundation level and below a water level. The high groundwater level should be used in uplift design as applicable.

Foundation Construction Considerations

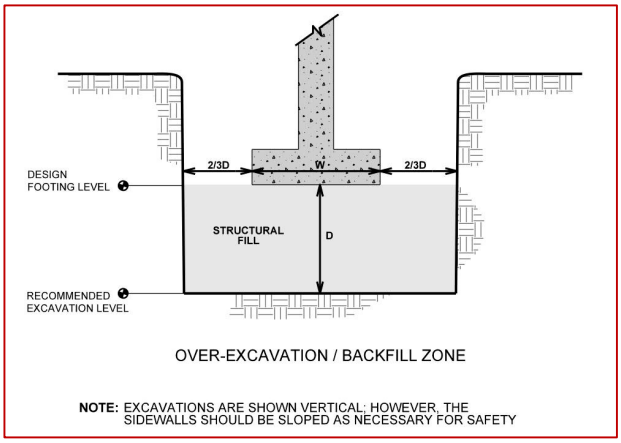
As noted in **Earthwork**, the footing excavations should be evaluated under the observation of the Geotechnical Engineer. The base of all foundation excavations should be free of water and loose soil, prior to placing concrete. Concrete should be placed soon after excavating to reduce bearing soil disturbance. Care should be taken to prevent wetting or drying of the bearing materials during construction. Excessively wet or dry material or any loose/disturbed material in the bottom of the footing excavations should be removed/reconditioned before foundation concrete is placed.

Sensitive soils exposed at the surface of footing excavations may require surficial compaction with hand-held dynamic compaction equipment prior to placing engineered fill, steel, and/or concrete. Should surficial compaction not be adequate, construction of a working surface consisting of either crushed stone or a lean concrete mud mat may be required prior to the placement of reinforcing steel and construction of foundations.

If unsuitable bearing soils are observed at the base of the planned footing excavation, the excavation should be extended deeper to suitable soils, and the footings could bear directly on these soils at the lower level or on lean concrete backfill placed in the excavations. The lean concrete replacement zone is illustrated on the sketch below.



Overexcavation for engineered fill placement below footings should be conducted as shown below. The overexcavation should be backfilled up to the footing base elevation, with approved engineered fill that is placed and compacted, as recommended in the **Earthwork** section.



Drilled Shaft Foundations

Drilled Shaft Vertical Design Parameters

Soil design parameters are provided below in the **Drilled Shaft Design Summary** table for the design of drilled shaft foundations. The values presented for allowable side friction and end bearing include a factor of safety.

Drilled Shaft Design Summary [1]

Stratigraphy [2]		Allowable Skin Friction (psf) [3]	Allowable End Bearing Pressure (psf) [4]
Layer No.	Material		
2	Granular Soil	500	2,500
3	Bedrock	1,000	10,000

1. Design capacities are dependent upon the method of installation and quality control parameters. The values provided are estimates and should be verified when installation protocol have been finalized.
2. See Subsurface Profile in **Geotechnical Characterization** for more details on stratigraphy.
3. Skin friction design is not applicable for shallow drilled piers. The skin friction value provided can be used in uplift load resistance design of the drilled shafts. Effective weight of the pier can be added to uplift load resistance to the extent permitted by IBC.
4. Shafts should extend at least one diameter into the bearing stratum (or to a depth equal to the bell diameter for belled shafts) for end bearing to be considered.

Piers should be adequately reinforced as designed by the Structural Engineer for both tension and shear to sufficient depths. Buoyant unit weights of the soil and concrete should be used in the calculations below the highest anticipated groundwater elevation.

A minimum shaft diameter of 18 inches should be used. Drilled shafts should have a minimum length of 4 feet and should extend into the bearing strata at least one shaft/pile/bell diameter for the allowable end-bearing pressures listed in the above table.

Post-construction settlements of drilled shafts designed and constructed as described in this report are estimated to range from about ½ to ¾ inch. Differential settlement between individual shafts is expected to be ½ to ⅔ of the total settlement.

Drilled Shaft Lateral Loading

The following table lists input values for use in LPILE analyses. versions of LPILE provide estimated default values of kh and E50 based on strength and are recommended for the project. Since deflection or a service limit criterion will most likely control lateral capacity design, no safety/resistance factor is included with the parameters.

Soil Inputs								
Stratigraphy[1]		L-Pile Soil Model	S_u (psf)[2]	ϕ[2]	γ' (pcf)[2]	ε_{50}	K (pci)	
Layer No.	Material						Static	Cyclic
2	Granular Soil	Sand (Reese)	---	35°	125	Use Default Value		

1. See Subsurface Profile in **Geotechnical Characterization** for more details on Stratigraphy.
2. Definition of Terms:
   S_u: Undrained shear strength
   ϕ: Internal friction angle
   γ': Effective unit weight

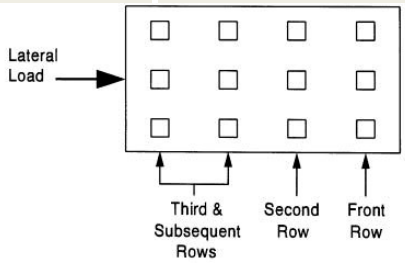
Rock Inputs							
Stratigraphy[1]		L-Pile Soil Model	γ' (pcf)[2]	K rm[2]	UCS (psi)[2]	Ei (psi)[2]	RQD (%)
Layer No.	Material						
3	Use Default Value	Weak Rock (Reese)	150	0.0005	750	68,000	0

1. See Subsurface Profile in **Geotechnical Characterization** for more details on Stratigraphy.
2. Definition of Terms:
   γ': Effective unit weight
   K rm: Strain Factor
   UCS: Uniaxial Compressive Strength (psi)
   Ei: Initial Modulus of Rock Mass (psi)
   RQD: Rock Quality Designation (%)

When shafts are used in groups, the When shafts are used in groups, the lateral capacities of the shafts in the second, third, and subsequent rows of the group should be reduced as compared to the capacity of a single, independent shaft. Guidance for applying p-multiplier factors to the p values in the p-y curves for each row of pile foundations within a pile group are as follows:

Center to Center Pile Spacing [1,2]	P-Multiplier, P_m [3]		
	Front Row	Second Row	Third and Subsequent Rows
3B	0.8	0.4	0.3
4B	0.9	0.65	0.5
5B	1.0	0.85	0.7
6B	1.0	1.0	1.0

1. Spacing in the direction of loading. B = pile diameter
2. For the case of a single row of piles supporting a laterally loaded grade beam, group action for lateral resistance of piles would need be considered when spacing is less than three pile diameters (measured center-to-center).
3. See adjacent figure for definition of front, second and third rows.



Spacing closer than 3D (where D is the diameter of the shaft) is not recommended without additional geotechnical consultation due to potential for the installation of a new shaft disturbing an adjacent installed shaft likely resulting in axial capacity reduction.

Drilled Shaft Construction Considerations

The drilling contractor should be experienced in the subsurface conditions observed at the site, and the excavations should be performed with equipment capable of providing a clean bearing surface. The drilled straight-shaft foundation system should be installed in general accordance with the procedures presented in "Standard Specification for the Construction of Drilled Piers", ACI Publication No. 336.1-01.

The contractor is generally expected to use conventional “dry” techniques for installation of the drilled shaft. Subsurface water was not encountered in boring during the drilling activities. Subsurface water levels are influenced by seasonal and climatic conditions, which result in fluctuations in subsurface water elevations. Additionally, it is common for water to be present after periods of significant rainfall. Casing or slurry drilling procedures could be required in soils zones of higher sand content (such as was observed in GeoModel Layer 3) to reduce the potential for excavation sidewall collapse.

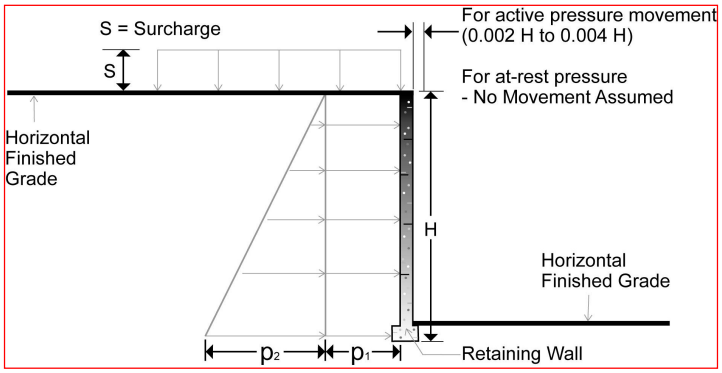
The drilling contractor should remove all soft and disturbed soils from the base of the drilled pier prior to placing concrete. The drilled shaft installation process should be performed under the observation of the Geotechnical Engineer. The Geotechnical

Engineer should document the shaft installation process including soil/rock and groundwater conditions observed, consistency with expected conditions, and details of the installed shaft.

Lateral Earth Pressures

Design Parameters

Structures with unbalanced backfill levels on opposite sides should be designed for earth pressures at least equal to values indicated in the following table. Earth pressures will be influenced by structural design of the walls, conditions of wall restraint, methods of construction, and/or compaction and the strength of the materials being restrained. Two wall restraint conditions are shown in the diagram below. Active earth pressure is commonly used for design of free-standing cantilever retaining walls and assumes wall movement. The "at-rest" condition assumes no wall movement and is commonly used for basement walls, loading dock walls, or other walls restrained at the top. The recommended design lateral earth pressures do not include a factor of safety and do not provide for possible hydrostatic pressure on the walls (unless stated).



Lateral Earth Pressure Design Parameters

Earth Pressure Condition [1]	Coefficient for Backfill Type [2]	Surcharge Pressure [3] p_1 (psf)	Equivalent Fluid Pressures (psf) [2,4]	
			Unsaturated [5]	Submerged [5]
Active (Ka)	Granular - 0.33 Fine Grained - 0.41	(0.33)S (0.41)S	(40)H (50)H	(80)H (85)H
At-Rest (Ko)	Granular - 0.50 Fine Grained - 0.58	(0.50)S (0.58)S	(60)H (70)H	(90)H (95)H

1. For active earth pressure, wall must rotate about base, with top lateral movements 0.002 H to 0.004 H, where H is wall height. For passive earth

Lateral Earth Pressure Design Parameters

Earth Pressure Condition [1]	Coefficient for Backfill Type [2]	Surcharge Pressure [3] p_1 (psf)	Equivalent Fluid Pressures (psf) [2,4]	
			Unsaturated [5]	Submerged [5]

pressure, wall must move horizontally to mobilize resistance. Fat clay or other expansive soils should not be used as backfill behind the wall.

2. Uniform, horizontal backfill, with a maximum unit weight of 120pcf for cohesive soils and 120pcf for granular soils.
3. Uniform surcharge, where S is surcharge pressure.
4. Loading from heavy compaction equipment is not included.
5. To achieve "Unsaturated" conditions, follow guidelines in **Subsurface Drainage for Below-Grade Walls** below. "Submerged" conditions are recommended when drainage behind walls is not incorporated into the design.

Backfill placed against structures should consist of granular soils or low plasticity cohesive soils. For the granular values to be valid, the granular backfill must extend out and up from the base of the wall at an angle of at least 45 degrees from vertical for the active case.

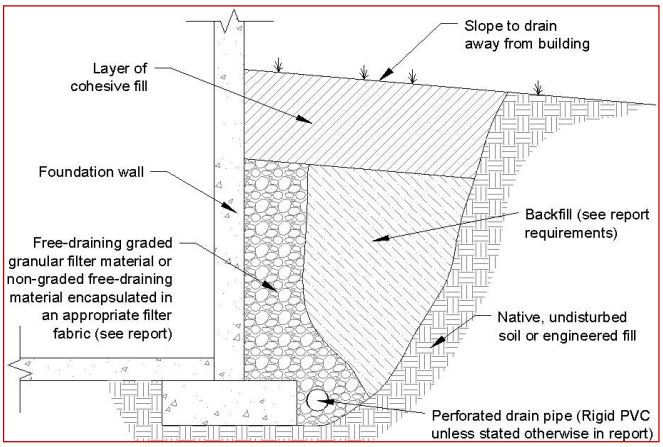
Footings, floor slabs or other loads bearing on backfill behind walls may have a significant influence on the lateral earth pressure. Placing footings within wall backfill and in the zone of active soil influence on the wall should be avoided unless structural analyses indicate the wall can safely withstand the increased pressure.

The lateral earth pressure recommendations given in this section are applicable to the design of rigid retaining walls subject to slight rotation, such as cantilever, or gravity type concrete walls. These recommendations are not applicable to the design of modular block - geogrid reinforced backfill walls (also termed MSE walls). Recommendations covering these types of wall systems are beyond the scope of services for this assignment. However, we would be pleased to develop a proposal for evaluation and design of such wall systems upon request.

Subsurface Drainage for Below-Grade Walls

A perforated rigid plastic drain line installed behind the base of walls and extending below adjacent grade is recommended to prevent hydrostatic loading on the walls. The invert of a drain line around a below-grade building area or exterior retaining wall should be placed near foundation bearing level. The drain line should be sloped to provide positive gravity drainage to daylight or to a sump pit and pump. The drain line should be surrounded by clean, free-draining granular material having less than 5% passing the No. 200 sieve, such as No. 57 aggregate. The free-draining aggregate should be encapsulated in a filter fabric. The granular fill should extend to within 2 feet of final

grade, where it should be capped with compacted cohesive fill to reduce infiltration of surface water into the drain system.



As an alternative to free-draining granular fill, a prefabricated drainage structure may be used. A prefabricated drainage structure is a plastic drainage core or mesh which is covered with filter fabric to prevent soil intrusion and is fastened to the wall prior to placing backfill.

We appreciate the opportunity to continue to be of service to you on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,

Terracon Consultants-MI, Inc.

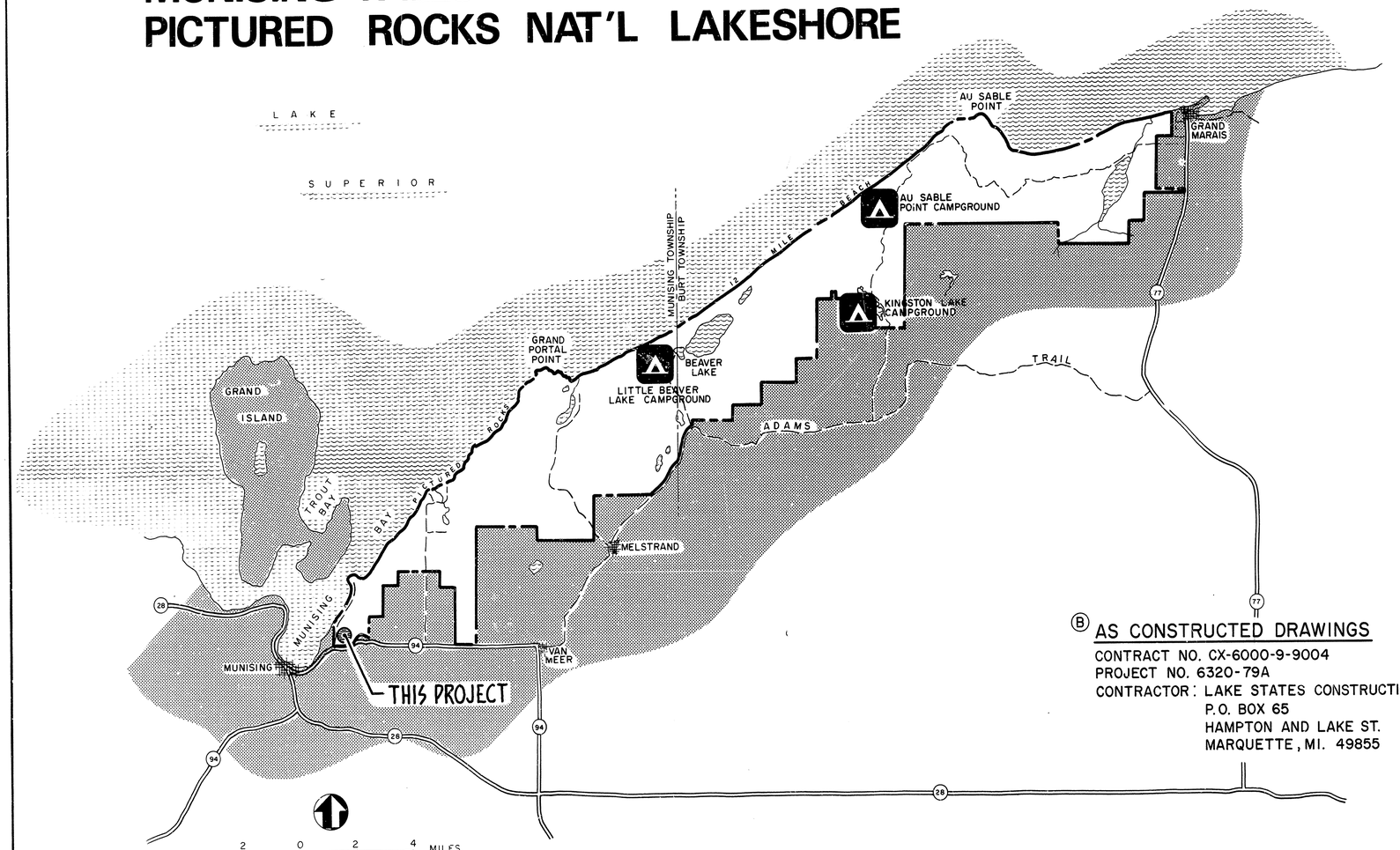
Thomas F. McDonnell, P.E.
Principal

Richard Sullivan, P.E.
Reviewing Engineer

APPENDIX B

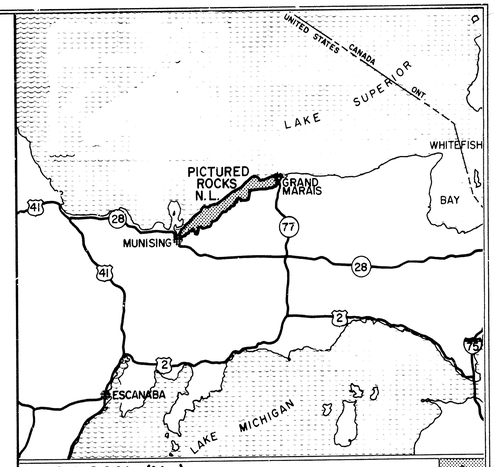
1982 As Constructed Drawings (Abridged)

INTERPRETIVE FACILITIES
MUNISING FALLS
PICTURED ROCKS NAT'L LAKESHORE



REDUCED SIZE REPRODUCTION

BASIC DATA



MICHIGAN (No.)

SCALE: 19 0 19 38 MILES

SHEET INDEX

SHEET NO.	TITLE
1	COVER
2	MUNISING FALLS - SITE PLAN
3	PARKING AREA - SITE PLAN
4	PARKING AREA - LAYOUT PLAN
5	PARKING AREA - GRADING
6	PARKING AREA - PLANTING
7	TRAILS - SITE PLAN
8	PAVED TRAIL - PROFILE
9	GRAVEL TRAIL - PROFILE
10	GRAVEL TRAIL - PROFILE
11	PARKING AREA, TRAIL SURFACE - DETAILS
12	BRIDGE - DETAILS
13	STONE RETAINING WALL, DELETED-DETAILS WOODBIN & CRIB WALLS
14	STAIRS I, II - DETAILS
15	- DETAILS TYPE III STAIRS
16	OVERLOOKS - DETAILS
17	OBSERVATION DECK - DETAILS
18	PLANTING - DETAILS NOT INCLUDED
19	CONTACT STATION
20	COMFORT STATION
21	COMFORT STATION - BUILDING SECTIONS
22	- DOOR & WINDOW DETAILS
23	- STRUCTURAL DETAILS
24	- MISC. DETAILS
25	WATER & SEWER - PLAN & PROFILE
26	WATER & SEWER - DETAILS NOT INCLUDED
27	ELECTRICAL
28	MECHANICAL
29	COMFORT/CONTACT STA. HARDWARE SCHEDULE
33	BRIDGE DETAILS

Ⓑ AS CONSTRUCTED DRAWINGS

CONTRACT NO. CX-6000-9-9004
PROJECT NO. 6320-79A
CONTRACTOR: LAKE STATES CONSTRUCTION
P.O. BOX 65
HAMPTON AND LAKE ST.
MARQUETTE, MI. 49855

Mark	Sheet	REVISION	Date	Initial
B		AS CONSTRUCTED DRAWINGS	1-82	MAP. BR.

This drawing has been prepared in compliance with Preliminary/Comprehensive Design Drawing No. 625-41027
Approved by M.D. BEAL
REGIONAL DIRECTOR on 8-16-77 Date
Associate Manager, D.S.C. 5-9-79 Date

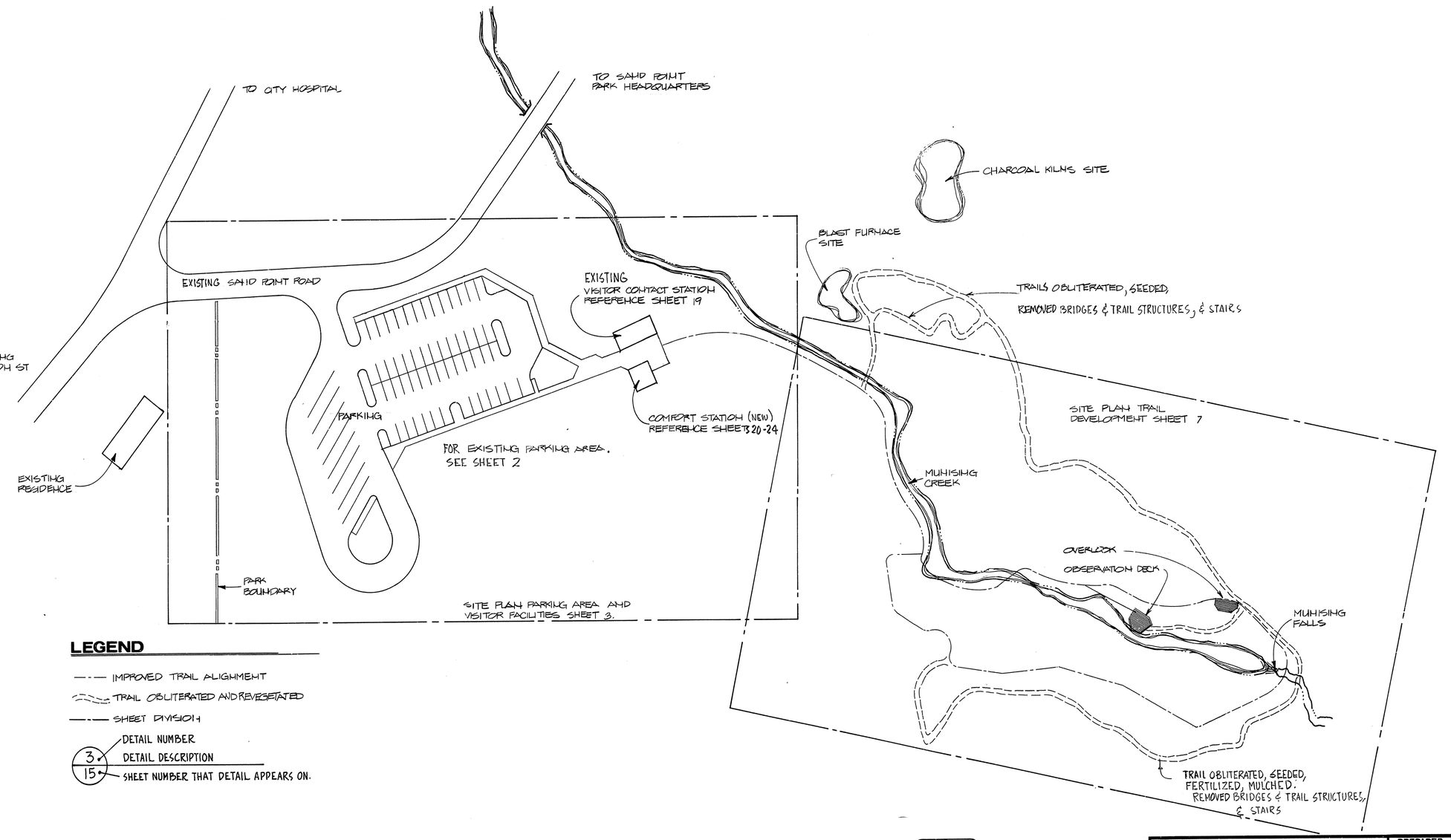
AS CONSTRUCTED DRAWINGS
UNITED STATES
DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
DENVER SERVICE CENTER

PREPARED MIDWEST TEAM
DESIGNED
DRAWN B. SHELLY
CHECKED
DATE

TITLE OF DRAWING
PARKING, TRAILS, COMFORT STATION, UTILITIES
LOCATION WITHIN PARK
MUNISING FALLS
NAME OF PARK
PICTURED ROCKS N.L.
MIDWEST REGION | ALGER COUNTY | MICH. STATE

DRAWING NO. 625 41,027 B
PCIP PKG 108
SHEET 1 OF 29

0599-101



LEGEND

- IMPROVED TRAIL ALIGNMENT
- TRAIL OBLITERATED AND REVEGETATED
- SHEET DIVISION
- 3 / 15 — DETAIL NUMBER; DETAIL DESCRIPTION; SHEET NUMBER THAT DETAIL APPEARS ON.

NORTH

0 50' 75' 100' 150

SCALE 1"=50'-0"

SITE DEVELOPMENT MUNISING FALLS

PREPARED	D. WENK
DESIGNED	D. WENK
DRAWN	RONSCAVAGE
CHECKED	4/79
DATE	
DRAWING NO.	625 41,027B
PCIP PKG.	728
SHEET	2 OF 29

☆ GPO: 1977 777-389

NOTE:
- EXISTING CONDITIONS - FADED LINES
- PROPOSED WORK - STRONG LINES

- SEE SHEET 5 FOR WORK CORRIDORS.

REMOVE ROAD BASE AND PLACE 8" TOPSOIL PRIOR TO PLANTING THIS AREA

PROTECT EXISTING TREE

6' CONCRETE WALK (8/11)

9/11 CONCRETE CURB & GUTTER

7/11 END OF CURB

SIGN LOCATIONS (1, 2, 3)

12/11

EXISTING TREES

1/17 BARRIER POSTS

PARKING 8 SPACES FOR BUSES AND RECREATION VEHICLES (5)

PAVEMENT MARKINGS

N.P.S. BOUNDARY

N10,100 E10,000 B.M. EL 626.77

N10,200 E10,100

4" S 3/4 W

6' CONCRETE WALK (8/11)

TRASH RECEPTACLE - SEE SPECS

REMOVED PARKING AREA BASE AND PLACE 8" TOPSOIL PRIOR TO PLANTING

6' WOOD BENCH

TRASH RECEPTACLE

NEW FLAGPOLE 2/17

VISITOR CONTACT STATION RE. SHEET 19

EXISTING N.P.S. BLDG ELEV. 654.54

CONC. SIDEWALK

MUNSING CREEK

11/11 HANDRAIL - START AT STA 0+35

STA. 0+00 START OF PAVED TRAIL 3/11

STA 1+25 MATCH WITH SHEET I TYPICAL SECTION SHEET II

OBLITERATE EXISTING CONCRETE WALK

2/11 STONE RETAINING WALL STA. 1+25 TO 1+75 TYPE A

CONCRETE TERRACE SCORING PATTERN EXPANSION JOINTS 30' O.C MAXIMUM

HANDICAPPED RAMP 6,10/11

HANDICAPPED PARKING STALLS

EXISTING TREE LINE

60 CAR PARKING AREA (PAVED BITUM.)

TRASH RECEPTACLE - SEE SPECS.

6' WOOD BENCHES 3,4,5/17

COMFORT STATION RE SHEETS 20 to 24

3/11 5' PAVED TRAIL

HANDICAPPED RAMP WALK PORTION

6' CONCRETE WALK (8/11)

WOOD BENCHES (3,4,5/17)

TRASH RECEPTACLES - SEE SPECS.

LIMITE EXISTING PARKING AREA (GRAVEL)

REMOVED PARKING AREA BASE & SUB BASE AND PLACE 8" TOPSOIL PRIOR TO PLANTING THIS AREA (8/11)

6' WIDE CONCRETE WALK

CONCRETE CURB & GUTTER (9/11)

8" TOPSOIL IN ALL PARKING LOT ISLANDS PRIOR TO SEEDING OR PLANTING

WOOD BARRIER POST 20' CH CENTER (1/17)

NOTE: ALL EXISTING FACILITIES ARE SHOWN ½ TONE.

SIGNS SEE DETAIL 1/3

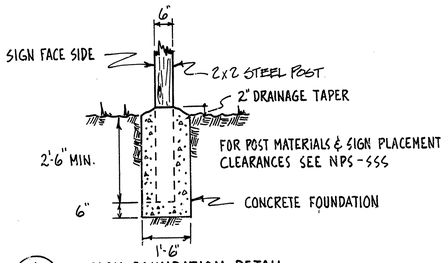
SYMBOL	QUAN.	MESSAGE	DESIGNATION	SIZE
1	1	MUNSING FALLS	ENTRANCE	60" X 30"
2	1	BUS & RV PARKING	RS-034	18" X 18"
3	1	STOP	R1-1	24" X 24"
4	2	HANDICAPPED PARKING	RS-028	1' X 1'
5	1	DO NOT ENTER	R5-1	30" X 30"
6	2	ONE WAY (DOUBLE FACE)	R6-2	18" X 24"

REMOVED PARKING AREA BASE & SUB BASE TO A MINIMUM DEPTH OF 8". PLACE MINIMUM OF 8" OF TOPSOIL PRIOR TO ANY PLANTING IN DESIGNATED AREAS

PARK WILL FURNISH SIGNS TO CONTRACTOR FOR INSTALLATION AT LOCATIONS SHOWN - MUNSING FALLS ENTRANCE SIGN WILL BE INSTALLED BY PARK.

SEE SHEET NO. 25 FOR NEW UTILITIES.
" 5 FOR GRADING PLAN.

STABLIZATION (SUBSURFACE) CELANESE "MIRAT" #140



1/3 SIGN FOUNDATION DETAIL
NO SCALE

NORTH

0' 10' 20' 40' 60'

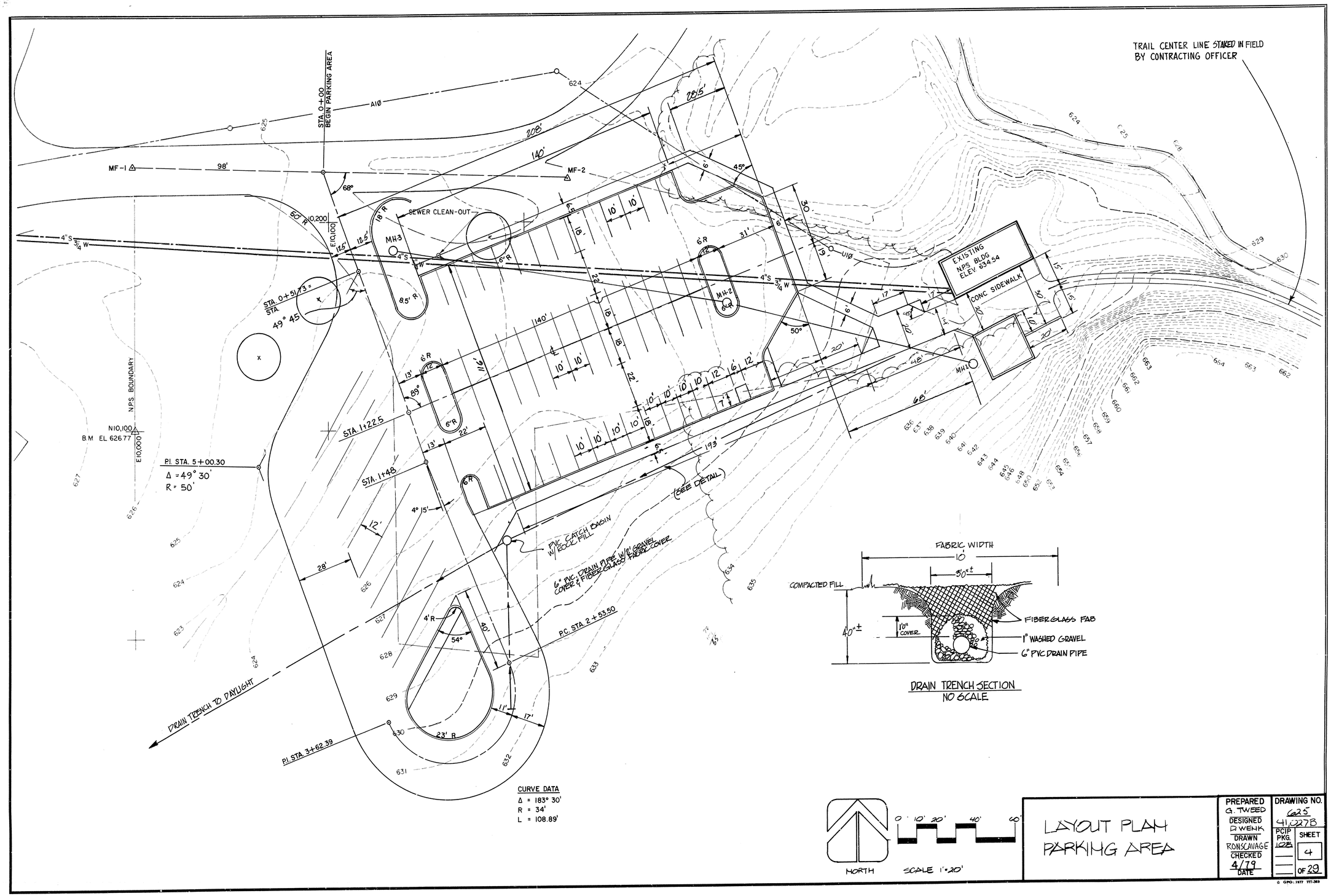
SCALE 1"=20'-0"

SITE PLAN

ENTRANCE FACILITIES
PARKING AREA

PREPARED D WENK
DESIGNED D WENK
DRAWN RONSCAVAGE
CHECKED 4/79
DATE

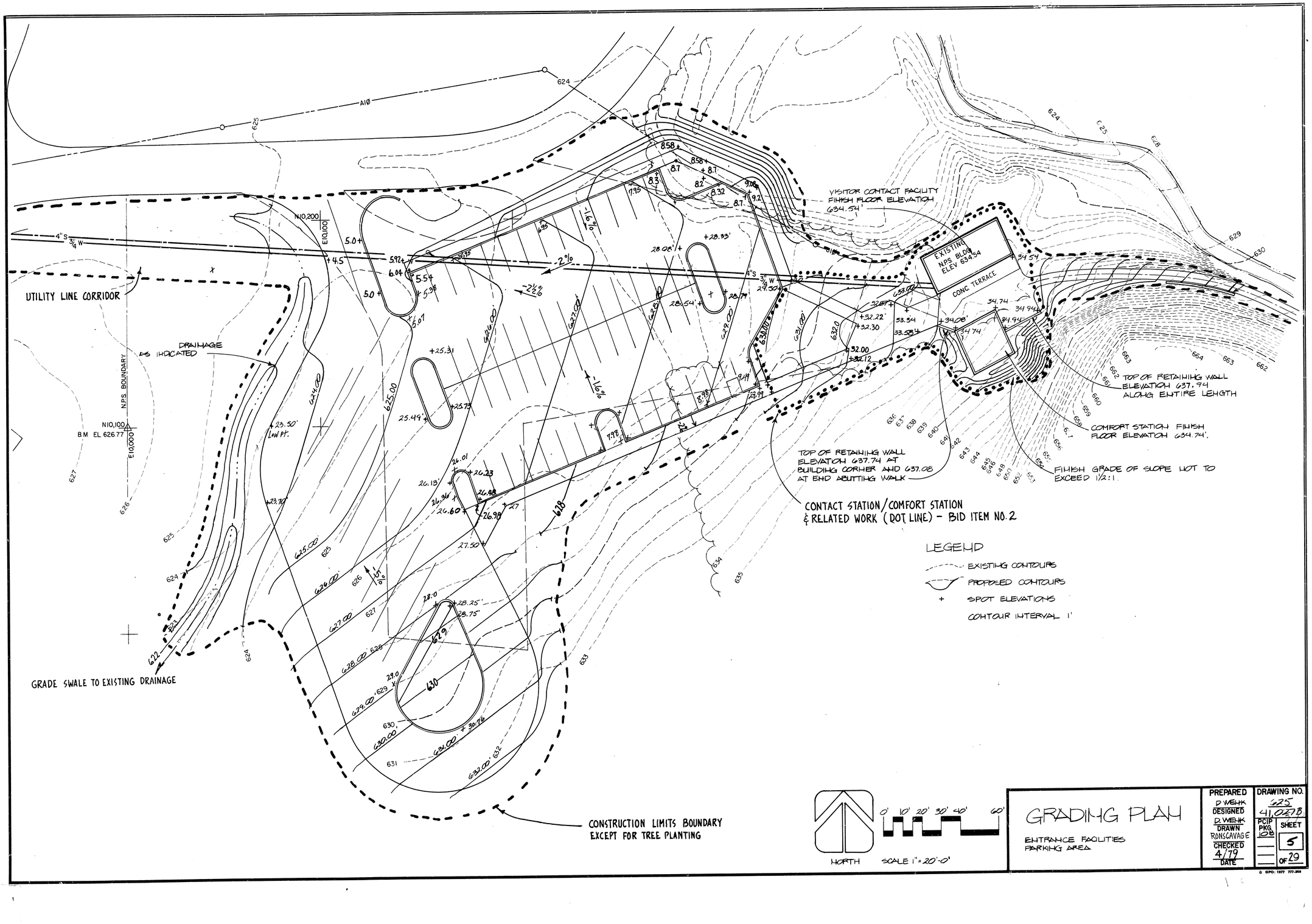
DRAWING NO. 625 41,027B
PCIP PKG. 625
SHEET 3 OF 29



LAYOUT PLAN
PARKING AREA

PREPARED	G. TWEED
DESIGNED	D. WENK
DRAWN	RONSCAVAGE
CHECKED	4/79
DATE	
DRAWING NO.	625 41,027B
PCIP PKG.	108
SHEET	4 OF 29

☆ GPO: 1977 777-369



GRADING PLAN

ENTRANCE FACILITIES
PARKING AREA

PREPARED	D.WEHK
DESIGNED	D.WEHK
DRAWN	RONSCAVAGE
CHECKED	4/79
	DATE

DRAWING NO. 425 41,027B
PCTP PKG. 128
SHEET 5 OF 29

☆ GPO: 1977 777-369

5 SORBUS AMERICANA
3 BETULA PAPYRIFERA
3 BETULA LUTEA

9 PINUS STROBUS

EROSION CONTROL NETTING & MULCH
FILL SLOPE (590 SY)
1 PINUS STROBUS
4 BETULA LUTEA
2 PINUS STROBUS

EXISTING N.P.S. BLDG ELEV. 634.54
CONC. TERRACE

EXISTING APPLE TREES

5 PINUS STROBUS

EROSION CONTROL NETTING & MULCH
DRAINAGE SWALE
(450 SY)

CUT SLOPE (70%)
EROSION CONTROL NET & MULCH

3 BETULA PAPYRIFERA
6 BETULA LUTEA

2 ACER SACCHARUM
2 FAGUS GRANDIFOLIA
3 BETULA PAPYRIFERA
1 SORBUS AMERICANA

10' WIDE OUTER PARKING PERIMETER (670 SY)
EROSION CONTROL NETTING & MULCH

5 ACER RUBRUM

3 BETULA LUTEA

16 BETULA LUTEA

5 PINUS RESINOSA

4 ACER RUBRUM

3 PINUS RESINOSA

3 ACER SACCHARUM
4 FAGUS GRANDIFOLIA

4 FAGUS GRANDIFOLIA

NOTE:
- ALL TREE LOCATIONS FLAGGED BY LANDSCAPE CONTRACTOR AND LOCATIONS APPROVED BY CONTRACTING OFFICER PRIOR TO INSTALLATION.
- SEE SHEET 18 FOR PLANTING DETAILS.

-SEED ALL AREAS DISTURBED BY CONSTRUCTION ACTIVITIES

PLANT MATERIAL LIST

QUAN	BOTANICAL NAME	COMMON NAME	SIZE	REMARKS
	TREES			
9	ACER RUBRUM	RED MAPLE	2"-2½"	B+B
10	ACER SACCHARUM	SUGAR MAPLE	2"-2½"	B+B
32	BETULA LUTEA	YELLOW BIRCH	1½"-2"	B+B
9	BETULA PAPYRIFERA	WHITE BIRCH	1½"-2"	B+B
11	FAGUS GRANDIFOLIA	AMERICAN BEECH	2"-2½"	B+B
5	SORBUS AMERICANA	MOUNTAIN ASH	2"-2½"	B+B
8	PINUS RESINOSA	RED PINE	6'-7'	B+B
17	PINUS STROBUS	WHITE PINE.	6'-7'	B+B
	GROUNDCOVER			
66 UNITS	SEED MIX	SEE SPECIFICATIONS		1 UNIT = 1,000 SF
	TRAIL PLANTINGS SEE PROFILE SHEET			
	TREES		2"-2½	B&B
2	ACER RUBRUM	RED MAPLE		
3	FAGUS GRANDIFOLIA	AMERICAN BEECH	1"-1½"	BB
3	SORBUS AMERICANA	MOUNTAIN ASH	2" 2½"	B&B
	GROUNDCOVER			
15 UNITS	SEED MIX	SEE SPECIFICATIONS		1 UNIT = 1,000 SF
1900	EROSION CONTROL NETTING & MULCH	SEE SPECIFICATIONS	SY	SY = SQUARE YARDS

NORTH SCALE 1"=20'0"

0 10 20 30 40 60

PLANTING PLAN

ENTRANCE AREA
PARKING AREA

PREPARED	DRAWING NO.
D.WENK	625
DESIGNED	41,027B
D.WENK	PCIP PKG.
DRAWN	SHEET
RONSCAVAGE	6
CHECKED	OF 29
4/79	
DATE	

© GPO 1977 781 788

NOTE: FOR USE OF RETAINING WALLS TYPES B & C, USE WILL BE DETERMINED IN FIELD BY CONTRACTING OFFICER. SEE SHEET 13 FOR WALL DETAILS.

MATCH WITH SHEET 3 AT STA. 1+25

11/11 HANDRAIL STA 1+25 TO STA 2+00±

REMOVED BRIDGE ACROSS MUNISING CREEK

STA 2+05 ± PLACE 11"x18" CMPA 15' LENGTH UNDER PAVED BIT. WALK

STONE RETAINING WALL STA 1+75 to 2+10
HEIGHT OF WALL 18" ± 2/11

STA 2+50 ± START STONE RETAINING WALL

STONE RETAINING WALL
HEIGHT OF RETAINING 4.5' ± 3,4,5/13

3/11 PAVED TRAIL

STA. 3+12 ± END STONE RETAINING WALL (62 L.F ±)

STA 3+40 ± START STONE RETAINING WALL (50 L.F.)
HANDRAIL STA. 3+40 TO 3+74 ±
STONE RETAINING WALL
HEIGHT OF WALL 4' ± 3,4,5/13
STA 3+90 ± END STONE RETAINING WALL

STA 3+34 ± PLACE 11"x18" CMPA 15' LENGTH UNDER PAVED WALK DRAIN INTO CREEK

STA 3+74 PAVED TRAIL, STA 3+62 GRAVEL TRAIL

BRIDGE #2 DETAIL 1/12

TYPE I STAIRS
LANDING-5'
TYPE II STAIRS
LANDING-5'
TYPE III STAIRS 11.8'
LANDING-A'
TYPE III STAIRS 10.7'
TYPE III STAIRS 10.7'
LANDING 10.5'
LANDING 20'
LANDINGS-2-4'
TYPE III STAIRS-14'
LANDING-5'
TYPE III STAIRS 14'
BRIDGE #4 DETAIL SH 12.
TYPE I STAIRS 6'
TYPE I STAIRS 8'
LANDING-8'
LANDING-3'
TYPE I STAIRS-8'
LANDING-14'

STA. 3+83
STA. 3+58
STA. 3+48
STA. 3+28

BRIDGE #1 DETAIL 1/12

STA. 5+61 START RET. WALL (45 L.F.)
STA. 5+96 END RET. WALL
STA. 6+88 END RET. WALL
STA. 6+73 START RET. WALL (15 L.F.)
STA 6+11 START RET. WALL (70 L.F.)

11/11 HANDRAIL ALONG GRAVEL TRAIL 318 L.F. 1/15

EXISTING TRAIL OBLITERATED, REMOVED ALL STAIRS, BRIDGES AND REVEGETATED LENGTH OF TRAIL 1,450 FEET ±

EXISTING TRAIL OBLITERATED 4/11

TYPE III STAIRS-13'
LANDING-8'
LANDING-5'
LANDING 4'
TYPE II STAIRS-14'
LANDING-4'
TYPE I STAIRS 5'
LANDING 5'
TYPE III STAIRS-14'
TYPE III STAIRS-12'
BRIDGE #3 DETAIL 1/12

OVERLOOK DECK 1/16 4/11
SAND TRAIL 4/11
7/13
OBSERVATION DECK DETAIL 6/17

STA. 6+86 END RET. WALL

REMOVED STONE RETAINING WALLS FROM POND AT BASE OF FALLS
REVEGETATED SLOPES TO LIMITS SHOWN PLACE EROSION CONTROL NETTING ON SLOPES 3:1 AND GREATER

3,4,5/13 STONE RETAINING WALL 70 LF IN LENGTH HEIGHT OF WALL 4' ± AV.

EXISTING SAND TRAIL 4/11

TYPE I STAIRS

EXISTING TRAIL OBLITERATED REMOVED ALL STAIRS, BRIDGES AND REVEGETATED LENGTH OF TRAIL 1,450 FEET ±

1/14 TYPE I STAIRS
2/14 TYPE II STAIRS
12/15 TYPE III STAIRS

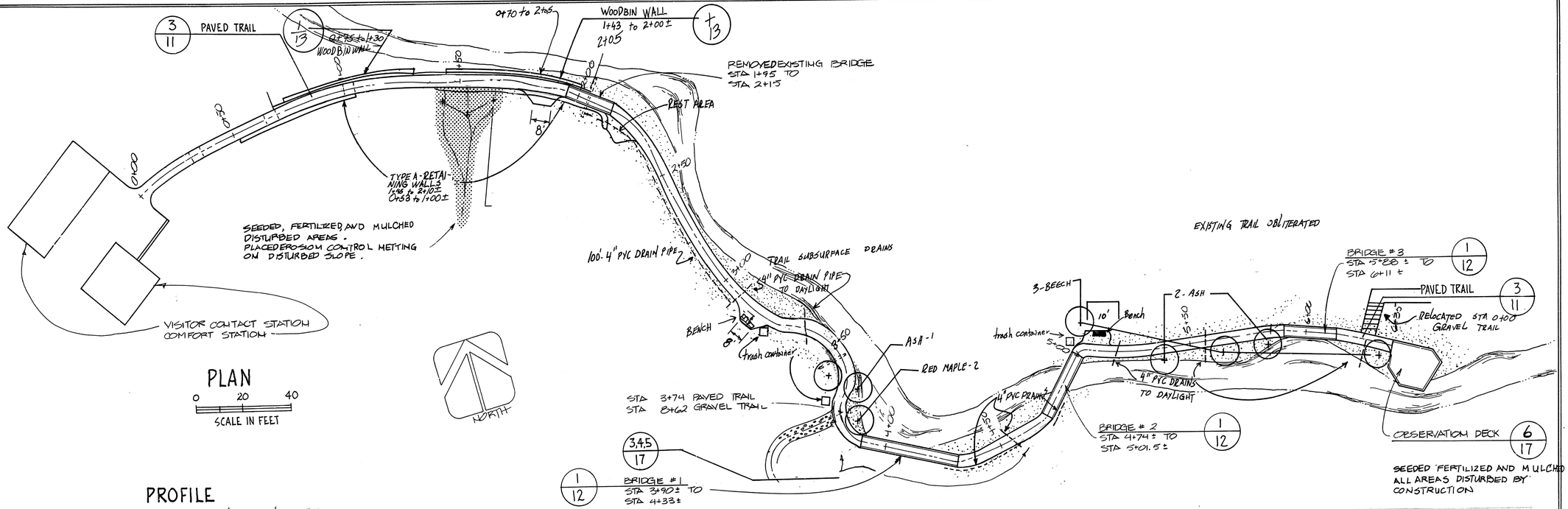
NORTH

0 20' 30' 40' 60'
SCALE 1"=20'-0"

SITE PLAN TRAILS

PREPARED	DRAWING NO.
D WEHK	625
DESIGNED	41,027B
D WEHK	PCIP PKG. 628
DRAWN	SHEET
RONS CAVAGE	7
CHECKED	OF 29
4/79	
DATE	

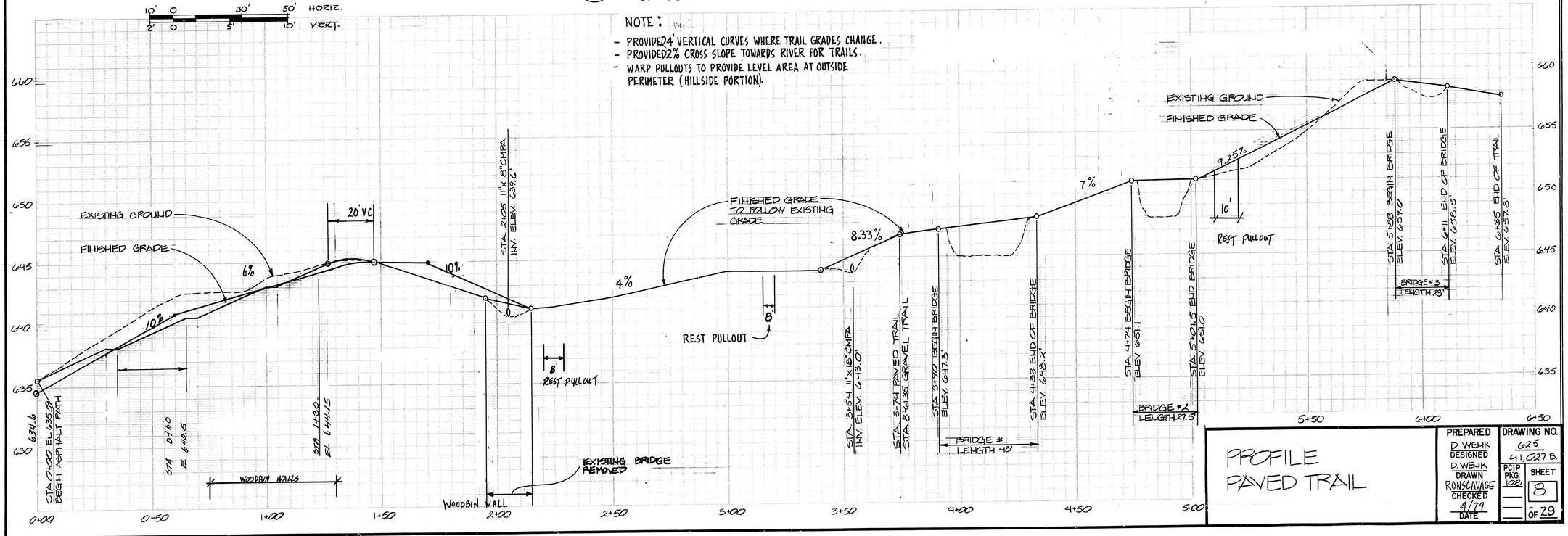
© GPO: 1977 781-788



PROFILE

10' 0 30' 50' HORIZ.
2' 0 5' 10' VERT.

NOTE:
- PROVIDED 4' VERTICAL CURVES WHERE TRAIL GRADES CHANGE.
- PROVIDED 2% CROSS SLOPE TOWARDS RIVER FOR TRAILS.
- WARP PULLOUTS TO PROVIDE LEVEL AREA AT OUTSIDE PERIMETER (HILLSIDE PORTION).



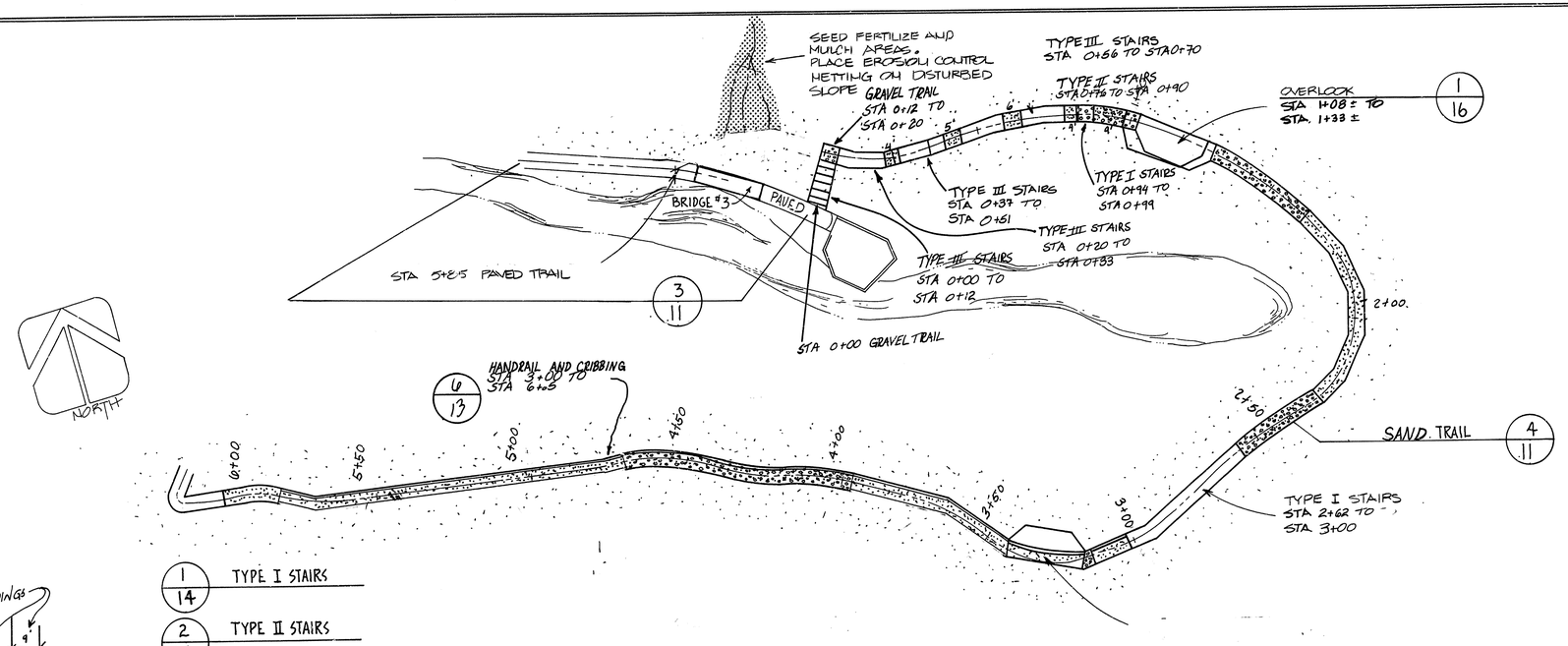
PROFILE
PAVED TRAIL

PREPARED	DRAWING NO.
D. WEHK DESIGNED	625 41,027 B.
D. WEHK DRAWN	PCTP PKG. 102 — SHEET 8
RONSCAVAGE CHECKED	—
4/79 DATE	— OF 29

PLAN

0 20 40

SCALE IN FEET



1/14 TYPE I STAIRS

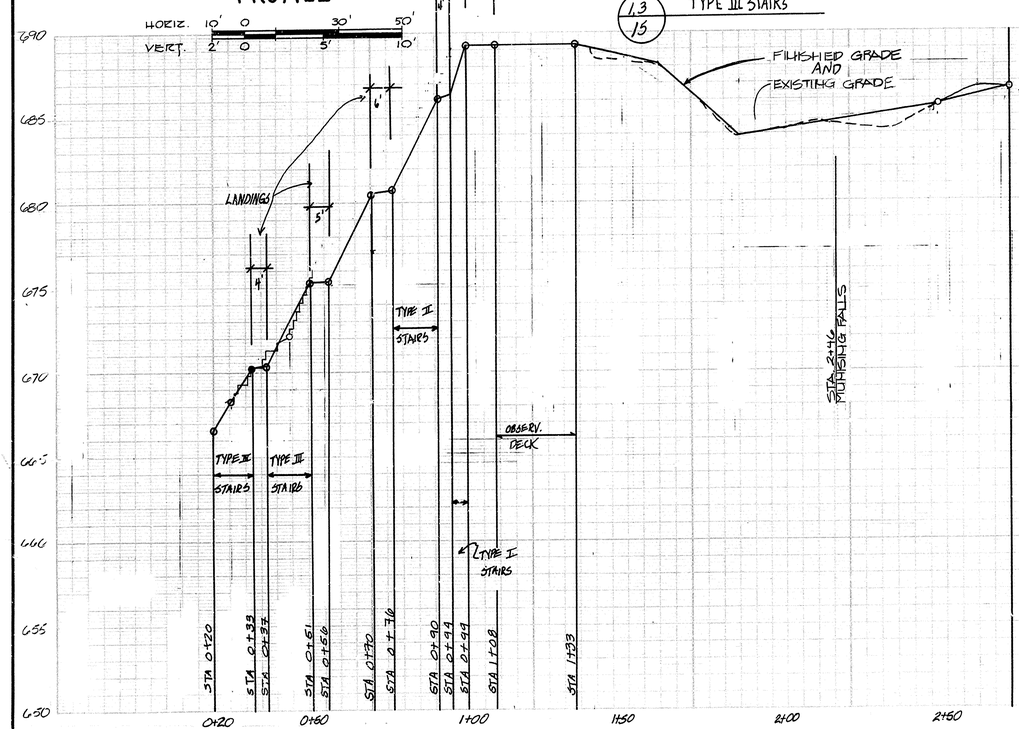
2/14 TYPE II STAIRS

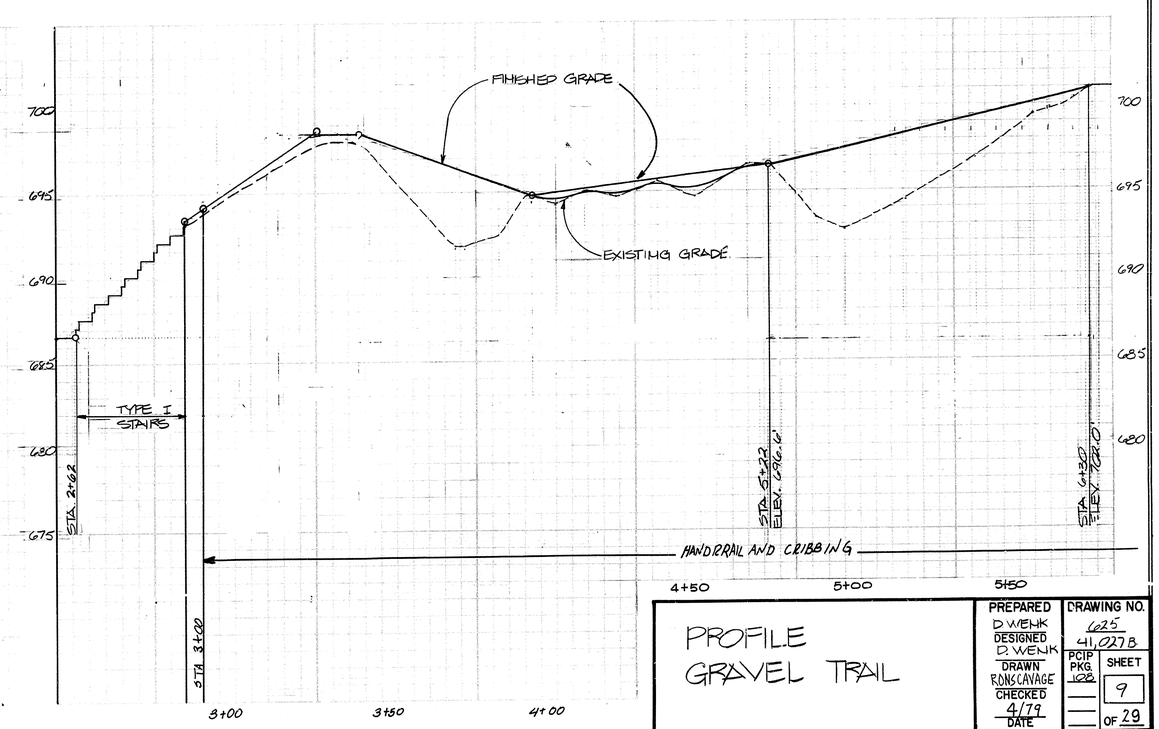
13/15 TYPE III STAIRS

PROFILE

HORIZ. 10' 0 30' 50'

VERT. 2' 0 5' 10'





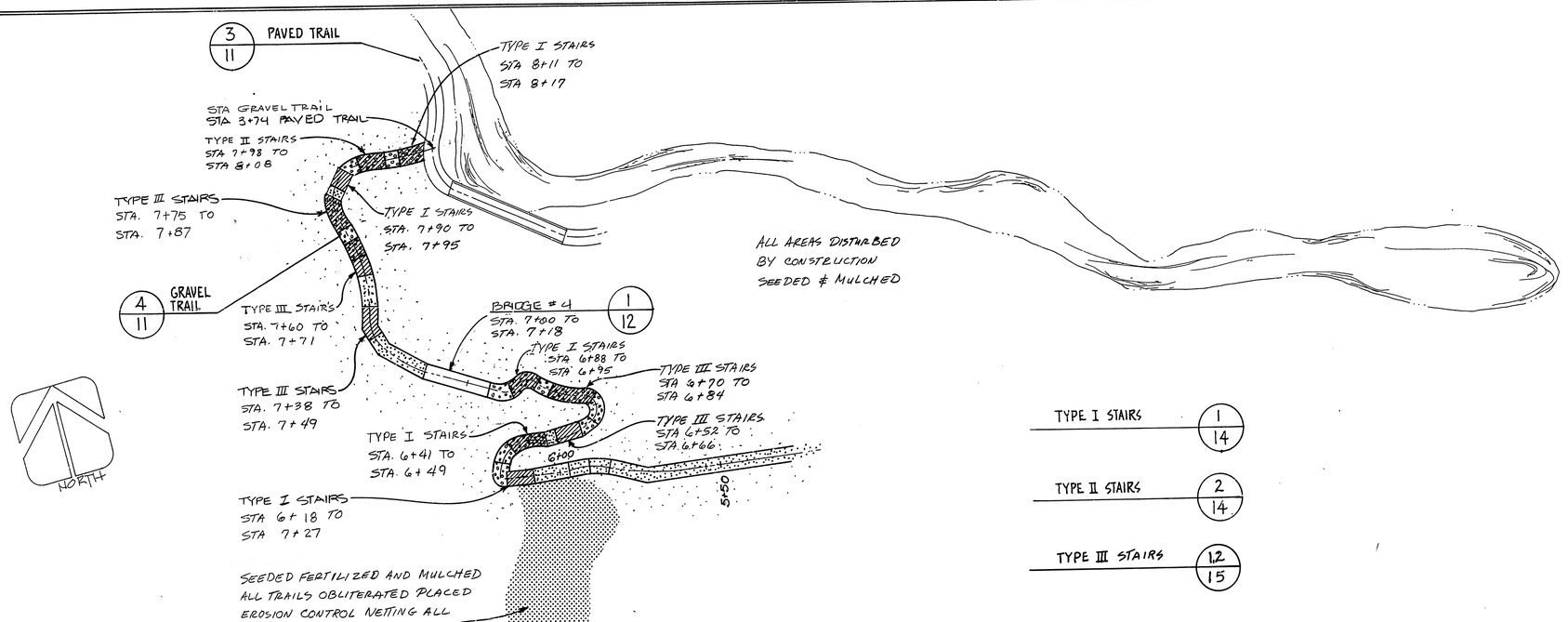
PROFILE GRAVEL TRAIL

PREPARED D WENK	DRAWING NO. 625 41,027 B
DESIGNED D. WENK	PCIP PKG. 108
DRAWN RONSCAVAGE	SHEET 9 OF 29
CHECKED 4/79 DATE	

PLAN

0 20 40

SCALE IN FEET



TYPE I STAIRS 1/14

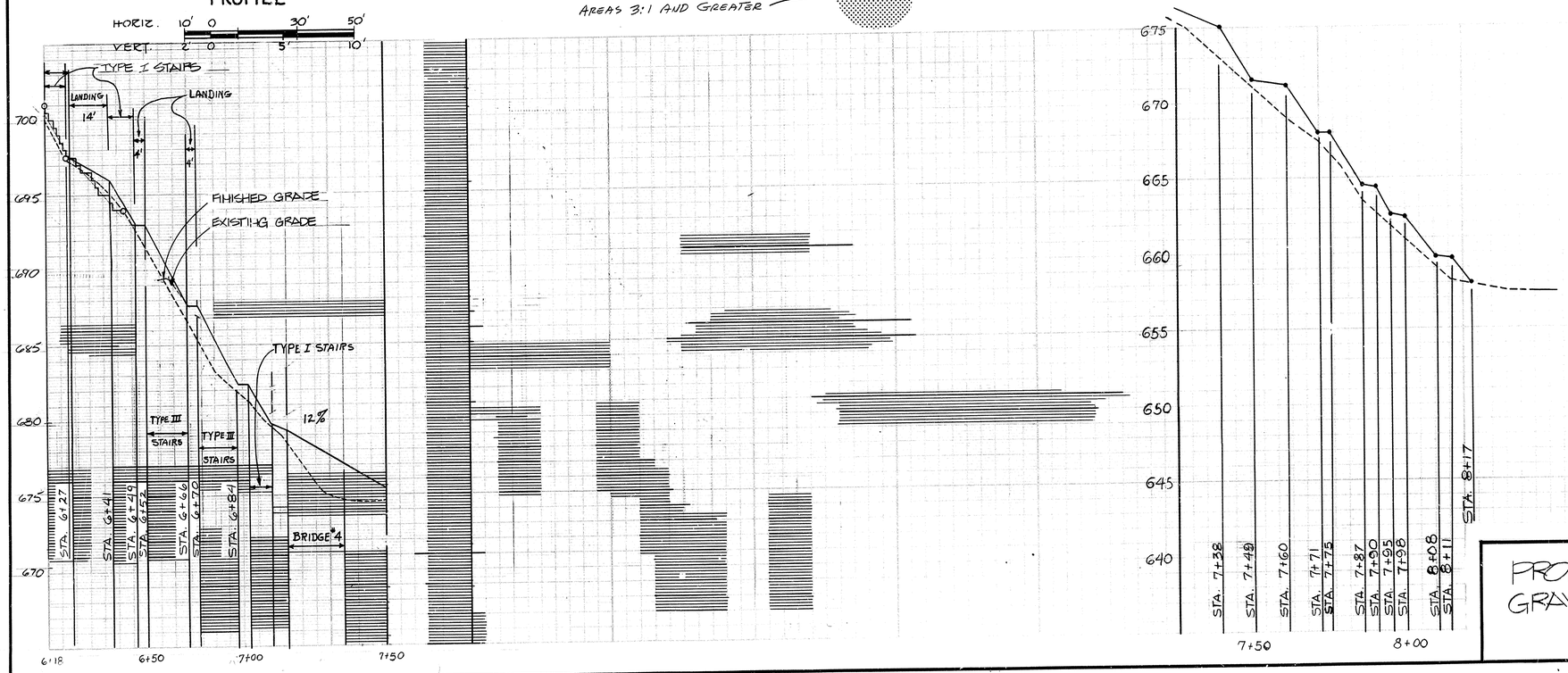
TYPE II STAIRS 2/14

TYPE III STAIRS 12/15

PROFILE

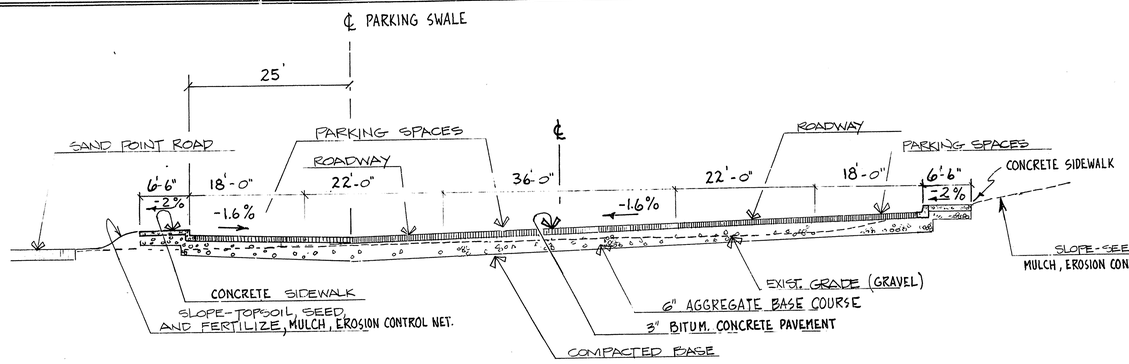
HORIZ. 10' 0 30' 50'

VERT. 2' 0 5' 10'

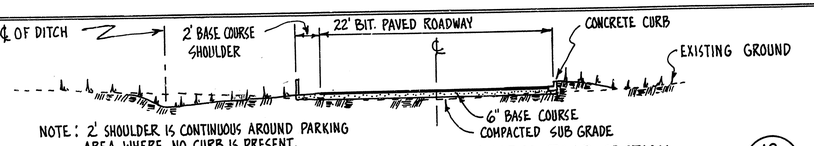


PROFILE GRAVEL TRAIL

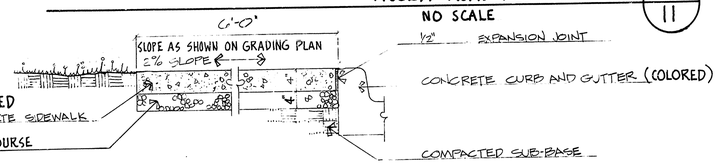
PREPARED	DRAWING NO.
D WENK	625 41.0278
DESIGNED D WENK	PCIP PKG. 128
DRAWN RONSCAVAGE	SHEET 10
CHECKED 4/79 DATE	OF 29



1/11 SECTION PARKING LOT
SCALE NONE

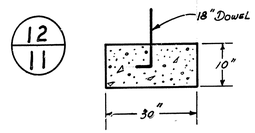


12/11 ACCESS ROAD SECTION
NO SCALE



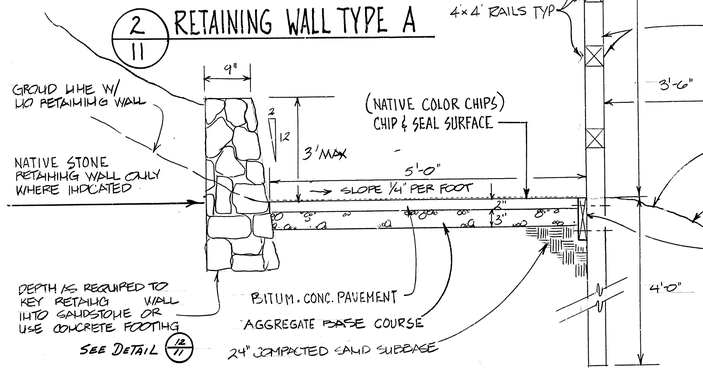
8/11 CONCRETE WALK & TERRACE
SCALE 1" = 1'-0"

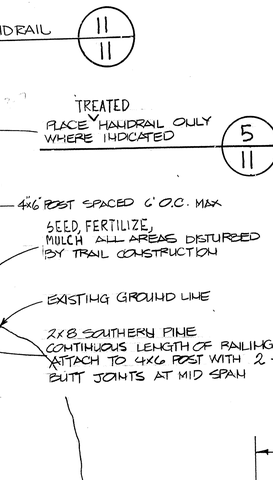
NOTE: ALL CONCRETE CURBS, WALKS & TERRACE SHALL BE INTEGRALLY COLORED. COLOR SHALL BE SIMILAR TO THAT OBTAINED BY ADDING 2 POUNDS OF CONRAD SOVIG NO. 17A03-2G PER SACK OF CEMENT.



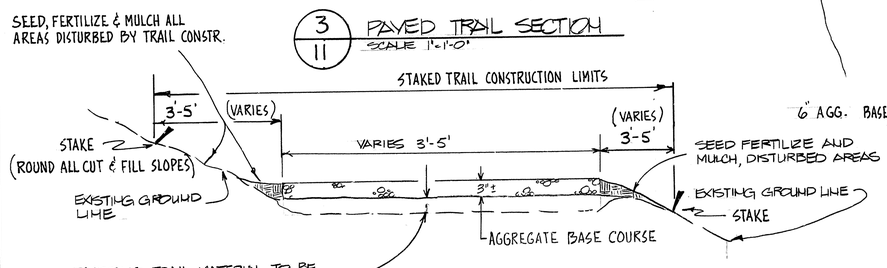
12/11

2/11 RETAINING WALL TYPE A



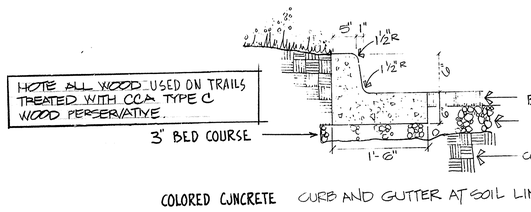


3/11 PAVED TRAIL SECTION
SCALE 1"-1'-0"

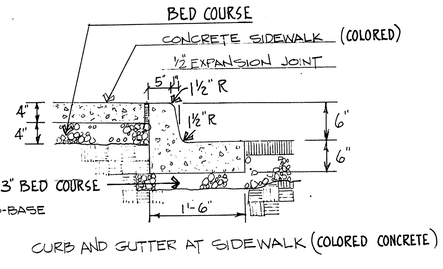


4/11 GRAVEL TRAIL
SCALE 1" = 1'-0"

NOTE:
WHERE NOT SHOWN ON DRAWINGS, THE LIMITS OF CONSTRUCTION SHALL BE CONFINED TO THE TRAIL PERIMETER AS STAKED IN FIELD BY CONTRACTING OFFICER. ANY WORK OUTSIDE STAKED LIMITS REQUIRES CONTRACTING OFFICER'S APPROVAL. ANY DAMAGE TO SLOPES AND VEGETATION BEYOND STAKED LIMITS SHALL BE RESTORED TO ORIGINAL CONDITION AT CONTRACTOR'S EXPENSE. MATERIAL STORAGE AREAS SHALL BE DETERMINED IN FIELD BY CONTRACTING OFFICER.

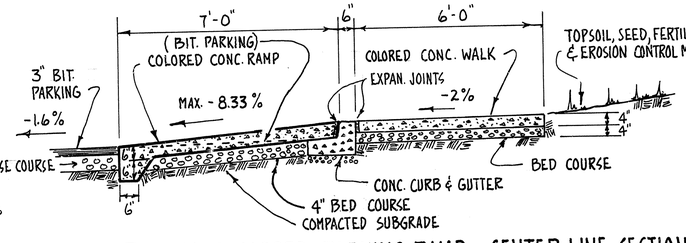


COLORED CONCRETE CURB AND GUTTER AT SOIL LINE

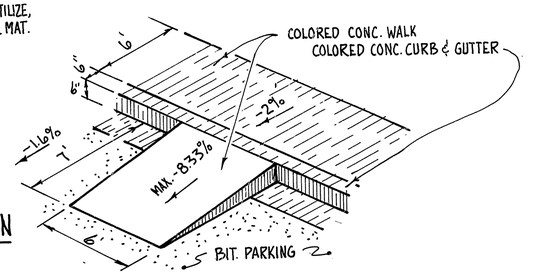


CURB AND GUTTER AT SIDEWALK (COLORED CONCRETE)

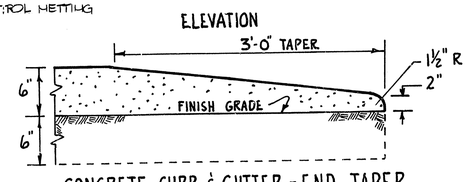
9/11 CURB AND GUTTER
SCALE 1"-1'-0"



6/11 HANDICAPPED PARKING RAMP - CENTER LINE SECTION



10/11 HANDICAPPED PARKING RAMP - PERSPECTIVE
NO SCALE

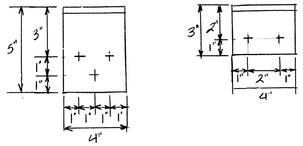


7/11 CONCRETE CURB & GUTTER - END TAPER

PARKING AREA DETAILS
TRAIL SURFACE DETAILS

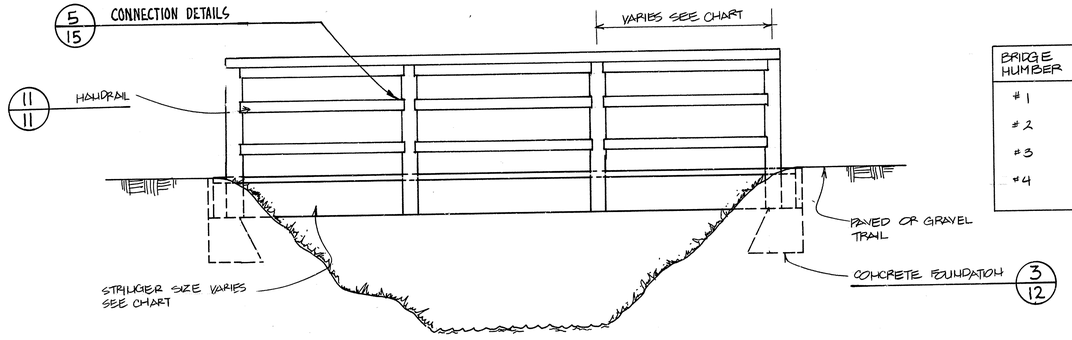
PREPARED	DRAWING NO.
BY ITLY WENK	625
DESIGNED D. WENK	41,027B
DRAWN RONSCAVAGE	PKG. NO. 628 / SHEET 11
CHECKED 4/79 DATE	OF 29

GPO 1974-678-710



6/12 ∠ 5"x3"x5/16"x0'-4"
SCALE 3"=1'-0"

5/15 CONNECTION DETAILS

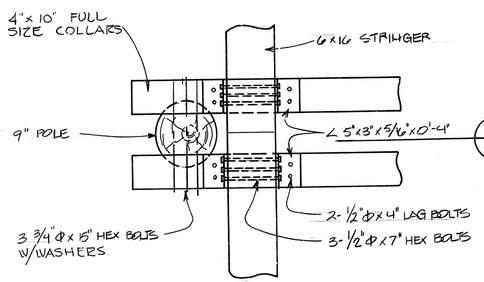


BRIDGE ELEVATION 2/12
SCALE 1/2"=1'-0"

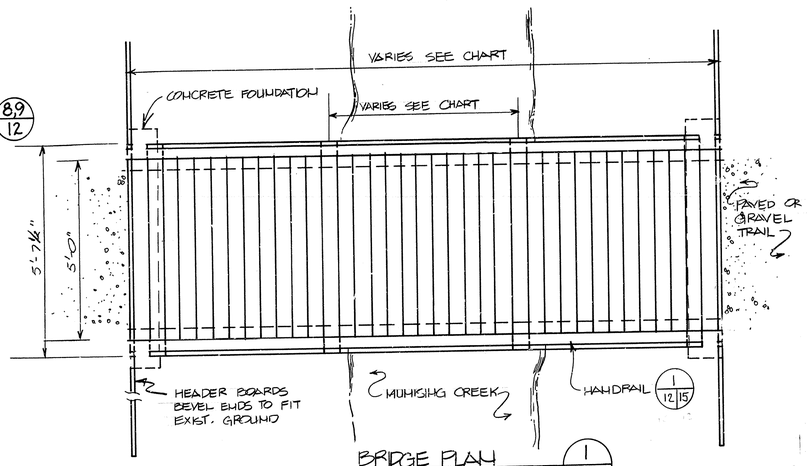
BRIDGE NUMBER	LENGTH	STRINGER SIZE	NUMBER OF VERTICAL POST	VERTICLE POST SPACING
#1	45'(2-22.5')	6x16	8 EA. SIDE	6'-5"
#2	29'	6x18	6 EA SIDE	5'-9½"
#3	23'	6x16	5 EA SIDE	5'-9"
#4	18.5'	4x14	4 EA. SIDE	6'-2"

BRIDGE SPAN CHART

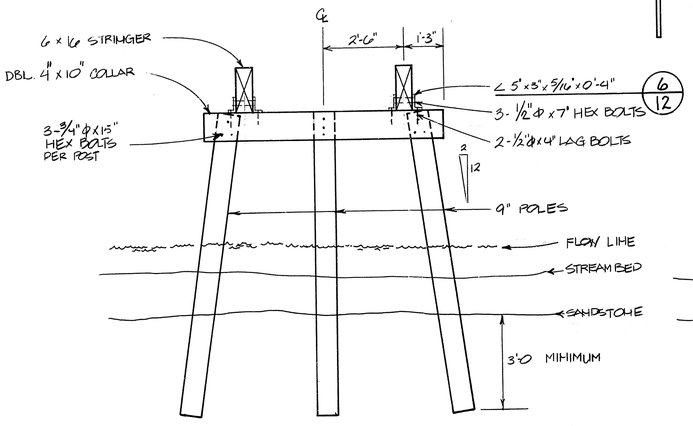
NOTE: ALL WOOD TO BE TREATED WITH CCA TYPE C WOOD PERSERVATIVE



7/12 BENT CONNECTION
SCALE 1½"=1'-0"

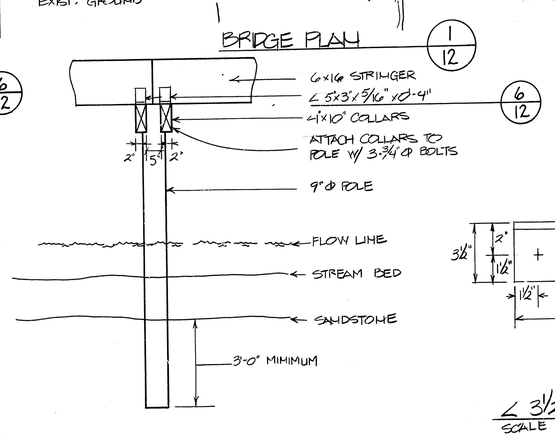


BRIDGE PLAN 1/12

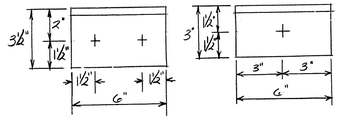


8/12 ELEVATION

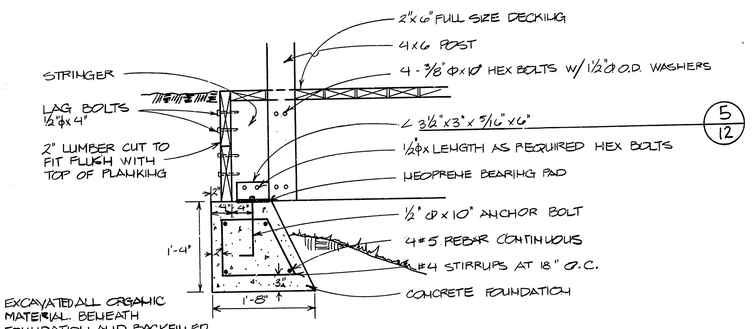
BRIDGE #1 ONLY
BRIDGE BENT DETAILS
SCALE ½"=1'-0"



9/12 ELEVATION

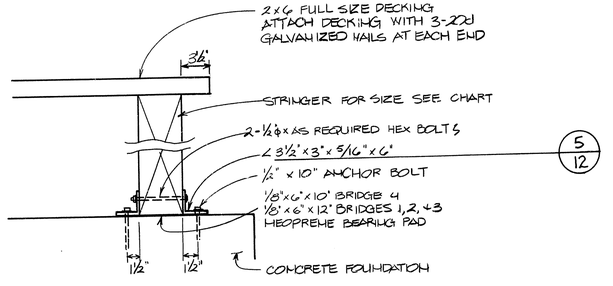


∠ 3½" x 3" x 5/16" x 6" 5/12
SCALE 3"=1'-0"



EXCAVATED ALL ORGANIC MATERIAL BENEATH FOUNDATION AND BACKFILLED WITH COMPACTED SELECT BACKFILL

FOUNDATION DETAIL 3/12
SCALE 1"=1'-0"



4/12 BRACKET DETAIL
SCALE 1½"=1'-0"

BRIDGE DETAILS

PREPARED	B. KELLER
DESIGNED	D. WENK
DRAWN	WHISSEN
CHECKED	4/79
DATE	
DRAWING NO.	625 41,027B
PCIP PKG. 108	
SHEET	12 OF 29

GPO: 1977 777-369

PREFERRED DIMENSIONS: H = W
CRITICAL DIMENSIONS:

$H_{MAX.} = 1\frac{1}{2} \times W$

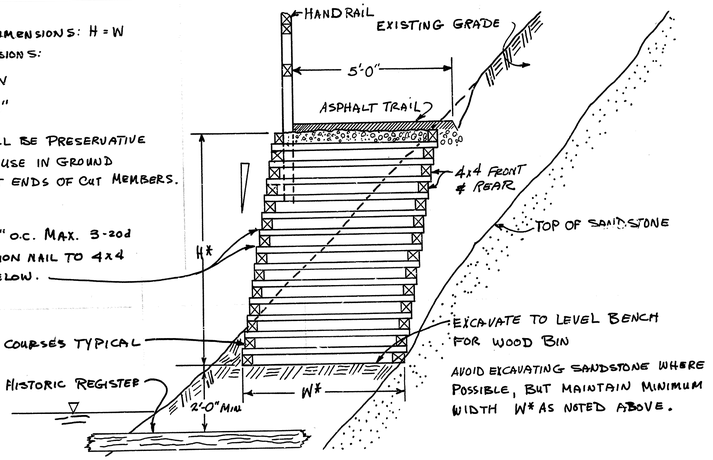
$H_{MAX.} = 10'-0"$

NOTE: ALL WOOD SHALL BE PRESERVATIVE TREATED FOR USE IN GROUND CONTACT. TREAT ENDS OF CUT MEMBERS.

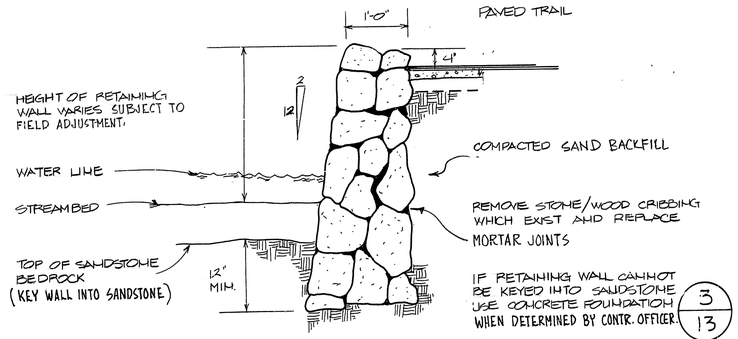
2x6's @ 4'-0" O.C. MAX. 3-20d NAILS/ CONNECTION NAIL TO 4x4 ABOVE AND BELOW.

BURY 2 COURSES TYPICAL

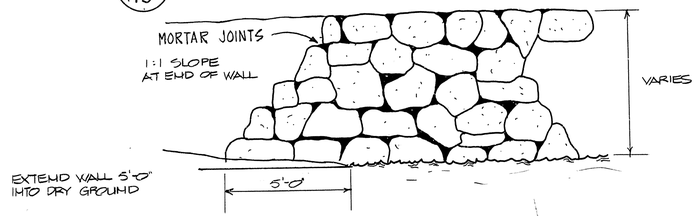
LOG ROAD ON HISTORIC REGISTER



RETAINING WALL TYPE C

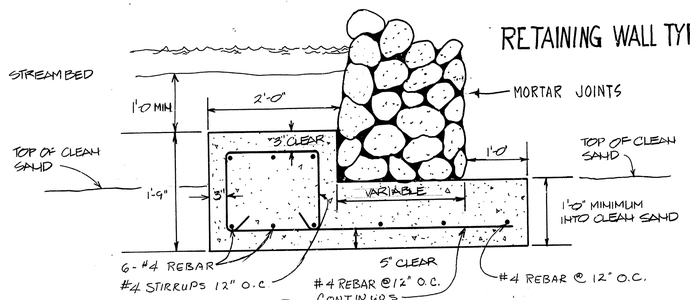


4/13 SECTION
SCALE 1"=1'-0"



5/13 STONE RETAINING WALL ELEVATION
SCALE ½"=1'-0"

RETAINING WALL TYPE B

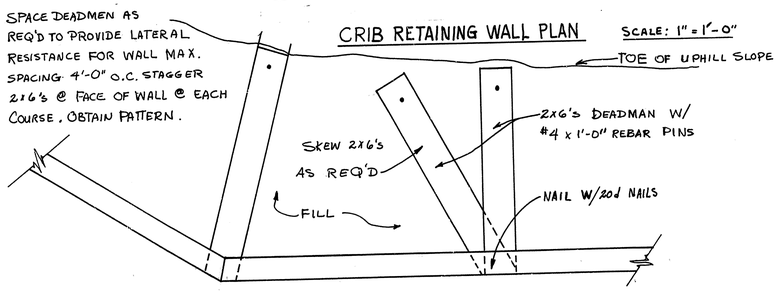


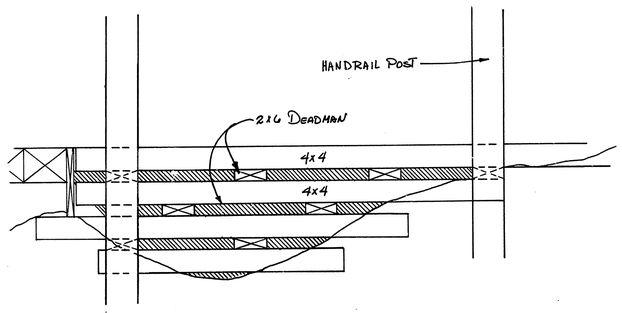
3/13 CONCRETE FOUNDATION
SCALE: 1"=1'-0"

NOTE ALL WOOD TO BE TREATED WITH CCA TYPE C WOOD PERSERVATIVE

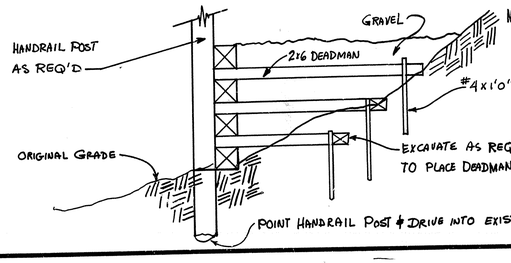
SPACE DEADMEN AS REQ'D TO PROVIDE LATERAL RESISTANCE FOR WALL MAX. SPACING 4'-0" O.C. STAGGER 2x6's @ FACE OF WALL @ EACH COURSE. OBTAIN PATTERN.

CRIB RETAINING WALL PLAN SCALE: 1"=1'-0"





7/13 STONE RETAINING WALL ELEVATION
SCALE: 1" = 1'-0"

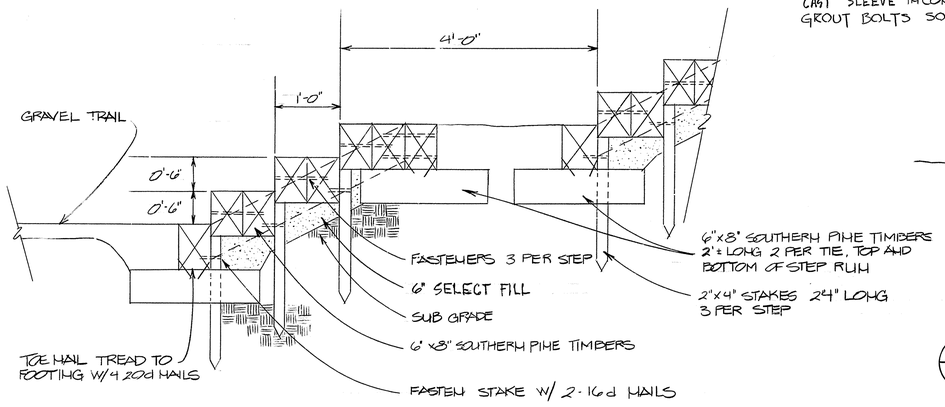


CRIB WALL SECTION 6/13

STONE RETAINING WALL
WOODBIN WALL
CRIB WALL

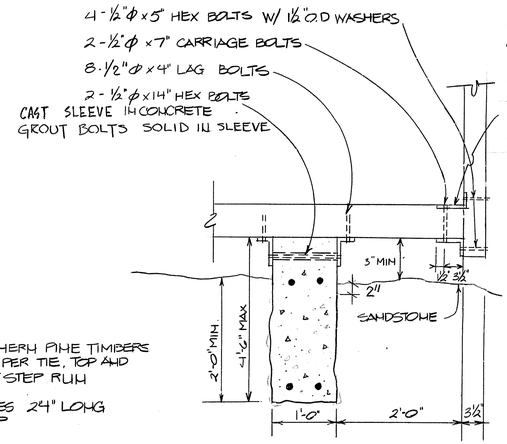
PREPARED	DRAWING NO.
B. KELLER	6275
DESIGNED	41,027.B
J. WENIK	PCIP PKG 102
DRAWN	SHEET
WHISSEN	13
CHECKED	OF 29
4/79 DATE	

☆ GPO: 1977 777-369

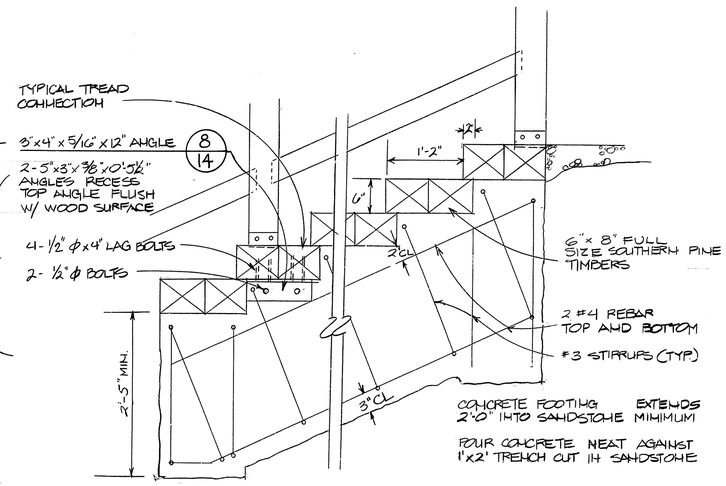


5/14 SECTION THRU STEPS

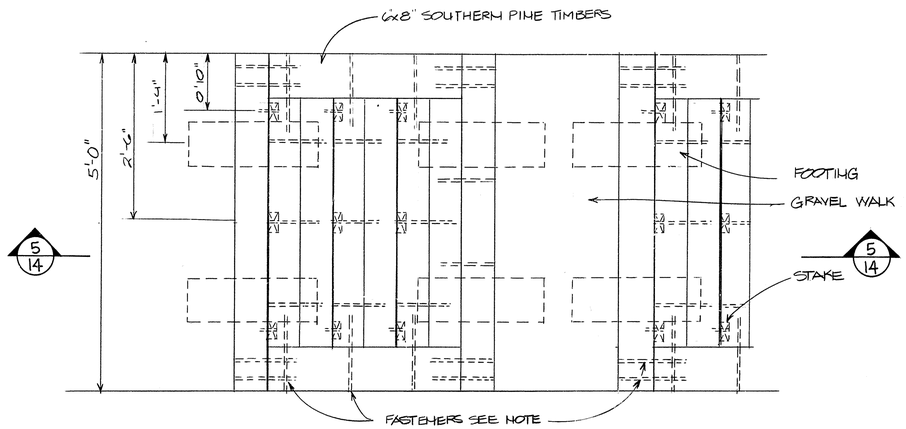
HOTE: ALL WOOD TREATED WITH CCA TYPE C WOOD PRESERVATIVE



7/14 SECTION

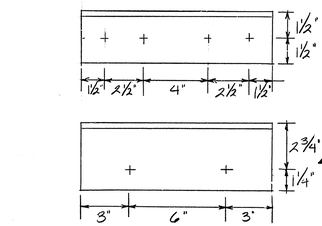


TREAD SECTION 6/14

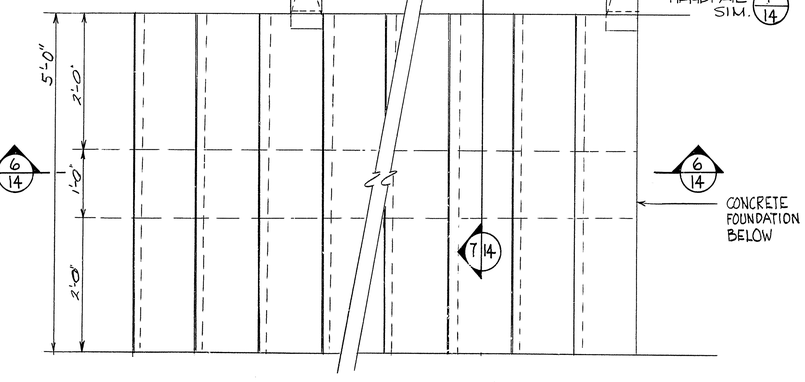


3/14 PLAN OF TIMBER STEPS

NOTE: FASTENERS ARE REINFORCING ROD OR ½" LAG BOLTS. WERE LEFT FLUSH WITH SURFACE



8/14 3"x4"x5/16"x12" ANGLE



4/14 PLAN

2/14 TYPE II TIMBER STAIRS
SCALE 1"=1'-0"

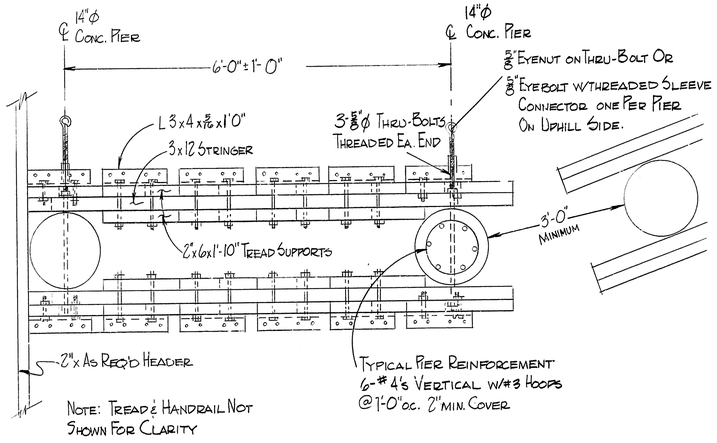
1/14 TYPE I TIMBER STAIRS
SCALE 1"=1'-0"

STAIR DETAILS

PREPARED	DRAWING NO.
B. KELLER	625
DESIGNED	41,0273
P. WENK	PCTB PKG. 626
DRAWN	SHEET
WHISSEN	14
CHECKED	OF 29
4/79	
DATE	

☆ GPO: 1977 777-393

K&E 10 1333 11-60 MC1747a



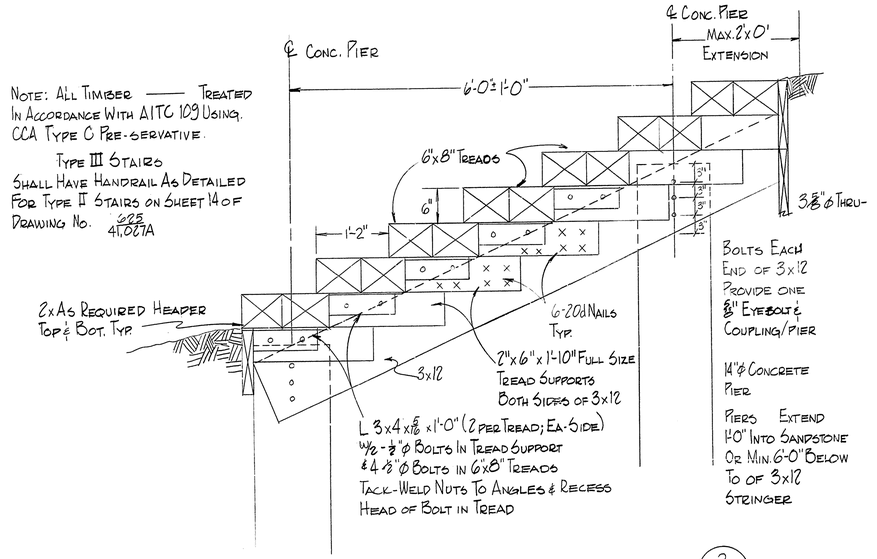
1/15

Plan Type III Stairs

Scale 1"=1' 0"

Note: All Timber —— Treated In Accordance With AITC 109 Using. CCA Type C Pre-servative.

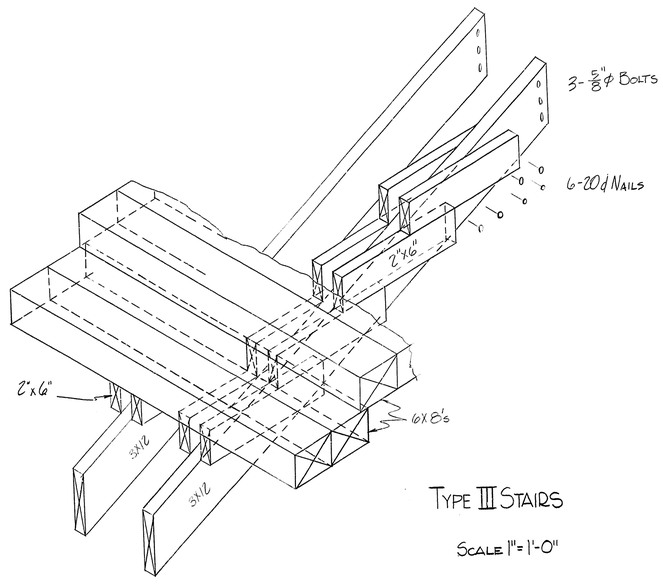
Type III Stairs Shall Have Handrail As Detailed For Type II Stairs on Sheet 14 of Drawing No. 625 41.027A



2/15

Elevation Type III Stairs

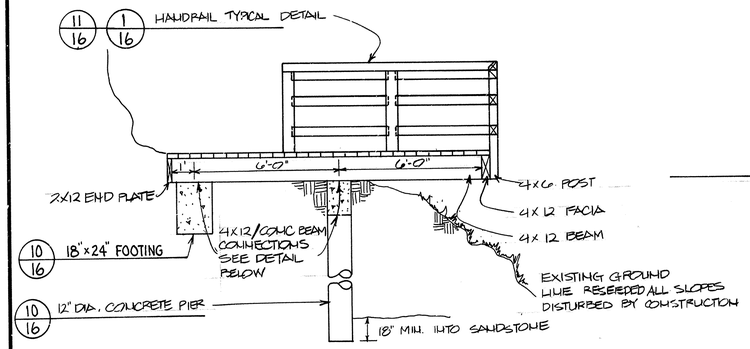
Scale 1"=1'-0"



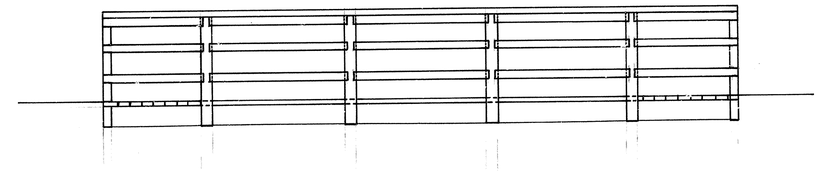
Type III Stairs

Scale 1"=1'-0"

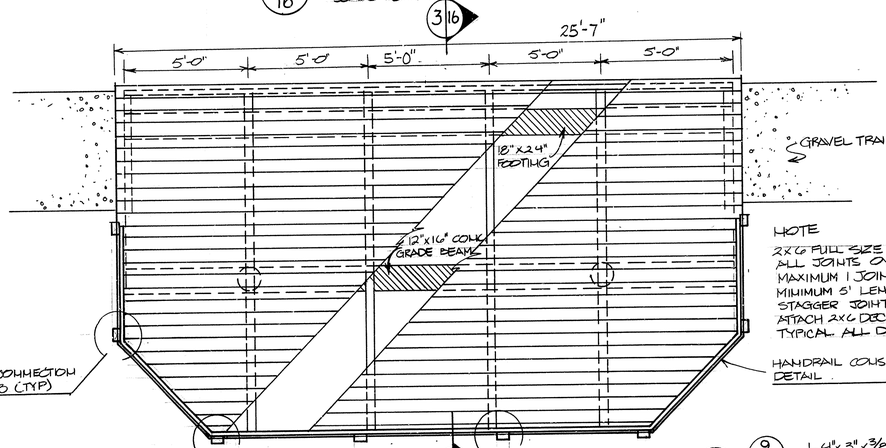
DESIGNED:	SUB SHEET NO.	TITLE OF SHEET	DRAWING NO.	
DRAWN:		Type III Stairs	625 41.027B	
TECH. REVIEW:			PKG. NO.	SHEET 15
DATE: /				OF 29



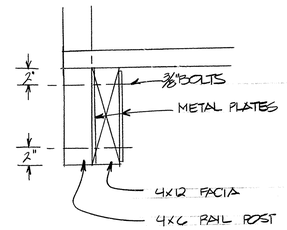
3/16 SECTION
SCALE 3/8"=1'-0"



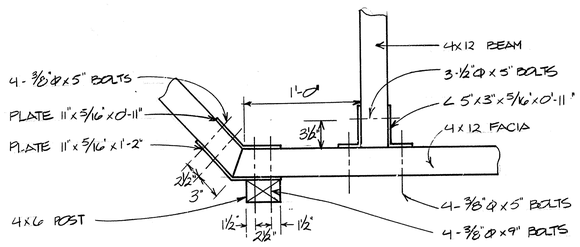
2/16 ELEVATION
SCALE 3/8"=1'-0"



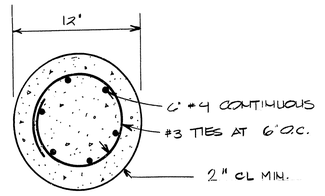
NOTE ALL WOOD TREATED WITH CCA TYPE C WOOD PRESERVATIVE



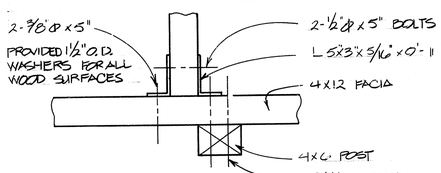
11/16 TYPICAL RAIL POST CONNECTION
SCALE 1½"=1'-0"



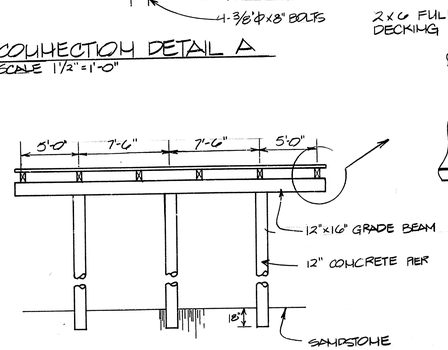
4/16 CONNECTION DETAIL C
SCALE 1½"=1'-0"



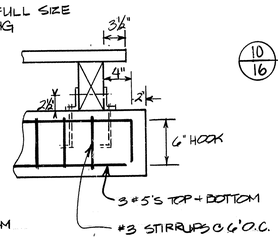
NOTE
2X6 FULL SIZE DECKING
ALL JOINTS OVER SUPPORTS
MAXIMUM 1 JOINT PER LENGTH OF DECK
MINIMUM 5' LENGTH FOR DECKING
STAGGER JOINTS RANDOM PATTERN
ATTACH 2X6 DECKING W/ 3-20d GALV. NAILS
TYPICAL ALL DECKS

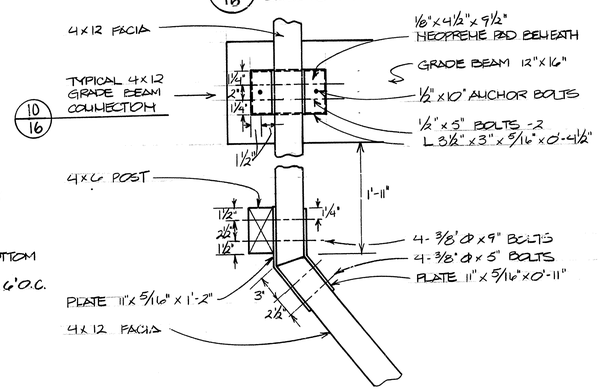


6/16 CONNECTION DETAIL A
SCALE 1½"=1'-0"

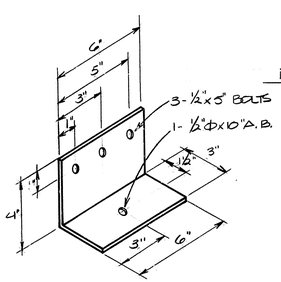


7/16 PIER LOCATION
SCALE 3/16"=1'-0"

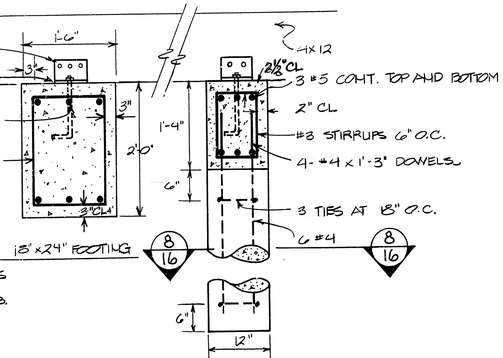




5/16 CONNECTION DETAIL B
SCALE 1½"=1'-0"



4"x3"x⅜"x0'-6" ANGLE 9/16



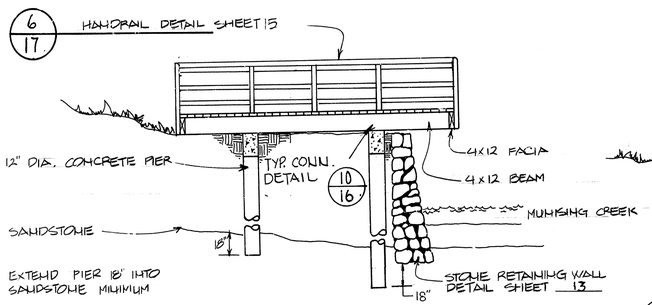
PIER SECTION C-C' 8/16

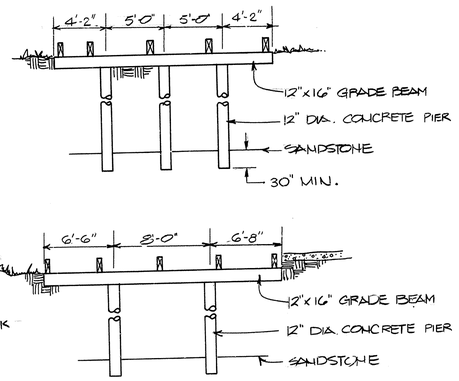
GRADE BEAM AND PIER 10/16
SCALE 1"=1'-0"

OVERLOOKS

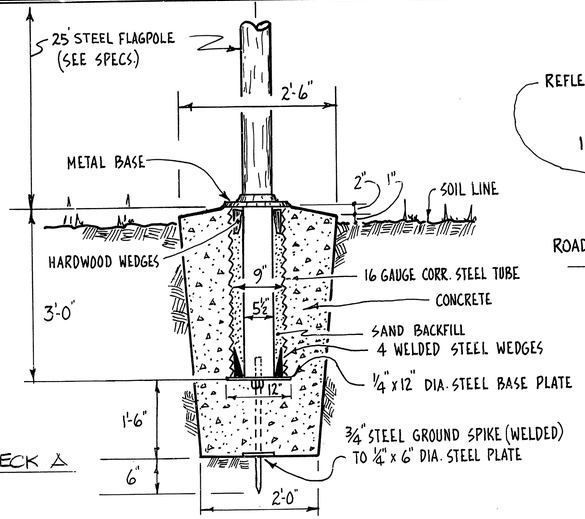
PREPARED	DRAWING NO.
B. KELLER DESIGNED	625 41,027B
D. WENK DRAWN	PCIP PKG. 108
WHISSEN CHECKED	SHEET 16
4/79 DATE	OF 29

☆ GPO: 1977 777-359

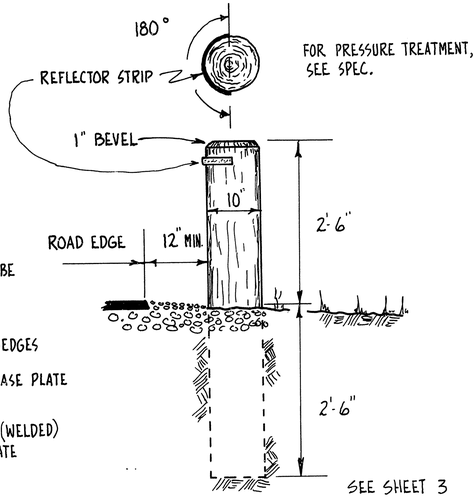




10/17 PIER LOCATIONS OBSERVATION DECK A
SCALE 1/4" = 1'-0"



2/17 FLAGPOLE BASE - DETAIL SEE SHEET 3



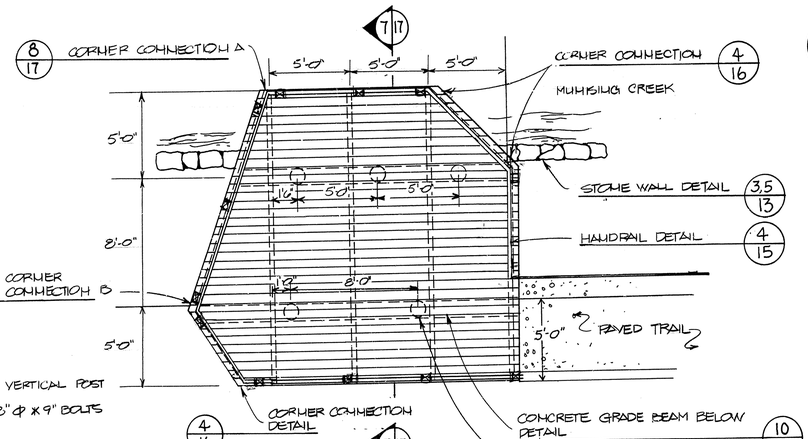
SEE SHEET 3

1/17 BARRIER POST - DETAIL

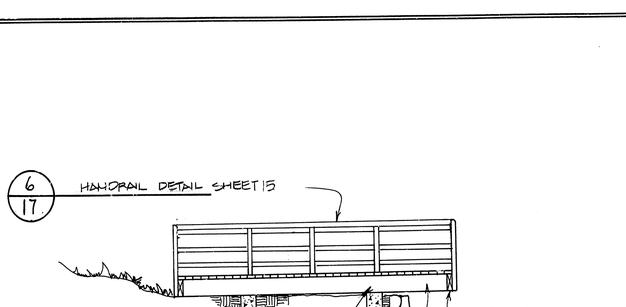
7/17 SECTION
SCALE ¼" = 1'-0"

NOTE: WOOD TO BE TREATED WITH CCA TYPE C WOOD PRESERVATIVE

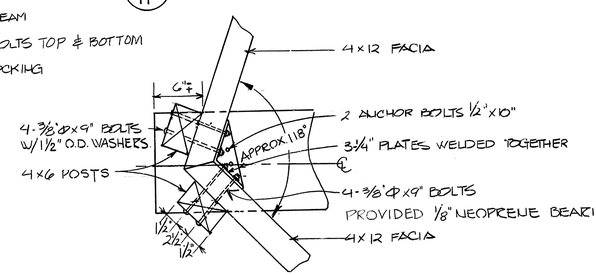
NOTE:
FOR TYPICAL DECK CONNECTION DETAILS, SEE SHT. 16



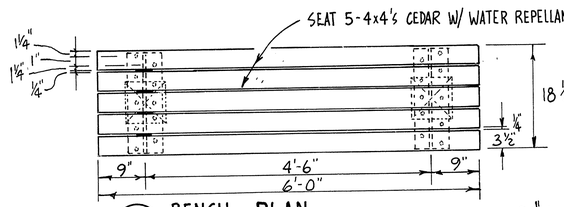
6/17 OBSERVATION DECK A
SCALE ¼" = 1'-0"



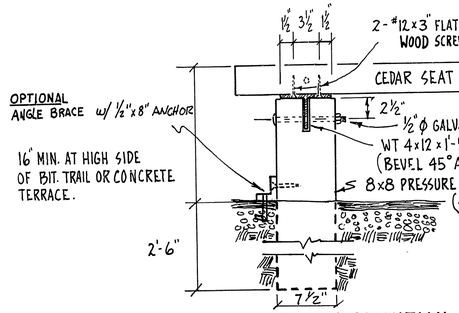
8/17 CORNER CONNECTION A
SCALE 1½" = 1'-0"



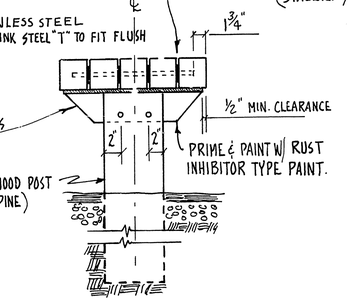
9/17 CORNER CONNECTION B
SCALE 1½" = 1'-0"



3/17 BENCH - PLAN



4/17 BENCH - FRONT ELEVATION

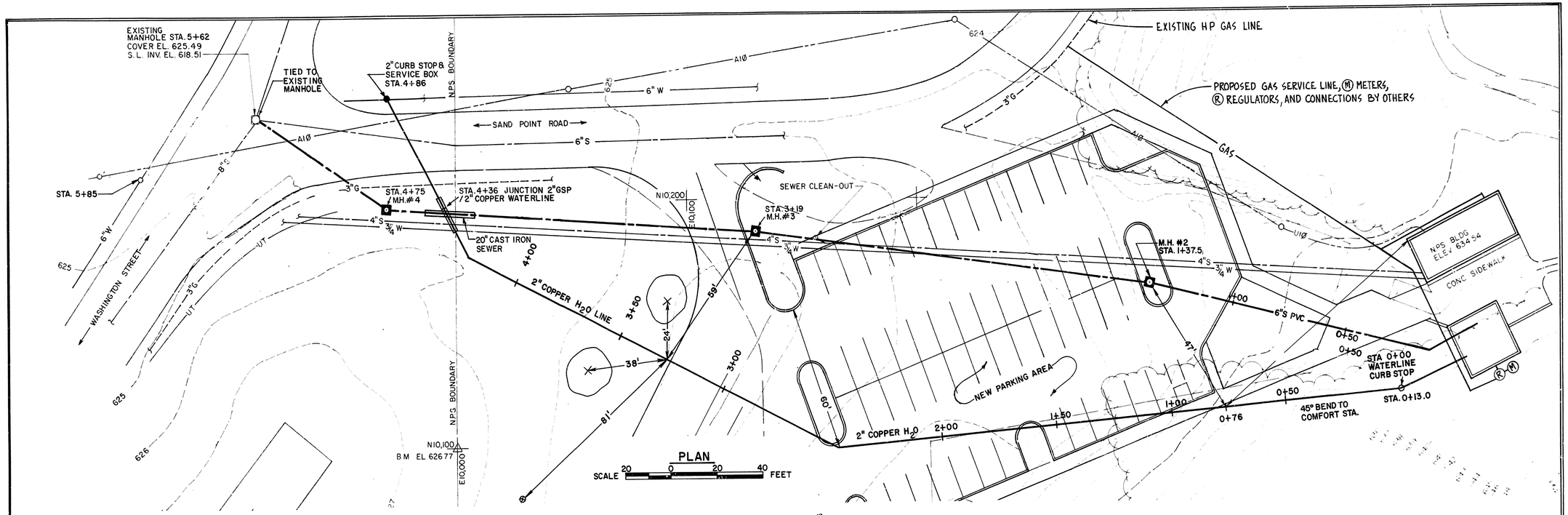


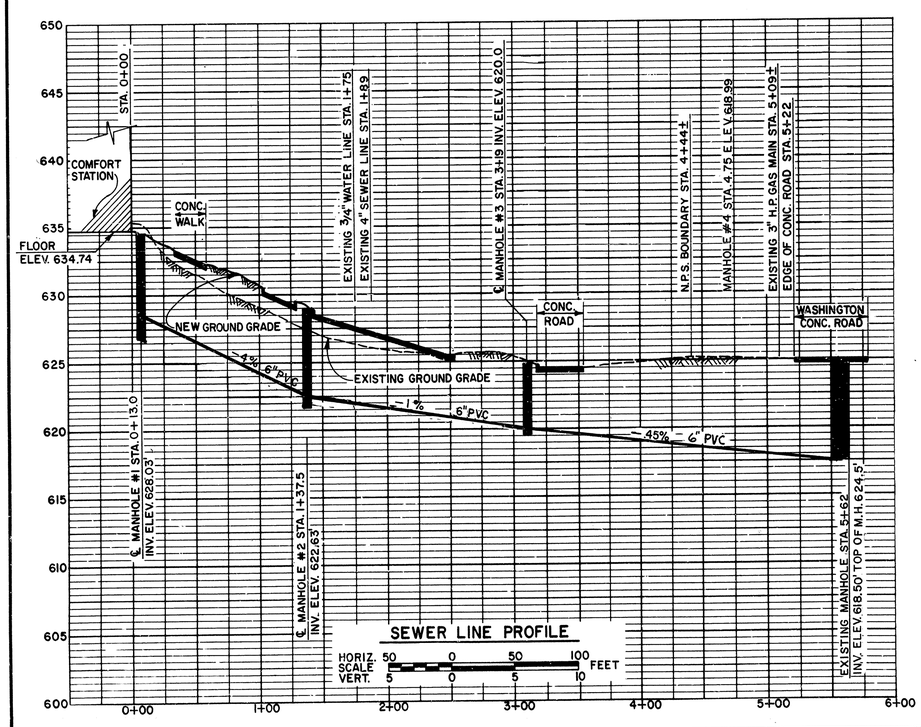
BENCH - END ELEVATION 5/17

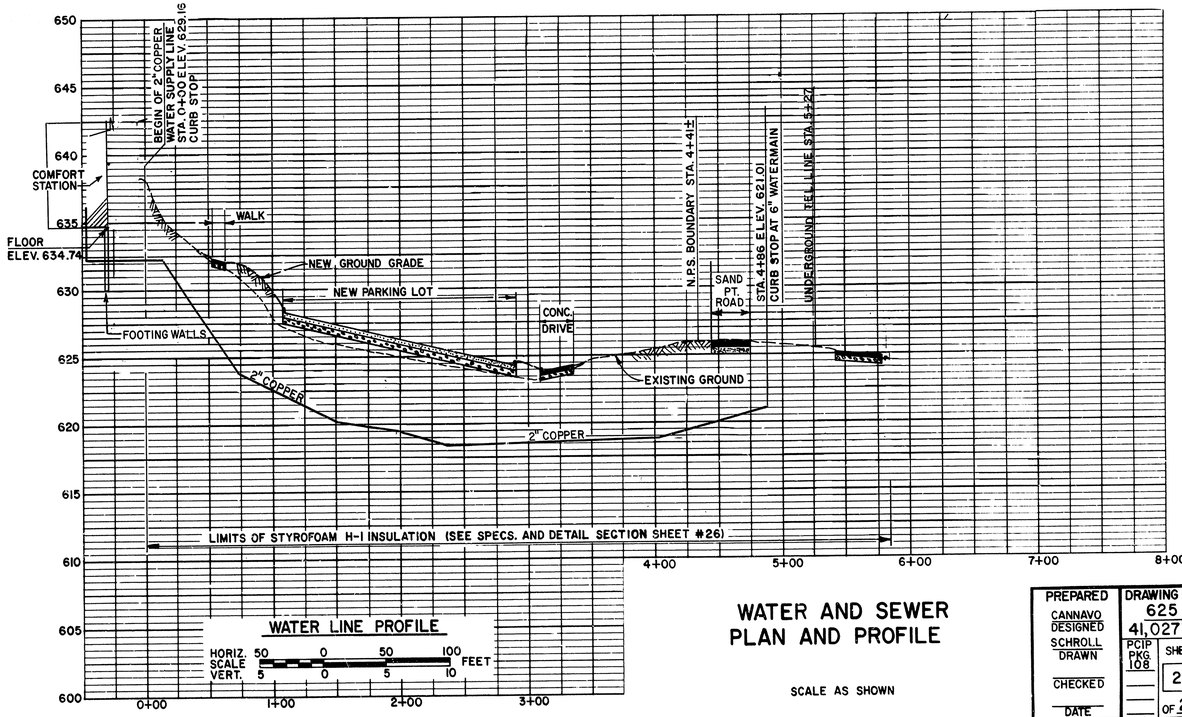
OBSERVATION DECK

PREPARED	DRAWING NO.
B KELLER	625
DESIGNED	41,027 B
D. WENK	PCIB PKG. 122
DRAWN WHIGGEN	SHEET 17
CHECKED	OF 29
4/79 DATE	

☆ GPO: 1977 777-369





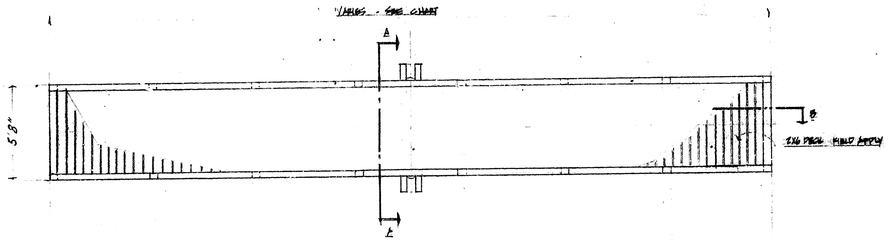


WATER AND SEWER PLAN AND PROFILE

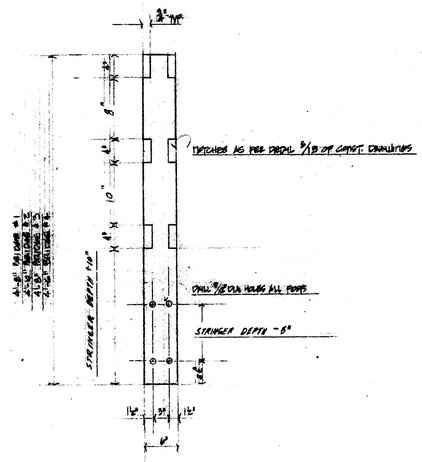
SCALE AS SHOWN

PREPARED	DRAWING NO.
CANNAVO	625
DESIGNED	41,027B
SCHROLL	PCIP PKG. 108
DRAWN	SHEET 25
CHECKED	OF 29
DATE	

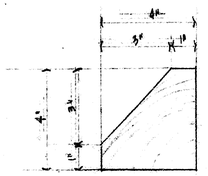
BRIDGES – BILL OF MATERIAL									
BRIDGE NO.	LENGTH	STRINGER SIZE	INTERMED. POSTS	END POSTS	POST SPACING	NO. RAILS - LG.	POST HTS.	DECK LG.	REMARKS
#1	45'-0" TWO - 28'-6"	6"x16"	12 PC.	4 PC.	6'-5"		4'-8"	5'-8"	
#2	29'-0"	6"x18"	8 PC.	4 PC.	5'-9½"		4'-10"	5'-8"	
#3	23'-0"	6"x16"	6 PC.	4 PC.	5'-9"		4'-8"	5'-8"	
#4	18'-6"	4"x14"	4 PC.	4 PC.	6'-2"		4'-6"	5'-8"	



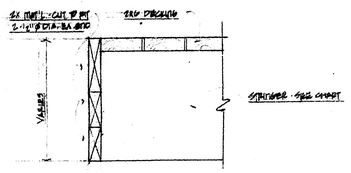
PLAN
SCALE 1/4" = 1'-0"



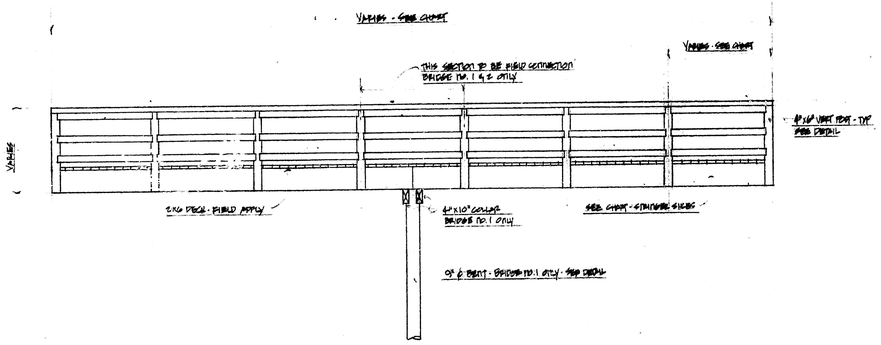
DETAIL - RAILING POSTS
SCALE 1" = 1'-0"



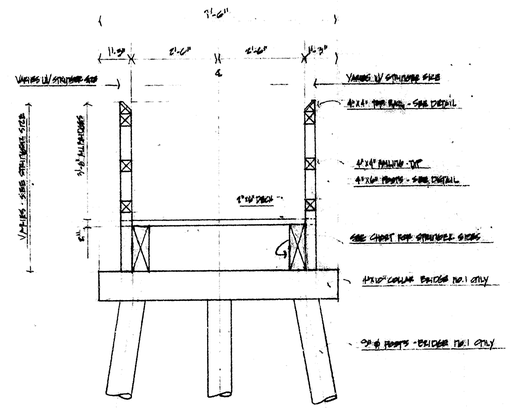
DETAIL - TOP RAIL
N.T.S.



SECTION B
N.T.S.



ELEVATION
SCALE 1/4" = 1'-0"



SECTION A-A
SCALE 1/2" = 1'-0"

NATIONAL PARK SERVICE
APPROVAL OF THIS SUBMITTAL IS SUBJECT TO THE PROVISIONS OF THE CONTRACT DRAWINGS AND SPECIFICATIONS. THIS ACTION IS FOR GENERAL CONCURRENCE ONLY AND THE GOVERNMENT IS NOT RESPONSIBLE FOR ERRORS OR OMISSIONS.
APPROVED
APPROVED WITH NOTATIONS INDICATED
NOT APPROVED
APPROVED WITH NOTATIONS INDICATED
NOT APPROVED, RESUBMIT
Chief Office of Architecture and Rec. Date
G. Bruce Kowalski 3/26/80
Chief Resident Engineer Date

IMPROVEMENTS - PICTURED ROCKS - BRIDGE DETAILS

SCALE: AS SHOWN	APPROVED BY:	DRAWN BY: WBM
DATE: OCT 9, 1979		REVISED

LAKE STATES CONSTRUCTION, INC.
MARQUETTE, MICH.

CONTRACT NO. CX-6000-9-9004 | DRAWING NUMBER: [illegible]

625/41027B