SECTION 26 05 00
COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

A. The Electrical drawings do not attempt to show complete details of building construction which affects the electrical installation. The Contractor shall refer to the complete set of project drawings and specifications for additional details, which affect the proper installation of this work.

B. The mention of any article, operation, or method requires that the Contractor shall provide same and perform each operation, in complete accordance with the conditions stated. The Contractor shall provide all material, labor, equipment and transportation as necessary to complete the project in compliance with the Contract Documents. In general, this work includes everything essential for a complete electrical system in operating order as shown on the drawings and as specified.

C. All work shall be installed in accordance with all State and Local Inspection Authorities having jurisdiction together with the recommendations of the manufacturer whose equipment is to be supplied and installed under this Contract. The omission of expressed reference to any item of labor or material necessary for the proper execution of the work in accordance with the present practices of the trade shall not relieve the Contractor from providing such additional labor and materials.

D. Before submitting his bid, each bidder shall examine the drawings relating to his work and shall become fully informed as to the extent and character of the work required and its relation to other work in the building.

E. The Contractor, in conjunction with the Architect, shall establish exact locations of all materials and equipment to be installed. Consideration shall be given to construction features, equipment of other trades and requirements of the equipment proper.

F. All materials shall be suitably stored and protected prior to installation and all work shall be protected after installation, during construction and prior to acceptance.

G. The Contractor shall furnish all scaffolding, rigging, hoisting and services necessary for delivery, erection and installation of all equipment and apparatus required to be installed by the Contractor. All such equipment shall be removed by the Contractor upon completion of the project.

1.2 PERMITS AND LICENSES

A. The Contractor shall prepare and submit all applications and working drawings, as required, to authorities having jurisdiction over the project. All licenses and permits required shall be secured and paid for by the Contractor. The Contractor shall submit a copy of all permits secured to the Owner.

B. Provide the Owner with a written certificate that all parts of the electrical system have been inspected and final approval has been obtained from the appropriate authority having jurisdiction.

C. Provide a copy of the electrical permit to the Owner representative prior to proceeding with any work.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. FMC: Flexible metal conduit.

C. IMC: Intermediate metal conduit.

D. LFMC: Liquidtight flexible metal conduit.

E. RNC: Rigid nonmetallic conduit.

F. Provide: Furnish, install and wire complete and ready for service.

G. Exposed: Exposed to view in any room, corridor or stairway.

H. This Contractor: The Electrical Contractor, also referred to as "The Contractor".

I. Code: National, State and Local Electrical codes including OSHA requirements.

J. The Owner: The individual who the Owner selects as his project representative.

K. Equivalent: Manufacturers or methods listed by name in the specifications, on the drawings or in an addendum are considered to be equivalent subject to Engineer review.

L. Substitution: Any manufacturer or method other than those listed by name in these specifications, on the drawings, or in an addendum.

1.4 SUBMITTALS

A. Submit to Engineer for review, the manufacturer's shop drawings and/or equipment brochures in quantities determined by the Architect for the following:
   1. Electrical Enclosure and Accessories.
   2. Panelboard.
   3. Electrical Handholes.

B. Shop drawings shall be submitted in advance of construction and installation so as to not cause delay in other Contractor's work and to allow for Engineer’s review.

C. All data submitted for Engineer's review shall be numbered consecutively, shall be noted to correlate with the electrical drawings, and shall bear:
   1. The name and location of the project.
   2. The name of the Contractor.
   3. The date of submittal.
   4. The date of the drawings and the date of each correction and revision

5. If more than one type of lighting fixture (or other material) is on a submitted sheet, the proposed equipment shall be conspicuously checked with red pen by the Electrical Contractor.
6. Failure to do this may result in the submittal(s) being returned to the Contractor for correction and re-submission.
7. Failing to follow these instructions does not relieve the Contractor from the requirement of meeting the project schedule.

D. The Contractor shall examine, stamp and sign shop drawings and equipment brochures prior to submission. The Contractor shall verify that the materials and equipment depicted will properly fit into the construction. The Contractor shall also review all previously completed work related to the installation of the equipment depicted to insure that it has been properly installed.

E. No materials or equipment subject to prior review by the Engineer shall be fabricated or installed by the Contractor. The Engineer's review of shop drawings shall not relieve the Contractor of responsibility for deviations from the requirements of the drawings and specifications, unless prior approval for such deviations has been granted.

F. Submit additional materials at the request of the Engineer.

G. Shop drawings shall bear the Contractor's stamp indicating approval or approved as noted.

H. Any equipment fabrication prior to shop drawing review shall be at the Contractor's risk.

1.5 MAINTENANCE MANUALS

A. The Contractor shall assemble and submit to the Architect for subsequent submission to the Owner, three complete sets of a Manual of Operation and Maintenance for the electrical system.

B. Each manual shall consist of a loose leaf bound volume instructing the Owner's personnel in the use, operation and maintenance of the system in question. The manual shall cover all phases of operation and maintenance of the equipment. Manuals shall accurately describe the operation, construction and adjustable features of the complete system and it's component parts.

C. Assemble material in three-ring or post binders, using an index at the front of each volume and tabs for each system or type of equipment. In addition to the data indicated in the General Requirements, include the following information:
1. Copies of all reviewed submittals bearing Contractor’s stamp indicating approval or approved as noted.
2. Manufacturer’s wiring diagrams for electrically powered equipment.
3. Records of tests performed to certify compliance with system requirements.
4. Certificates of inspection by regulatory agencies.
5. Parts lists for manufactured equipment.
6. Preventive maintenance recommendations.
7. Warranties.
8. Additional information as indicated in the technical specification sections.

1.6 QUALITY ASSURANCE

A. Substitution of Materials: Refer to Division 01, General Conditions of the Contract, and SUBSTITUTION AND APPROVAL OF MATERIAL, EQUIPMENT OR DESIGN.

B. Where equipment or accessories are used which differ in arrangement, configuration, dimensions, ratings, or engineering parameters from those indicated on the contract documents, the Contractor is responsible for all costs involved in integrating the equipment or accessories into the system and the assigned space and for obtaining the performance from the system into which these items are placed.

C. Manufacturer references used herein are intended to establish a level of quality and performance requirements unless more explicit restrictions are stated to apply

D. All work and material shall conform with the National Electrical Code (ANSI/NFPA 70).

E. All materials shall be listed by and shall bear the label of an approved electrical testing laboratory. If none of the approved electrical testing laboratories has published standards for a particular item, then other national independent testing standards, if available, applicable, and approved by the Architect/Engineer, shall apply and such items shall bear those labels. Where one of the approved electrical testing laboratories has an applicable system listing and label, the entire system shall be so labeled.

1.7 COORDINATION

A. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work.

B. The Contractor shall verify that all devices are compatible for the surfaces on which they will be used.

C. Coordinate all work with other contractors/subcontractors prior to installation. Any installed work that is not coordinated and that interferes with other contractor's work shall be removed or relocated at the installing contractor's expense.

D. Coordinate electrical service connections to components furnished by utility companies.
   1. Coordinate installation and connection of exterior underground utilities and services, including provision for electricity-metering components.
   2. Comply with requirements of authorities having jurisdiction and of utility company providing electrical power and other services.

E. Coordination Meetings: Attend coordination meetings for the purpose of coordinating the locations of all electrical work for the entire project. The goal of these meetings is to avoid conflicts between trades in the field.

F. Conflicts Between Trades: Resolve all conflicts with trades at no additional cost to the Owner or Architect/Engineer.

1.8 INTENT OF DRAWINGS AND SPECIFICATIONS

A. These specifications and attendant drawings are intended to cover a complete installation of systems. The omission of expressed reference to any item of labor or material necessary for the proper execution of the work in accordance with present practices of the trade shall not relieve the Contractor from providing such additional labor and materials. No later than ten

(10) days before bid opening, the Contractor shall call the attention of the Architect/Engineer in writing to any materials or apparatus the Contractor believes to be inadequate and to any necessary items of work omitted. If in the opinion of the Contractor there are omissions or errors in the plans or specifications, the Contractor shall clarify these points in writing with the Architect/Engineer before submitting his bid. In lieu of written clarification by addendum, resolve all conflicts in favor of the greater quantity or better quality.

B. The Contractor shall furnish and install all the necessary materials, apparatus, and devices to complete the electrical equipment and systems installation herein specified, except such parts as are specifically exempted herein.

C. If an item is either called for in the specifications or shown on the plans, it shall be considered sufficient for the inclusion of said item in this contract. If a conflict exists within the Specifications or exists within the Drawings, the Contractor shall furnish the item, system, or workmanship, which is the highest quality, largest, or most closely fits the Architect/Engineer's intent (as determined by the Engineer). Refer to the General Conditions of the Contract for further clarification.

D. It must be understood that the details and drawings are diagrammatic. The Contractor shall verify all dimensions at the site with the Owner's representative and be responsible for their accuracy. Where appropriate the location shall be established in accordance with the manufacturer's installation drawings and details subject to the Architect's review.

E. All sizes as given are minimum except as noted.

F. Materials and labor shall be new (unless noted or stated otherwise), first class, and workmanlike, and shall be subject at all times to the Authority Having Jurisdiction inspections and A/E's reviews, tests and approval from the commencement until the acceptance of the completed work.

G. Whenever a particular manufacturer's product is named, it is intended to establish a level of quality and performance requirements unless more explicit restrictions are stated to apply. Refer to Division 01, General Conditions of the Contract.

H. The Contractor shall refer to shop drawings and submittal drawings for all equipment requiring electrical connections to verify rough-in and connection locations.

I. Unless specifically stated to the contrary, no measurement of an electric drawing derived by scaling shall be used as a dimension to work by. Dimensions noted on the electric drawings are subject to measurements of adjacent and previously completed work. All measurements shall be performed prior to the actual installation of equipment.

1.9 DRAWINGS

A. The Electrical drawings do not attempt to show the complete details of construction which affect the electrical installation. The Contractor shall refer to the architectural and civil, drawings for additional details which affect the proper installation of this work. Bring any discrepancies to the attention of the A/E for resolution. The Contractor is cautioned that diagrams showing electrical connections and/or circuiting are diagrammatic only and must not be used for obtaining lineal runs of wire and conduit. Wiring diagrams do not necessarily show the exact physical arrangement of the equipment.

B. The Contractor shall be responsible for all existing field conditions, review existing field conditions prior to bid and shall take into account in bid proposal. No additional compensation will be allowed due to Contractor's failure to include all necessary work in the bid proposal.

1.10 MATERIAL AND EQUIPMENT

A. All material and equipment shall be new and of the quality used for the purpose in good commercial practice, and shall be standard product of reputable manufacturers. Each major component of equipment shall have the manufacturer's name, catalog number, and capacity or rating on a nameplate, securely affixed on the equipment in a conspicuous place.

1.11 DAMAGE TO OTHER WORK

A. The Electrical Contractor will be held rigidly responsible for all damages to the work of his own or any other trade resulting from the execution of his work. It shall be the Contractor's responsibility to adequately protect his work at all times. All damages resulting from his operations shall be repaired or the damaged portions replaced by the party originally performing the work, (to the entire satisfaction of the Architect), and all cost thereof shall be borne by the Contractor responsible for the damage.

1.12 COOPERATION WITH OTHER TRADES

A. This Contractor shall completely cooperate with all other trades in the matter of planning and executing of the work. Every reasonable effort shall be made to prevent conflict and interferences as to space requirements, dimensions, locations, openings, sleeving or other matters which tend to delay or obstruct the work of any trade.

1.13 NEGLIGENCE

A. Should the Contractor fail to provide materials, templates, etc., or other necessary information causing delay or expense to another party, he shall pay the actual amount of the damages to the party who sustained the loss.

1.14 FIELD CHANGES

A. Should any change in drawings or specifications be required to comply with local regulations and/or field conditions, the Contractor shall refer same to Architect/Engineer for approval before any work which deviates from the original requirements of the drawings and specifications is started. In the event of disagreements as to the necessity of such changes, the decision of the Architect/Engineer shall be final.

1.15 CUTTING AND PATCHING

A. Provide all necessary cutting and patching, and with approval, to permit the installation of conduit or any part of the work under this branch. The Contractor shall be responsible for any cost caused by defective or ill-timed work. Patching of holes, openings, etc. resulting from the work of this branch shall be provided by this Contractor.

1.16 STANDARDS, CODES AND PERMITS

A. All work and materials are to conform in every detail to applicable rules and requirements of National, State and Local electrical codes, laws, ordinances, and regulations. Comply with all applicable OSHA regulations.

B. Conform with other applicable National Fire Protection Association codes, the National Electrical Safety Code, and present manufacturing standards (including NEMA).

C. All Division 26 work shall be done under the direction of a currently State Certified Master Electrician.

D. All materials shall have a U.L. label where a U.L. standard and/or test exists.

E. Prepare and submit to all authorities having jurisdiction, for their approval, all applications and working drawings required by them. Secure and pay for all permits and licenses required.

F. Abbreviations of standards organizations referenced in this and other sections are as follows:
   1. ANSI American National Standards Institute
   2. ASTM American Society for Testing and Materials
   3. EPA Environmental Protection Agency
   4. ETL Electrical Testing Laboratories, Inc.
   5. IEEE Institute of Electrical and Electronics Engineers
   6. IES Illuminating Engineering Society
   7. ISA Instrument Society of America
   8. NBS National Bureau of Standards
   9. NEC National Electric Code
   10. NEMA National Electrical Manufacturers Association
   11. NESC National Electrical Safety Code
   12. NFPA National Fire Protection Association
   13. UL Underwriters Laboratories Inc.

1.17 CLEAN-UP

A. Refer to Division 01, General Requirements, Cleaning for additional requirements.

B. This Contractor shall at all times keep the project site free from excessive accumulation of waste material or rubbish resulting from his work, including tools, scaffolding and surplus materials, and he shall leave his work broom-clean or its equivalent. In case of disputes, the Architect may order the removal of such rubbish and charge the cost to the responsible contractor as determined by the Architect/Engineer. At the time of final clean-up all fixtures and equipment shall be thoroughly cleaned and left in proper condition for their intended use.

C. The Contractor shall repair all damage to new and existing equipment resulting from his work. When job is complete, this Contractor shall remove all tools, excess material and equipment, etc., from the site.

1.18 TESTS

A. General: The Contractor shall provide all instrumentation, labor and conduct all tests required by the Architect. All tests shall be made before any circuit or item of equipment is permanently energized. Circuits shall be phased out and loads shall be distributed as evenly as possible on all phases. All phase conductors shall be entirely free from grounds and short circuits. All instrumentation and personnel required for testing shall be provided by the

Contractor and all tests shall be conducted in the presence of the Architect or his authorized representative.

B. System Tests:
   1. Service ground tests.
   2. Secondary feeders shall have an insulation resistance test utilizing a megger applying a test potential of 500 volts DC minimum.
   3. Establish secondary phase to ground voltages.
   4. Set transformer taps to deliver nominal rated voltage.
   5. Establish proper phase relationship.

The following tests are required under normal load condition:

   6. Record secondary phase to phase and phase to ground voltages and phase currents at all major equipment, apparatus, and on all secondary feeders. Voltage readings shall be taken at line side terminals of panelboards.
   7. Confirm proper phase relationship.
   8. Confirm load balance at panelboards. Rebalance load if necessary such that the minimum unbalance between phases shall not exceed 7-1/2%.
   9. Reset transformer taps if necessary to deliver nominal rated voltage. Identify final tap settings on transformers nameplates.
   10. Confirm operation of all electrically operated apparatus, such as circuit breakers by exercising same under load.
   11. Record all settings and calibrations of circuit breakers, transformers, meters, timing devices, etc.

C. Records: All test data obtained by the Contractor or manufacturer/supplier shall be recorded and filed with the maintenance manual as part of permanent job records. Test data shall include identification of instruments employed, (field test only) condition of test (time, date, weather, etc.), parameters of test, personnel conducting test, and any pertinent information or conditions noted during the test.

1.19 DRAWINGS OF OTHER TRADES

A. The Contractor shall consult the drawings of the work for the various other trades; field layouts of the parties performing the work of the other trades; their shop drawings, and he shall be governed accordingly in laying out his work.

B. Specifically examine shop drawings of other trades to confirm voltage, current characteristics, and other wiring requirements for utilization equipment. Bring any discrepancies to the attention of the A/E.

1.20 FIELD MEASUREMENTS

A. The Contractor shall take all field measurements necessary for his work and shall assume the full responsibility for their accuracy.

B. Should any interferences prevent the installation of handholes, running of conduits, etc., at points shown on drawings, the necessary minor deviations therefrom, as determined by the Architect, may be permitted. Minor changes in the position of the fixtures or equipment if decided upon before any work has been done by the Contractor shall be made without additional charge.

1.21 EXAMINATION OF PLANS, SPECIFICATIONS AND SITE

A. Before submitting a bid, the Contractor shall familiarize himself with all features of the project site which may affect the execution of his work. No extra payment will be allowed for the failure to obtain this information. As soon as possible but no later than ten (10) days before bid opening, the Contractor shall call the attention of the Architect/Engineer in writing of any materials or apparatus the Contractor believes to be inadequate and/or any necessary items of work omitted. If the Contractor believes there are inadequacies in the specifications or drawings, where clarifications are necessary to complete the project in accordance with the Contract Documents, the Contractor shall clarify these points with the Architect/Engineer before submitting his bid. In lieu of written clarification by addendum, resolve all conflicts in favor of the greater quantity or better quality.

1.22 GUARANTEE

A. The Contractor shall unconditionally guarantee his work and all components thereof, excluding lamps, for a period of one year from the date of his final payment. He shall remedy any defects in workmanship and repair or replace any faulty equipment which shall appear within the guarantee period to the entire satisfaction of the Owner/Architect at no additional charge.

1.23 DEMOLITION, RENOVATION AND DISPOSITION OF EXISTING EQUIPMENT

A. Areas of the site will be vacated as required to facilitate construction. This Contractor shall proceed with the completion of his work in such a manner as to cause the least possible interference with the Owner's operation. All work required at the site shall be done in a manner and time acceptable to the Owner.

B. Electrical equipment in conflict with construction shall be removed and/or relocated as directed or required. This Contractor shall remove all electrical equipment released from service as a result of construction, and no equipment removed shall be reused, except as specifically directed on the drawings or elsewhere herein. Except for conduit, conductor and miscellaneous hardware, all electrical equipment shall remain the property of the Owner and shall be stored on the site for removal by the Owner. All other equipment removed shall become the property of this Contractor and shall be removed from the site.

C. Any existing circuits or equipment not shown on the drawings and which are logically expected to be continued in service and which may be interrupted or disturbed during construction shall be reconnected in an approved manner. In addition, any existing circuit or equipment which may require relocation or rerouting, as a result of construction, shall be considered a part of the work of this branch and shall be done by this Contractor with no additional compensation.

D. All ballasts, lamps, transformers, or other equipment containing hazardous materials removed during the project become the Contractor's property and he shall dispose of them in accordance with applicable DNR and EPA regulations

E. Feeders, branch circuits, and other system wiring which are to remain in service, but which are presently routed through areas being demolished shall be rerouted around demolition area.

1.24 SUBSTITUTION AND APPROVAL OF MATERIAL, EQUIPMENT OR DESIGN

A. Such requests shall be accompanied by three copies of all necessary illustrations, cuts, drawings and descriptions of material proposed for substitution and shall fully describe all points in which it differs from the articles specified. The Engineer will retain two copies and one copy returned to the Contractor with acceptance, rejection or revisions indicated thereon.

B. The proposed substitution does not affect dimensions shown on Drawings or as specified.

C. The proposed substitution will have no adverse affect on other trades, the construction schedule, or specified warranty requirements.

D. All proposed substitutions will be subject to satisfactory performance to the specification and considered as a deduct alternate rather than as an equivalent.

E. Where equipment or accessories are used which differ in arrangement, configuration, dimensions, ratings, or engineering parameters from those indicated on the contract documents, the Contractor is responsible for all costs, including architectural/engineering design and construction costs, involved in integrating the equipment or accessories into the system and the assigned space and for obtaining the performance from the system into which these items are placed.

F. All substitution review costs shall be reimburse to the Engineer by the contractor or their suppliers on a Time/Material bases. This cost shall be paid on approval on disproval of the substitution material, equipment or design.

1.25 WORKMANSHIP

A. The installation of all work shall be made so that its several component parts will function as a workable system complete with all accessories necessary for its operation, and shall be left with all equipment properly adjusted and in working order. The work shall be executed in conformity with the best-accepted standard practice of the trade so as to contribute to efficiency and appearance.

PART 2 - PRODUCTS

2.1 SUPPORTING DEVICES

A. Material: Cold-formed steel, with corrosion-resistant coating acceptable to authorities having jurisdiction.

B. Metal Items for use Outdoors: Stainless steel.

C. Slotted-Steel Channel Supports: Flange edges turned toward web, and 9/16-inch- diameter slotted holes at a maximum of 2 inches O.C., in webs.

D. Slotted-Steel Channel Supports: Comply with Division 05 Section "Metal Fabrications" for slotted channel framing.
   1. Channel Thickness: Selected to suit structural loading.
   2. Fittings and Accessories: Products of the same manufacturer as channel supports.

E. Raceway Supports: Manufactured straps, brackets, and clamps.

F. Expansion Anchors: Carbon-steel wedge or sleeve type.

G. Toggle Bolts: All-steel springhead type.

H. Powder-Driven Threaded Studs: Heat-treated steel.

2.2 CONCRETE BASES

A. Concrete: 3000-psi, 28-day compressive strength.

B. Provide a 6” thick reinforced concrete pad under the free-standing electrical equipment enclosure.

2.3 TOUCHUP PAINT

A. For Equipment: Equipment manufacturer's paint selected to match installed equipment finish.

B. Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

PART 3 - EXECUTION

3.1 ELECTRICAL EQUIPMENT INSTALLATION

A. Materials and Components: Install level, plumb, and parallel and perpendicular to other components, unless otherwise indicated.

B. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.

C. Right of Way: Give to raceways and piping systems installed at a required slope.

3.2 ELECTRICAL SUPPORTING DEVICE APPLICATION

A. Outdoors: Stainless steel U-channel system components.

B. Install equipment grounding conductors in all feeders and branch circuits.

C. Selection of Supports: Comply with manufacturer's written instructions.

D. Strength of Supports: Adequate to carry present and future loads, times a safety factor of at least four; minimum of 200-lb design load.

3.3 SUPPORT INSTALLATION

A. Install support devices to securely and permanently fasten and support electrical components.

B. Support individual raceways with separate, conduit hanger straps.

C. Perform fastening according to the following unless other fastening methods are indicated:
   1. New Concrete: Concrete inserts with machine screws and bolts.

2. Light Steel: Sheet-metal screws.
3. Fasteners: Select so the load applied to each fastener does not exceed 25 percent of its proof-test load.

3.4 UTILITY COMPANY ELECTRICITY-METERING EQUIPMENT

A. Install equipment according to utility company's written requirements. Provide grounding and empty conduits as required by utility company.

3.5 CONCRETE BASES

A. Construct concrete bases of dimensions indicated, but not less than 4 inches larger, in both directions, than supported unit. Follow supported equipment manufacturer's anchorage recommendations and setting templates for anchor-bolt and tie locations, unless otherwise indicated. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

3.6 DEMOLITION

A. Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.

B. Accessible Work: Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety.

C. Abandoned Work: Cut and remove buried raceway and wiring, indicated to be abandoned in place, 2 inches below the surface of adjacent construction. Cap raceways and patch surface to match existing finish.

D. Remove demolished material from Project site.

E. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.

3.7 FIELD QUALITY CONTROL

A. Inspect installed components for damage and faulty work, including the following:
1. Raceways.
2. Wire and connectors.
3. Supporting devices for electrical components.
4. Electrical identification.
5. Electricity-metering components.
6. Concrete bases.
7. Electrical demolition.
8. Touchup painting.

3.8 REFINISHING AND TOUCHUP PAINTING

A. Refinish and touch up paint. Paint materials and application requirements are specified in Division 09 “Finishes”.

1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
4. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.9 CLEANING AND PROTECTION

A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.

B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

END OF SECTION

SECTION 26 05 19
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - **GENERAL**

1.1 SUMMARY

A. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

1.2 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 CONDUCTORS AND CABLES

A. Manufacturers:
   1. American Insulated Wire Corp.; a Leviton Company.
   2. General Cable Corporation.
   3. Senator Wire & Cable Company.
   4. Southwire Company.

B. Refer to Part 3 "Conductor and Insulation Applications" Article for insulation type, cable construction, and ratings.

C. Conductor Material: Copper complying with NEMA WC 5; #10 AWG and smaller to be solid conductor, and #8 AWG and larger to be stranded conductor.

D. Conductor Insulation Types: Type XHHW-2 complying with NEMA WC 5.

2.3 CONNECTORS AND SPLICES

A. Manufacturers:

   1. AFC Cable Systems, Inc.
   2. AMP Incorporated/Tyco International.
   3. Hubbell/Anderson.
   4. O-Z/Gedney; EGS Electrical Group LLC.

5. 3M Company; Electrical Products Division.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 CONDUCTOR AND INSULATION APPLICATIONS

A. Service Entrance: Type THHN-THWN, single conductors in raceway.

B. Exposed Feeders and Branch Circuits: Type THHN-THWN, single conductors in raceway.

C. Underground Feeders and Branch Circuits: Type XHHW-2, single conductors in raceway.

D. Class 1 and Class 2 Control Circuits: Type THHN-THWN, in raceway.

3.2 INSTALLATION

A. All conductors shall be installed in raceway.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Support conductors and cables according to Division 26 "Common Work results for Electrical."

E. Identify and color-code conductors and cables according to Division 26 "Identification for Electrical Systems."

F. Conductor sizes indicated on the drawings are minimum sizes. Ampacities of conductors do not take voltage drop into consideration. Contractor shall size conductors for feeders and branch circuits to prevent a voltage drop exceeding 3 percent at the farthest outlet of power, heating, and lighting loads, or combination of such loads, and where the maximum total voltage drop on both feeders and branch circuits to the farthest outlet does not exceed 5 percent, to provide reasonable efficiency of operation.
   1. As a minimum use 10 AWG conductor for 20 ampere, 120 volt branch circuit home runs longer than 100 feet (30 m).

3.3 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

3.4 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing:

1. After installing conductors and cables and before electrical circuitry has been energized, test for compliance with requirements.
2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.3.1. Certify compliance with test parameters.

B. Test Reports: Prepare a written report to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

END OF SECTION

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

B. Related Sections include the following:

1. Division 26 "Underground Ducts and Raceways for Electrical Systems" for ground test wells.

1.2 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1. Comply with UL 467.

B. Comply with NFPA 70.

C. Field Test Reports: Submit written test reports to include the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.3 COORDINATION

A. Show location of all service grounding equipment and describe method of grounding installation. Show the following:
1. Service ground conductor.
2. Location of Ground Rods and Test Wells.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Grounding Conductors, Cables, Connectors, and Rods:

a) Chance/Hubbell.
b) Copperweld Corp.

c) Erico Inc.; Electrical Products Group.
d) Framatome Connectors/Burndy Electrical.
e) Galvan Industries, Inc.
f) Ideal Industries, Inc.
g) ILSCO.
h) Raco, Inc.; Division of Hubbell.
i) Thomas & Betts, Electrical.

2.2 GROUNDING CONDUCTORS

A. For insulated conductors, comply with Division 26 "Low-Voltage Electrical Power Conductors and Cables."

B. Material: Copper.

C. Equipment Grounding Conductors: Insulated with green-colored insulation.

D. Grounding Electrode Conductors: Stranded cable.

E. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.

F. Bare Copper Conductors: Comply with the following:

1. Solid Conductors: ASTM B 3.
2. Assembly of Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.

G. Copper Bonding Conductors: As follows:

1. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
2. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
3. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.3 CONNECTOR PRODUCTS

A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.

B. Bolted Connectors: Bolted-pressure-type connectors, or compression type (at bus bars, equipment, and test wells only).

C. Welded Connectors: Exothermic-welded type, in kit forms, and selected per manufacturers written instructions.

2.4 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel.

1. Size: ¾ inches in diameter by 10 feet in length.

B. Test Wells: Provide handholes as specified in Division 26 "Underground Ducts and Raceways for Electrical."

PART 3 - EXECUTION

3.1 APPLICATION

A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.

B. In raceways, use insulated equipment grounding conductors.

C. Exothermic-Welded Connections: Use for underground connections, except those at test wells.

D. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.

E. Ground Rod Clamps at Test Wells: Use bolted pressure clamps with at least two bolts.

F. Underground Grounding Conductors: Use tinned- copper conductor. Bury at least 24 inches below grade.

3.2 EQUIPMENT GROUNDING CONDUCTORS

A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.

B. Install insulated equipment grounding conductor with circuit conductors for the following items, in addition to those required by NEC:

1. Feeders and branch circuits.
2. Receptacle circuits.
3. Single-phase appliance branch circuits.

C. Nonmetallic Raceways: Install an equipment grounding conductor in all nonmetallic raceways.

3.3 INSTALLATION

A. Ground Rods: Install at least three ground rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes.

1. Drive ground rods until tops are 2 inches below final grade.
2. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except at test well. Make connections without exposing steel or damaging copper coating.

B. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Install straps only in locations accessible for maintenance.

C. Install one test well for each service at the ground rod electrically closest to the service entrance. Set top of well flush with finished grade.

3.4 CONNECTIONS

A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

D. Connections at Test Wells: Use compression-type connectors on conductors and make bolted- and clamped-type connections between conductors and ground rods.

E. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

F. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

G. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.5 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing:

1. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.
2. Test completed grounding system at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of

reducing natural ground resistance. Perform tests, by the fall-of-potential method according to IEEE 81.

3. Provide as-built drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

   a) Equipment Rated 500 kVA and Less: 10 ohms.
   b) Equipment Rated 500 to 1000 kVA: 5 ohms.
   c) Equipment Rated More Than 1000 kVA: 3 ohms.

4. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

3.6 GRADING AND PLANTING

A. Restore surface features, including vegetation, at areas disturbed by Work of this Section. Reestablish original grades, unless otherwise indicated. If sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include application of topsoil, fertilizer, lime, seed, sod, sprig, and mulch. Comply with Division 32 "Landscape Grading." Maintain restored surfaces. Restore disturbed paving.

END OF SECTION

SECTION 26 05 33
RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. Related Sections include the following:
   1. Division 26 "Underground Ducts and Raceways for Electrical Systems" for exterior duct banks, handholes, and underground utility construction.
   2. Division 26 "Common Work Results for Electrical" for supports, anchors, and identification products.
   3. Division 26 "Wiring Devices" for devices installed in outlet boxes.

1.2 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. LFMC: Liquidtight flexible metal conduit.

C. RNC: Rigid nonmetallic conduit.

1.3 SUBMITTALS

A. Product Data: For free-standing, 2-door electrical enclosure and interior components.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

1.5 COORDINATION

A. Coordinate layout and installation of raceways, boxes, and enclosures with other construction.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 METAL CONDUIT AND TUBING

A. Manufacturer:
   1. AFC Cable Systems, Inc.
   2. Grinnell Co./Tyco International; Allied Tube and Conduit Div.
   3. Wheatland Tube Co.

B. Rigid Steel Conduit: ANSI C80.1.

C. EMT and Fittings: ANSI C80.3.

D. LFMC: Flexible steel conduit with PVC jacket.

E. Fittings: NEMA FB 1; compatible with conduit and tubing materials.

2.3 NONMETALLIC CONDUIT

A. Manufacturer:
   1. Cantex Inc.
   2. Certainteed Corp.; Pipe & Plastics Group.
   3. Lamson & Sessions; Carlon Electrical Products.

B. RNC: NEMA TC 2, Schedule 40 PVC.

C. RNC Fittings: NEMA TC 3; match to conduit type and material.

2.4 METAL WIREWAYS

A. Manufacturer:
   1. Hoffman.
   2. Square D.

B. Material and Construction: Sheet metal sized and shaped as indicated, NEMA 1.

C. Fittings and Accessories: Include end caps, and other fittings to match and mate with wireways as required for complete system.

D. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.

E. Wireway Covers: Hinged type.

F. Finish: Manufacturer's standard enamel finish.

2.5 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturer:
   1. Emerson/General Signal; Appleton Electric Company.
   2. Hoffman.
   3. RACO; Division of Hubbell, Inc.
   4. Spring City Electrical Manufacturing Co.
   5. Thomas & Betts Corporation.

B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover.

D. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

E. Cabinets: NEMA 250, Type 4X, free-standing, two-door, stainless steel box with removable interior panel and removable centerpost. Hinged, gasketed doors with three-point latching mechanism operated by a stainless steel padlocking handle. Interior steel panel finished with white polyester powder paint. Enclosure to include a print pocket and thermostatically controlled electric space heater.

2.6 FACTORY FINISHES

A. Finish: For raceway, enclosure, or cabinet components installed inside of the electrical control cabinet, provide manufacturer's standard grey paint applied to factory-assembled enclosures, and cabinets before shipping.

B. For enclosures and cabinets installed outdoors, provide stainless steel enclosures and cabinets.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors:
   1. Exposed: Rigid steel.
   2. Underground: RNC.
   3. Boxes and Enclosures: NEMA 250, Type 4X.

B. Indoors (inside free-standing electrical enclosure):
   1. Exposed: Rigid steel conduit or EMT.
   2. Connection to Vibrating Equipment: LFMC.
   3. Boxes and Enclosures: NEMA 250, Type 1.

C. Minimum Raceway Size: 1/2-inch trade size, except that all underground raceway shall be 1” minimum.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.
   1. EMT Conduit: Use steel set screw or compression type with insulated throat (no cast).
   2. Rigid Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.

3.2 INSTALLATION

A. Complete raceway installation before starting conductor installation.

B. Support raceways as specified in Division 26 "Hangers and Supports for Electrical Systems."

C. Install temporary closures to prevent foreign matter from entering raceways.

D. Make bends and offsets so ID is not reduced.

E. Install exposed raceways parallel or at right angles to nearby surfaces.

F. Join raceways with fittings designed and approved for that purpose and make joints tight.
   1. Use insulating bushings to protect conductors.

G. Tighten set screws of threadless fittings with suitable tools.

H. Terminations:
   1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.
   2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.

I. Flexible Connections: Use maximum of 12 inches of LFMC for equipment subject to vibration, noise transmission, or movement. Install separate ground conductor within each flexible connection.

J. Install hinged-cover wireways plumb. Support at each corner.

3.3 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   2. Repair damage to painted finishes with matching touchup coating recommended by manufacturer.

3.4 CLEANING

A. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes.

END OF SECTION

SECTION 26 05 43
UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Ducts in direct-buried duct banks.
2. Ducts in concrete-encased duct banks.
3. Handholes and handhole accessories.

B. Related Sections include the following:
1. Division 26 "Common Work Results for Electrical" for supports, anchors, and identification products.
2. Division 26 "Grounding and Bonding for Electrical Systems" for grounding electrodes, and testing of grounds.

1.2 SUBMITTALS

A. Product Data: For the following:

1. Handholes.
2. Warning tape.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with ANSI C2.

C. Comply with NFPA 70.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

B. Store precast concrete units at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

C. Lift and support precast concrete units only at designated lifting or supporting points.

1.5 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated.

1. Notify Architect at least two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.

1.6 COORDINATION

A. Coordinate layout and installation of ducts and handholes with final arrangement of other utilities and site grading, as determined in the field.

B. Coordinate elevations of ducts and duct-bank entrances into handholes with final profiles of conduits as determined by coordination with other utilities and underground obstructions. Revise locations and elevations as required to suit field conditions and to ensure duct runs drain to handholes.

PART 2 - PRODUCTS

2.1 PRODUCTS AND MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Underground Precast Polymer Concrete Utility Structures:
   a) Quazite/Hubbell Power Systems.

2. Nonmetallic Ducts and Accessories:
   a) Cantex, Inc.
   b) Certainteed Corp.; Pipe & Plastics Group.
   c) Lamson & Sessions; Carlon Electrical Products.

2.2 CONDUIT

A. Conduit and fittings are specified in Division 26 "Raceways and Boxes for Electrical Systems."

2.3 DUCTS

A. Rigid Nonmetallic Conduit: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by the same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.4 HANDHOLES

A. Cast-Metal Boxes: Cast aluminum, with outside flanges and recessed, gasketed cover for flush mounting and with nonskid finish and legend on cover. Unit, when buried, shall be designed to support AASHTO H10 loading.

B. Precast Handholes: Reinforced concrete, monolithically poured walls and bottom, with cast-aluminum frame and access door assembly as the top of handhole. Duct entrances and windows shall be located near corners to facilitate racking. Pulling-in irons and other built-in items shall be installed before pouring concrete. Cover shall have nonskid finish and legend. Unit, when buried, shall be designed to support AASHTO H10 loading.

C. Polymer Concrete Handholes: Molded fiberglass reinforced precast polymer concrete, with cable entrance at each end and gasketed heavy-duty bolted cover with nonskid finish and legend. Unit, when buried, shall be designed to support ANSI/SCTE 77 Tier 15 loading for

driveway, parking lot, and off-roadway applications subject to occasional non-deliberate heavy vehicular traffic.

D. Cover Legend: "ELECTRIC."

2.5 ACCESSORIES

A. Duct Spacers: Rigid PVC interlocking spacers, selected to provide recommended duct spacings and cover depths while supporting ducts during concreting and backfilling; produced by the same manufacturer as the ducts.

B. Grounding Materials: Comply with Division 26 "Grounding and Bonding for Electrical Systems."

C. Warning Tape: Underground-line warning tape specified in Division 26 “Identification for Electrical Systems."

PART 3 - EXECUTION

3.1 APPLICATION

A. Underground Ducts for Electrical Feeders and Branch Circuits: Type EPC-40-PVC, direct-buried duct bank, except use Type EPC-40-PVC concrete encased duct bank or Type EPC-80-PVC direct buried duct bank when crossing roads and traffic areas of parking lots.

3.2 EARTHWORK

A. Excavation and Backfill: Comply with Division 31 "Site Excavation and Back Fill and Compaction" but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

C. Restore all areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoil, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32 "Planting."

D. Restore disturbed pavement. Refer to Division 01 "Cutting and Patching."

3.3 CONDUIT AND DUCT INSTALLATION

A. Slope: Pitch ducts a minimum slope of 1:300 down toward handholes and away from equipment. Slope ducts from a high point in runs between two handholes to drain in both directions.

B. Curves and Bends: Use manufactured elbows for stub-ups at equipment and light pole bases. Use long sweep bends at other locations.

C. Use solvent-cement joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.

D. Concrete-Encased, Nonmetallic Ducts: Support ducts on duct spacers, spaced as recommended by manufacturer and coordinated with duct size, duct spacing, and outdoor temperature. Install as follows:

1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts and secure separators to earth and to ducts to prevent floating during concreting. Stagger spacers approximately 6 inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
2. Concreting: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application. Pour each run of envelope between handholes or other terminations in one continuous operation. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing rod dowels extending 18 inches into concrete on both sides of joint near corners of envelope.
3. Reinforcement: Reinforce duct banks where they cross disturbed earth.
4. Forms: Use walls of trench to form sidewalls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
5. Minimum Clearances between Ducts: 3 inches between ducts and exterior envelope wall, and 2 inches between ducts.
6. Depth: Install top of duct bank at least 24 inches below finished grade in nontraffic areas and at least 30 inches below finished grade in vehicular traffic areas.

E. Direct-Buried Ducts: Support ducts on duct spacers, spaced as recommended by manufacturer and coordinated with duct size, duct spacing, and outdoor temperature. Install as follows:

1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts.
2. Trench Bottom: Continuous, firm, and uniform support for duct bank. Prepare trench bottoms as specified in Division 31 "Site Excavation Backfilland Compaction" for pipes less than 6 inches in nominal diameter.
3. Backfill: Install backfill as specified in Division 31 "Site Excavation Backfilland Compaction." Hand-place backfill to 4 inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over ducts, complete backfilling normally.
4. Minimum Clearances between Ducts: 3 inches between ducts.
5. Depth: Install top of duct bank at least 36 inches below finished grade.

F. Warning Tape: Bury warning tape approximately 6 to 8 inches below finished grade. Align tape parallel to and within 3 inches of the centerline of duct bank.

G. Stub-ups: Use rigid steel conduit for stub-ups to equipment. For equipment mounted on outdoor concrete bases, extend steel conduit a minimum of 5 feet from edge of base. Install insulated grounding bushings on terminations. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches of concrete.

H. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.

I. Pulling Cord: Install 100-lbf- test nylon cord along with the circuit conductors in all ducts.

3.4 HANDHOLE INSTALLATION

A. Elevation: Install handholes with cover set 1 inch above grade.

B. Drainage: Install drains in bottom of precast handholes. Polymer concrete handholes to have open bottoms. Set handholes on a 12-inch minimum bed of gravel to allow for drainage.

3.5 FIELD QUALITY CONTROL

A. Testing: Demonstrate capability and compliance with requirements on completion of installation of underground ducts and handholes.

B. Grounding: Test grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 26 Section "Grounding and Bonding for Electrical Systems."

C. Duct Integrity: Pull aluminum or wood test mandrel through each duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of the duct. If obstructions are indicated, remove obstructions and retest.

D. Correct installations if possible and retest to demonstrate compliance. Remove and replace defective products and retest.

3.6 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

END OF SECTION

SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes electrical identification materials and devices required to comply with ANSI C2, NFPA 70, OSHA standards, and authorities having jurisdiction.

1.2 QUALITY ASSURANCE

A. Comply with ANSI C2.

B. Comply with NFPA 70.

C. Comply with ANSI A13.1 and NFPA 70 for color-coding.

PART 2 - PRODUCTS

2.1 RACEWAY AND CABLE LABELS

A. Comply with ANSI A13.1, Table 3, for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

1. Color: Black letters on white field.
2. Legend: Indicates voltage and service.

B. Adhesive Labels: Preprinted, flexible, self-adhesive vinyl with legend over-laminated with a clear, weather- and chemical-resistant coating.

C. Pretensioned, Wraparound Plastic Sleeves: Flexible, preprinted, color-coded, acrylic band sized to suit the diameter of the line it identifies and arranged to stay in place by pretensioned gripping action when placed in position.

D. Underground-Line Warning Tape: Permanent, bright-colored, continuous-printed, vinyl tape.

1. Not less than 6 inches wide by 4 mils thick.
2. Compounded for permanent direct-burial service.
3. Embedded continuous metallic strip or core.
4. Printed legend indicating type of underground line.

E. Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.

2.2 NAMEPLATES AND SIGNS

A. Engraved Plastic Nameplates and Signs: Engraving stock, melamine plastic laminate, minimum 1/16 inch thick for signs up to 20 sq. in.

1. Engraved legend with black letters on white face.

2. Punched or drilled for mechanical fasteners.

B. Fasteners for Nameplates and Signs: Self-tapping, stainless-steel screws or No. 10/32, stainless-steel machine screws with nuts and flat and lock washers.

2.3 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon cable ties.

1. Minimum Width: 3/16 inch.
2. Tensile Strength: 50 lb minimum.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: According to color-coding.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Identification Materials and Devices: Install at locations for most convenient viewing without interference with operation and maintenance of equipment.

B. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and other designations with corresponding designations in the Contract Documents or with those required by codes and standards. Use consistent designations throughout Project.

C. Sequence of Work: If identification is applied to surfaces that require finish, install identification after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before applying.

E. Caution Labels for Boxes and Enclosures for Power and Lighting: Install pressure-sensitive, self-adhesive labels identifying system voltage with black letters on orange background. Install on exterior of door or cover. Install on exterior of door or cover

F. Circuit Identification Labels on Boxes: Install labels externally.

1. Exposed Boxes: Pressure-sensitive, self-adhesive plastic label on cover.
2. Labeling Legend: Permanent, waterproof listing of panel and circuit number or equivalent.

G. Paths of Underground Electrical Lines: During trench backfilling, install continuous underground plastic line marker located directly above line at 6 to 8 inches below finished grade. Where width of multiple lines installed in a common trench or concrete envelope does not exceed 16 inches overall, use a single line marker. Install line marker for underground wiring, both direct-buried ducts and concrete encased ducts.

H. Color-Coding of Secondary Phase Conductors: Use the following colors for service feeder and branch circuit phase conductors:

1. 240/120-V Conductors:

a) Phase A: Black.
b) Phase B: Red.

2. Factory apply color the entire length of conductors, except the following field-applied, color-coding methods may be used instead of factory-coded wire for sizes larger than No. 10 AWG:

a) Colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Use 1-inch- wide tape in colors specified. Adjust tape bands to avoid obscuring cable identification markings.
b) Colored cable ties applied in groups of three ties of specified color to each wire at each terminal or splice point starting 3 inches from the terminal and spaced 3 inches apart. Apply with a special tool or pliers, tighten to a snug fit, and cut off excess length.

I. Power-Circuit Identification: Metal tags or aluminum, wraparound marker bands for cables, feeders, and power circuits in pull and junction boxes, and handholes.

1. Legend: 1/4-inch- steel letter and number stamping or embossing with legend corresponding to indicated circuit designations.
2. Tag Fasteners: Nylon cable ties.
3. Band Fasteners: Integral ears.

J. Apply identification to conductors as follows:

1. Multiple Power Circuits in the Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color-coding to identify circuits' voltage and phase.

K. Apply warning, caution, and instruction signs as follows:

1. Warnings, Cautions, and Instructions: Install to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions are needed for system or equipment operation.

L. Equipment Identification Labels: Engraved plastic laminate. Install on each unit of equipment. Provide a single line of text with 1/2-inch- high lettering on 1-1/2-inch- high label; where two lines of text are required, use labels 2 inches high. Use white lettering on black field. Apply labels for each unit of the following categories of equipment using mechanical fasteners:

1. Panelboard, electrical cabinets, and enclosures.

END OF SECTION

SECTION 26 24 16
PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Lighting and appliance branch-circuit panelboards.

1.2 SUBMITTALS

A. Product Data: For each panelboard, overcurrent protective devices, accessories, and components indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Dimensioned elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a) Enclosure type and details.
b) Bus configuration, current, and voltage ratings.
c) Short-circuit current rating of panelboards and overcurrent protective devices.
d) UL listing for series rating of installed devices.
e) Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
f) Coordination drawing of location and layout.

2. Wiring Diagrams.

C. Field quality-control test reports including the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

D. Panelboard Circuit Directories: For installation in panelboards. Submit final versions after load balancing.

E. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Closeout Procedures," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

1.3 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of panelboards and are based on the specific system indicated. Refer to Division 01 "Product Requirements."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with NEMA PB 1.

E. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Panelboards, Overcurrent Protective Devices, Controllers, Contactors, and Accessories:

a) Square D.
b) Eaton Corporation; Cutler-Hammer Products.
c) General Electric Co.; Electrical Distribution & Protection Div.

2.2 MANUFACTURED UNITS

A. Enclosures: Surface-mounted cabinets. NEMA PB 1, Type 1.
1. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
2. Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.
3. Directory Card: With transparent protective cover, mounted in metal frame, inside panelboard door.

B. Phase and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.

C. Conductor Connectors: Suitable for use with conductor material.

1. Main and Neutral Lugs: Mechanical type.

D. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.

2.3 PANELBOARD SHORT-CIRCUIT RATING

A. Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

B. Mains: Circuit breaker.

C. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

D. Doors: Concealed hinges; secured with flush latch with tumbler lock.

2.5 OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker: UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits.

B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.

1. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Comply with mounting and anchoring requirements specified in Section 26 05 00 – Common Work Results for Electrical.

C. Mounting: Refer to electrical equipment enclosure detail on drawings.

D. Mount plumb and rigid without distortion of box.

E. Install overcurrent protective devices.

F. Install filler plates in unused spaces.

G. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

3.2 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section “Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label panelboard with engraved laminated-plastic nameplate mounted with corrosion-resistant screws.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Load Balancing: Measure load balancing and make circuit changes.

1. Measure as directed during period of normal system loading.
2. Record all load readings and submit test records.
3. Tolerance: Difference exceeding 7.5 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.5 CLEANING

A. On completion of installation, inspect interior and exterior of panelboards. Remove dirt, debris, and other accumulated residue. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Wash and wipe clean the front cover and door and repair exposed surfaces to match original finish.

END OF SECTION

SECTION 26 27 26
WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Duplex ground-fault circuit interrupter receptacles.
   2. Device cover plates.

1.2 DEFINITIONS

A. GFCI: Ground-fault circuit interrupter.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Field quality-control test reports.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate from one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Wiring Devices:

      a) Cooper Wiring Devices.
      b) Hubbell Incorporated; Wiring Device-Kellems.
      c) Leviton Mfg. Company Inc.
      d) Pass & Seymour/Legrand (Pass & Seymour).

2.2 GFCI RECEPTACLES

A. Duplex GFCI Convenience Receptacles, 125V, 20A:
   1. Straight blade, heavy-duty, specification grade.
   2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.

3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

2.3 COVER PLATES

A. Single and combination types to match corresponding wiring devices.
   1. Plate-Securing Screws: Metal with head color to match plate finish.
   2. Material: Galvanizer steel.
   3. Material for Wet Locations: Cast aluminum, and listed and labeled for use in wet locations while “In Use.”

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install devices and assemblies level, plumb, and square.

B. Wrap wiring devices with insulating tape before installing and placing plates.

3.2 CONNECTIONS

A. Ground equipment according to Division 26 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 "Low-Voltage Electrical Power Conductors and Cables."

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. After installing wiring devices and after electrical circuitry has been energized, test for proper polarity, ground continuity, and compliance with requirements.
   2. Test GFCI operation with both local and remote fault simulations according to manufacturer's written instructions.

B. Remove malfunctioning units, replace with new units, and retest as specified above.

END OF SECTION

SECTION 26 28 13
FUSES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes cartridge fuses, rated 250 V and less.

1.2 QUALITY ASSURANCE

A. Source Limitations: Provide fuses from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NEMA FU 1.

D. Comply with NFPA 70.

1.3 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Industries, Inc.; Bussmann Div.
2. Eagle Electric Mfg. Co., Inc.
3. Ferraz Shawmut, Inc.
4. Littelfuse, Inc.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class and current rating indicated; voltage rating consistent with circuit voltage.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

B. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

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

3.2 FUSE APPLICATIONS

A. Branch Circuits: Class RK5, time delay.

3.3 INSTALLATION

A. Install fuses in fusible devices.

3.4 IDENTIFICATION

A. Install labels indicating fuse replacement information.

END OF SECTION

SECTION 311000

SITE CLEARING

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following:
   1. Removing existing trees, shrubs, groundcovers, plants, and grass.
   2. Clearing and grubbing.
   3. Tree protection
   4. Stripping and stockpiling topsoil.
   5. Removing above- and below-grade site improvements.
   6. Disconnecting and capping or sealing site utilities.
   7. Temporary erosion and sedimentation control measures.

1.02 MATERIAL OWNERSHIP

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

1.03 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
   2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

B. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.

C. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.

D. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place.

PART 2 - PRODUCTS

2.01 SOIL MATERIALS

A. Satisfactory Soil Materials: Requirements for satisfactory soil materials are specified in Section 31 20 00 Earth Moving.
   1. Obtain approved borrow soil materials off-site when satisfactory soil materials are not available on-site.

PART 3 - EXECUTION

3.01 PREPARATION

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

B. Locate and clearly flag trees and vegetation to remain or to be relocated. Contractor shall walk site with Owner to identify any trees to be removed that may be salvaged by Owner for milling or reuse for other purposes.

C. Protect existing site improvements to remain from damage during construction.
   1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.02 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Contractor shall obtain erosion control permit from City of Milwaukee prior to any land disturbance.

B. Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to site erosion control plan**,** and City of Milwaukee Erosion Control Permit.

C. Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.

D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.03 UTILITIES

A. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed.
   1. Arrange with utility companies to shut off indicated utilities.

B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
   1. Notify Architect not less than three days in advance of proposed utility interruptions.
   2. Do not proceed with utility interruptions without Architect's written permission.

C. Backfill trenches associated with utility removals in accordance with Section 31 20 00 Earth Moving.

3.04 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs and other vegetation to permit installation of new construction.

B. Contractor shall use care and take necessary precautions to protect trees to remain from damage from clearing and grubbing activities.

C. If feasible, fell trees towards the center of the area being cleared. If this is not possible due to danger to or injury to other trees, structure, or surrounding property, cut them into sections from the top down.

D. Do not injure or damage trees and shrubs left in place on either side of the roadway. Care must be taken in the removal / grubbing of stumps adjacent to the outside limit area of construction when existing trees and root zone is in close proximity. Symmetrically trim lower limbs or branches of trees left in place and overhanging the roadway to at least 20 feet above the finished grade. Trim plants following generally accepted arboricultural practices.

E. Grind down stumps and remove roots, obstructions and debris to a depth of 2 feet below proposed finished grade or to a depth of four feet below proposed grade within proposed building footprints.

F. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
   1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches (200 mm), and compact each layer to a density equal to adjacent original ground.

3.05 TREE PROTECTION

A. Protect existing trees and shrubs not designated for removal, as indicated by construction limit lines, including protection and irrigation (watering) during site work and construction.

B. Erect and maintain a temporary fence around drip line of individual trees or around perimeter drip line of group of trees to remain. Prevent damage to roots before driving and setting posts. Maintain fence during construction. Remove fence when construction is complete.

C. Do not store construction materials, debris, or excavated material within drip line of remaining trees.

D. Do not permit vehicles, equipment, or foot traffic within drip line of remaining trees.

E. Do not excavate earth surface within drip line of trees, unless otherwise indicated.

F. When excavation for new construction is required within drip line of trees, hand clear and excavate to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.

G. If clearing any hazard trees, plants where grubbing is not required, cut trees, shrubs and brush to within 3 inches of ground surface.

H. Prevent the spread of oak wilt by treating all cut surfaces and abrasions sustained between April 1 and September 30 by healthy oak trees and saplings with a thorough application of tree paint immediately upon discovering a wound. Between these dates, also paint the cut surfaces of the stumps of all healthy oak trees and saplings immediately after cutting, whether remaining in place or grubbed.

I. Cover exposed roots with burlap and water regularly until they are permanently relocated and covered with soil.

J. Coat cut faces of roots more than 1-1/2 inches in diameter with emulsified asphalt or other approved coating formulated for use on damaged plant tissues.

K. Employ a certified arborist, licensed in state where Project is located, to submit details of repairs and to repair damage to trees and shrubs. Contractor to submit name of certified arborist, license number to the Landscape Architect.

L. If a plant is to be preserved in place, do not disturb the ground within the drip line. If this is not possible, tree wells or retaining walls can be built to accommodate grade changes. Remember that the greater the number of roots removed when the grade is lowered and the greater the amount of fill added when the grade is raised, the less likely the plant's chances of survival are.

M. If a tree, which is to remain, is destroyed or damaged by construction operations and in the judgment of Milwaukee County officials or their agent it needs to be replaced, the contractor will be held accountable for the following:
   1. It shall be removed at contractor's expense.
   2. Damages will be assessed at the rate of Three Hundred Dollars ($300.00) per inch caliper.
   3. Trunk caliper will be measured at Diameter Breast Height (DBH) 4.5' above ground level.

3.06 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.

C. Stockpile topsoil materials away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust.

3.07 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.

3.08 PAVEMENT REMOVAL

A. Remove existing pavements as shown on the plans and as required to accommodate new construction.

B. Sawcut all pavement full-depth prior to removal. Sawcuts shall be in neat, straight lines parallel or perpendicular to existing pavement edges and/or joints.

3.09 DISPOSAL

A. Disposal: 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.
   1. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities.

END OF SECTION

SECTION 312000

EARTH MOVING

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following:
   1. Preparing subgrades for slabs-on-grade, walks, and pavements.
   2. Excavating, backfilling and placing soil fill for buildings, structures and pavements.
   3. Base course for concrete walks, pavements.
   4. Base course for asphalt paving.

1.02 REFERENCES

A. Standard Specifications for Sewer and Water Construction in Wisconsin, Latest Edition

B. State of Wisconsin Standard Specifications for Highway and Structure Construction, Latest Edition

C. Geotechnical Engineering Report; Bliffert Site Parking Lot; Milwaukee, Wisconsin; Gestra Engineering, November 18, 2014

D. Data Package; Milwaukee County – Bliffert Lumber; TRC; July 13, 2013

1.03 DEFINITIONS

A. Backfill: Soil material used to fill an excavation.

B. Base Course: Course placed between the prepared subgrade and hot-mix asphalt paving or cement concrete pavement, sidewalk or curb and gutter.

C. Bedding Course: Course placed in a sewer or water trench beneath the sewer or water pipe and up to the springline of the sewer or water pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Clay liner material: Material used for lining of storm water basin.

F. Granular Mat: Material placed directly below floor slab on grade.

G. Drainage Material: Free draining granular aggregate to prevent buildup of hydrostatic pressures behind below grade walls and structures

H. Engineered Fill: Material used to bring areas to proper design grade in structural areas.

I. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
   1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Engineer. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
   2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Engineer. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

J. Fill: Soil materials used to raise existing grades. Retain one of two "rock" definitions below for classified excavation. See Evaluations for further discussion.

K. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

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

M. Trench Backfill: Material placed in a trench above the pipe cover material for sewer or water pipe.

N. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.04 SUBMITTALS

A. Provide samples of each type of on-site or borrow soil, aggregate, engineered fill proposed for use on the project. Samples shall consist of a minimum of 50 pound samples. The Contractor shall be responsible for delivering the soil samples to the testing agency as designated by the County. Provide samples a minimum of 2 weeks prior to starting construction for review and approval. Testing agency may collect additional samples if conditions vary.

B. Pre-excavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces, which might be misconstrued as damage caused by earthwork operations. Submit before earthwork begins.

1.05 QUALITY ASSURANCE

A. Geotechnical Testing Agency Qualifications: County 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.

1.06 PROJECT CONDITIONS

A. Utility Locator Service: Contractor shall have existing utilities marked by utility locator service prior to initiating earth moving activities.

B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Architect and then only after arranging to provide temporary utility services according to requirements indicated.
   1. Notify Architect not less than two days in advance of proposed utility interruptions.
   2. Do not proceed with utility interruptions without Architect's written permission.
   3. Contact utility-locator service for area where Project is located before excavating.

C. Existing Structures to Remain: Protect all existing structures and buildings to remain. Contractor will be responsible for any damage to existing structures and buildings to remain caused by their construction activities.

D. Pavements to Remain: Protect all pavements to remain. Contractor will be responsible for replacing any pavements to remain that are damaged during construction activities.

E. Soil/Groundwater Contamination: Site is known to contain soil and groundwater contamination for Gasoline Range Organics, benzene, and Polycyclic Aromatic Hydrocarbons above State of Wisconsin Residual Contaminant Level standards for soil and State Enforcement Standards for groundwater. It is the intent to manage all contaminated soil on-site and cap contaminated soil with asphalt parking area.

PART 2 - - PRODUCTS

2.01 SOIL MATERIALS

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

B. Satisfactory Soils: ASTM D 2487 Soil Classification Groups GW, GP, GM, SW, SP, GC, SC, CL, and SM or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter or any other fill material deemed suitable by the project geotechnical engineer.

C. Unsatisfactory Soils: Soil Classification Groups CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487 or a combination of these groups.
   1. Unsatisfactory soils also include satisfactory soils not maintained within 3 percent of optimum moisture content at time of compaction.

D. Base Course: Shall be 1-1/4 inch dense graded base course in accordance with Section 305 of the WisDOT Standard Specifications.

E. Engineered Fill: 1-1/4" dense graded base course in accordance with Section 305 of the State of Wisconsin Standard Specifications for Sewer and Water Construction or excavated on-site inorganic soils free from construction debris, organic material, deleterious material or frost and within 3% of optimum moisture content at time of compaction if deemed suitable by the project geotechnical engineer and meeting requirements of satisfactory soils.

F. Clay Liner Material: Clay soil with the following properties:
   1. Average plasticity index (PI) of 7 or more with none less than 5
   2. Average liquid limit (LL) of 16 or greater with none less than 14
   3. A minimum of 50% of the soil by weight finer than the #200 sieve
   4. A minimum of 90% of the soil by weight finer than the #4 sieve
   5. In-place hydraulic conductivity of the compacted soils shall be $1x10^{-6}$ cm/second or less

G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand conforming to the requirements of Section 8.43.2 of the Standard Specifications for Sewer and Water Construction in Wisconsin, Latest Edition.

H. Pipe Cover Material: Pipe cover material shall conform to Section 8.43.3 of the Standard Specifications for Sewer and Water Construction in Wisconsin.

I. Trench Backfill: Granular backfill conforming to Section 8.43.4 of the Standard Specifications for Sewer and Water Construction in Wisconsin.

PART 3 - - EXECUTION

3.01 PREPARATION

A. Site preparation shall be in accordance with the recommendations of the geotechnical engineering report, project geotechnical engineer in the field and these specifications. In case of conflict between these specifications and the recommendations of the project geotechnical engineer, the recommendations of the project geotechnical engineer shall rule.

B. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

C. Remove exposed concrete/asphalt, pavements/slabs, debris, vegetation and topsoil and excavate to the planned subgrades. Unsuitable materials such as buried topsoil, vegetation, roots, debris, deleterious material, soils that contains significant amounts of organics that are encountered during excavation shall be removed.

D. Compact subgrade with a minimum of 10 overlapping passes (2 sets of 5 at right angles) with a heavy (10 ton minimum) compactor.

E. Soils that are soft, wet disturbed, unstable or otherwise unsuitable should be disked, dried and recompacted if weather permits or removed and replaced with engineered fill as determined by the project geotechnical engineer.

F. Proof roll subgrade to identify unstable, yielding soils in the presence of the project geotechnical engineer. Proofrolling shall consist of overlapping passes in a perpendicular grid pattern of a minimum 20 ton tri-axle dump truck, or other equipment imparting similar static loading on the soil moving at no more than walking speed.

G. Soft or unstable areas shall be overexcavated as directed by the project geotechnical engineer and backfilled with engineered fill. Engineered fill shall be placed in lifts not more than 9” in thickness, at moisture content within 3% of optimum, and compacted to a minimum density of 95% dry density as determined by ASTM D-1557. Engineered fill shall be placed to a minimum of five feet beyond the edges of the building and pavement areas and an additional foot horizontally for each vertical foot of new fill to be placed. Excavated soil within landscape areas shall be replaced with suitable soils compacted to no less than 90% of dry density as determined by ASTM D-1557.

H. When a firm and stable subgrade is established, low areas may be raised to planned grades with properly compacted engineered fill within building and pavement footprint areas and with satisfactory soils within landscape areas. Engineered fill should be unfrozen and free of organics, wood, construction debris, lumps and/or other harmful material.

I. Engineered fill shall be placed in lifts not more than 9” in thickness for cohesive soil and 12” in thickness for granular soils, at moisture content near optimum, and compacted to a minimum density of 95% dry density as determined by ASTM D-1557. Engineered fill shall be placed to a minimum of five feet beyond the edges of the building and pavement areas and an additional foot horizontally for each vertical foot of new fill to be placed. Fill placed within landscape areas shall be compacted to no less than 90% dry density as determined by ASTM D-1557.

J. If new fill depth in retaining wall, pavement or building areas is greater than 15 feet, the lower half of the fill sequence for clayey soil shall be compacted to 100% of the dry density as determined by ASTM D-1557 with the remaining fill above compacted to 95% of the dry density as determined by ASTM D-1557; or the lower half of the fill sequence shall consist of well graded sand with gravel with 15% or less fine material compacted to 95% of the Modified Proctor density (ASTM D-1557).

K. Where unsuitable materials are encountered at the foundation elevation for buildings, soil correction shall consist of additional excavation to remove unsuitable soils. If the overexcavation is filled with engineered fill, the overexcavation shall be widened to a minimum of 1H:1V ratio from the edge of the foundation. The overexcavation can then be backfilled to grade with suitable engineered fill consisting of a well graded granular material placed in lifts not exceeding 12” and compacted to at least 95% of the Modified Proctor density (ASTM D-1557). Alternatively, lean concrete with a minimum compressive strength of 1,000 psi could be used to fill the overexcavation to grade and lateral overexcavation will not be required.

L. Protect and maintain erosion and sedimentation controls during earthwork operations.

M. Provide protective insulating materials to protect subgrades and foundation soils against freezing temperatures or frost.

3.02 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
   1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
   2. Install a dewatering system to keep subgrades dry and convey ground water away from excavations. Maintain until dewatering is no longer required.

3.03 EXPLOSIVES

A. Explosives: Do not use explosives.

3.04 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil

materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

B. Shoring, Sheeting and Bracing: Shore, brace or slope banks of excavation to protect workmen, banks, adjacent paving, structures, and utilities to meet OSHA requirements. Design of temporary support of excavation is the responsibility of the Contractor.

3.05 SUBGRADE INSPECTION/PREPARATION

A. Building slab subgrade and pavement subgrade shall be evaluated by project geotechnical engineer prior to placement of any fill or base material to identify any soft or unstable areas.

B. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.

C. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.06 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings with engineered fill. Fill shall be compacted to 95% of the dry density and at moisture content within 3% of optimum moisture content as determined by modified Proctor test (ASTM D-1557).

3.07 STORAGE OF SOIL MATERIALS

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

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.08 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Testing of subgrades.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

C. Fill shall be placed in lifts not more than 9” in thickness for cohesive soils and 12” in thickness for granular soils, at moisture content near optimum, and compacted to a minimum density of 95% dry density as determined by ASTM D-1557. On-site soils may be used as new fill to raise grades over large areas as directed by the project geotechnical engineer.

3.09 SOIL FILL

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

B. Place and compact fill material in layers to required elevations as follows:

1. Under grass and planted areas, use satisfactory soil material.
2. Under walks and pavements, use engineered fill.
3. Under steps and ramps, use engineered fill.
4. Under building slabs, use engineered fill.
5. Under footings and foundations, use engineered fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.10 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 3 percent of optimum moisture content or as directed by project geotechnical engineer.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry otherwise satisfactory soil material that exceeds optimum moisture content by 3 percent and is too wet to compact to specified dry unit weight.

3.11 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 9 inches for cohesive soils and 12" for granular soil in loose depth for 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 soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 1557:
   1. Under structures, building slabs, and steps, scarify and re-compact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.
   2. Under pavements and walkways, scarify and re-compact top 6 inches below subgrade and compact each layer of backfill or fill soil material within three feet of the base course elevation at 95 percent.
   3. If new fill depth in retaining wall, pavement or building areas is greater than 15 feet, the lower half of the fill sequence for clayey soil shall be compacted to 100% of the dry density as determined by ASTM D-1557 with the remaining fill above compacted to 95% of the dry density as determined by ASTM D-1557; or the lower half of the fill sequence shall consist of well graded sand with gravel with 15% or less fine material compacted to 95% of the Modified Proctor density (ASTM D-1557).
   4. Under lawn or unpaved areas, scarify and re-compact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 90 percent.

3.12 CLAY LINER PLACEMENT

A. Clay liner should be compacted using a sheepsfoot (or similar type) compactor to a minimum of 90% of the Modified Proctor dry density value and at a moisture content approximately 2% wet of optimum as determined by ASTM D-1557.

B. Material shall be compacted in maximum 6-inch loose lifts.

C. Material shall be free of organics, cobbles, boulders, debris and any other unsuitable soils.

D. Clay shall be disked or otherwise mechanically processed before compaction to break up closds so that the maximum clod size is 4 inches.

E. Resulting clay liner shall have a minimum thickness of 2 feet.

3.13 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
   1. Provide a smooth transition between adjacent existing grades and new grades.
   2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
   3. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
      a. Lawn or Unpaved Areas: Plus or minus 1 inch.
      b. Walks: Plus or minus 1/2 inch.
      c. Pavements: Plus or minus 1/2 inch.

B. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.14 BASE COURSES

A. Place base course on subgrades free of mud, frost, snow, or ice.

B. Place base course in accordance with Section 305 of the Wisconsin Standard Specifications for Highway and Structure Construction.

3.15 FIELD QUALITY CONTROL

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

B. Allow testing agency to 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 evaluate all subgrades prior to placement of fill materials or base course material.

D. Testing agency shall evaluate pavement subgrades and base courses.

E. Testing agency will 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. Building/Pavement Slab Areas: At subgrade and at each compacted fill and backfill layer, at least 1 test for every 2000 sq. ft. or less of building/pavement slab or as recommended by project geotechnical engineer, but in no case fewer than 3 tests.
   2. Clay liner:
      a. At subgrade and at each compacted fill layer, at least 1 test on 100 foot grid intervals for every one foot thickness of clay liner.
      b. One modified proctor, atterberg limit test, grain size distribution test and permeability test shall be run for every 5,000 cubic yards of clay liner material placed.

F. 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.

3.16 PROTECTION

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

B. Repair and reestablish grades to specify 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 Architect; 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 greatest extent possible.

3.17 CONTAMINATED SOIL MANAGEMENT

A. Contaminated soil shall be managed on-site in accordance with the soil management plan.

B. Any contaminated soil hauled off-site shall be properly disposed of in accordance with applicable Federal and State Laws and shall be coordinated with the Project Manager, Philip Hung (414-315-4932) and the County Environmental Engineer, Tim Detzer (414-278-2988).

3.18 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

END OF SECTION

GEOTECHNICAL ENGINEERING REPORT

Bliffert Site Parking Lot
Milwaukee, Wisconsin

GESTRA Project No.: 14133-10
November 18, 2014

Prepared For:
The SIGMA Group
Milwaukee, WI

GESTRA

Geotechnical Engineering Report

Bliffert Site Parking Lot
Milwaukee, Wisconsin

GESTRA Project Number: 14133-10

November 18, 2014

Report Prepared for:
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Appendix I Project Vicinity Map
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Soil Evaluation Form for SB-1
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Appendix II Laboratory Test Results

Appendix III Preliminary Project Plan – "Rough Grading Package" provided by SIGMA

Geotechnical Engineering Report
Bliffert Site Parking Lot
Milwaukee, Wisconsin

GESTRA project No. 14133-10
November 18, 2014

1.0 INTRODUCTION

This report provides the results of the geotechnical exploration, analysis and recommendations by GESTRA Engineering, Inc. (GESTRA) for the proposed Bliffert Site Parking Lot project located west of Milwaukee County Zoo in Milwaukee, Wisconsin. Authorization to perform our services was given by Mr. James Leedom with The Sigma Group (SIGMA) on October 3rd, 2014. For the purpose of preparing this report, GESTRA has been provided with a Rough Grading Package plan (dated Nov. 19, 2014) prepared by SIGMA, a Plat of Survey Existing Site prepared by Milwaukee County Department of Parks & Public Infrastructure (dated Apr. 6, 2005), and a current Topographic Survey prepared by SIGMA.

1.1 Project Information

It is our understanding that the proposed project includes a surface parking lot which will encompass the majority of the project area. The design parking lot surface ranges from approximate elevations 795 feet (USGS datum 1929) at the north entrance road to elevation 763 feet at the south end. A stormwater management basin designed as a detention pond with a Type B liner is planned in the southwest corner with a bottom elevation of designed at elevation 757 feet. Four small slab on grade buildings are planned in the southeast corner of the site, which includes buildings identified as Turnstile (finish floor elevation=764 feet), Holding (FF= 763 feet), Retail (FF=764 feet), and Restrooms (FF= 762.4 feet). A new sanitary lift station is planned adjacent to the proposed Restroom building.

Retaining walls are planned along the west, north and east sides of the proposed parking lot. Per the Rough Grading Package plan, the north end retaining wall, the northern 700 feet of the east retaining wall, and northern 800 feet of the west retaining wall are designed as fill type walls with the exposed wall facing out from the parking lot and will retain the parking lot soils. The southern 500 feet of the east retaining wall and southern 550 feet of the west retaining wall are designed as cut type walls with the exposed wall facing in toward the parking lot, stormwater basin, or buildings and will retain the soils outside the parking lot. The rough grading plans indicate the retaining wall heights will be on the order of 1 foot to 18 feet along the perimeter of the northern fill type walls, a maximum 6 feet on the west side cut type wall, and 2 feet to 12 feet on the east side of the southern cut type wall.

The primary entrance and exit road for the parking lot is planned at the northeast corner of the property off of W. Bluemound Road. The parking lot is designed as seasonal lot for automobiles with traffic limited between May and October and occasional use on weekends in April. Maximum traffic is anticipated to be 700 cars per day.

The site currently has some significant variations in the existing grades. Therefore, extensive earthwork is anticipated for the site preparation. Excavations on the order of 15 feet may be required on the south end of the site and a combination of excavation and fill estimated between

2 feet to 18 feet will be necessary for the remainder of the site. Regrading of the existing slope on the east side of the site may also be required.

2.0 SCOPE OF WORK

GESTRA has performed the following services for the proposed Bliffert Site Parking Lot project in Milwaukee, Wisconsin:

1. Coordinated and adjusted the subsurface exploration program for the proposed parking lot and related facilities (pavement, buildings, slope, retaining wall and stormwater basin). The geotechnical soil boring scope was adjusted from the original locations based on site accessibility (buried utilities, wooded, sloped or fenced areas) and previous fill/soil conditions (environmentally impacted and partially remediated).
2. Performed thirteen (13) standard penetration (SPT) borings to depths ranging between 15 feet to 50 feet and one (1) 3 foot deep hand auger boring and dynamic cone penetration (DCP) test. Soil borings were performed using a rubber tire all terrain drilling rig (CME550) and truck mounted drill rigs (CME45 and CME75) then backfilled after completion as required by WDNR. Drilling spoil from selected borings identified by Milwaukee County was drummed for disposal by others.
3. Performed laboratory soil tests to assign classification and engineering properties to the soils encountered.
4. Prepared a preliminary geotechnical engineering report for review and comment by SIGMA and Milwaukee County. Updated the preliminary report based on comments and design changes for this geotechnical engineering report presenting the field explorations and lab testing results, subgrade conditions and recommendations pertaining to site preparation, building foundations, parking lot pavement, stormwater basin and soil parameters for the slope analysis and retaining wall design.

The design and evaluation of retaining walls and planned or existing slopes is outside the scope of our services. We understand contractor's design-build contract will require external stability evaluation of all retaining wall and evaluation of new or altered slopes. GESTRA is not responsible for the interpretation of our information by others in their design.

3.0 EXPLORATION RESULTS

3.1 Site Conditions

The overall existing site grades range from approximately 762 feet to 798 feet and generally slope downward from north to south with significant local variation. The surface of the site is generally grass and tree covered with some remnant pavement areas. Apparent unused metal and block buildings are present in the center portion of the site. The southern block building was reportedly used for environmental soil remediation.

Soil fill piles were observed in various areas of the site, but the most significant piles were observed mainly south of previous remediation system control building. Some of the soil fill was grass covered or had small shrub and tree growth.

The area of the planned entrance/exit road (around boring PB-4) and planned detention pond (south of boring SB-1) are severely wooded and steeply sloped, respectively. A portion of the future building area (around boring BB-1) is divided by fence for the County Zoo and has a sloped grade.

3.2 Previous Site History

The site previously included a railway staging area and industrial buildings before 1950's, but no records are available related to the demolition work or any associated earthwork that may have occurred. Some apparent recent site disturbance was noted around the existing billboard sign on the west side of the site. It was reported that remediation was performed on the north portion of the site for soil/groundwater contamination, but detailed information related to this work was not available.

3.3 Field Exploration

Field exploration work included thirteen (13) standard penetration (SPT) borings to depths ranging between 15 feet to 50 feet, and one (1) 3 foot deep hand auger boring and dynamic cone penetration (DCP) test. Boring BB-1 was performed in the area of the future buildings. Boring SB-1 was performed for the future stormwater basin design. Borings PB-1 through PB-4 were performed in the proposed surface parking lot and access road areas. Borings WRB-1 through WRB-5, ERB-1 and ERB-2 were performed in the area of future retaining walls and boring TB-1 was performed at the top of the existing slope on the east side of the site.

GESTRA performed all the borings using continuous hollow stem augers or mud rotary drilling. The specific drilling method used including the depths, rig type, crew chief, and borehole abandonment are included on each of the individual boring logs. All representative soil samples were taken in general accordance with the "Standard Method for Penetration Test and Split-Barrel Sampling of Soils" (ASTM D1586), and "Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes" (ASTM D1587). The samples were obtained at 2-½ foot intervals to a depth of 20 feet and then 5 foot intervals thereafter. The soil samples were visually and manually classified in the field by the crew in accordance with ASTM: D2487-93 and D2488-93.

The borings were completed at the approximate locations shown on the attached Topographic Survey in Appendix I. The location of each of boring was initially selected by GESTRA and located in the field by a representative from SIGMA. During site work, adjustments to the scope and location of the boring were made based on discussions with GESTRA, SIGMA and Milwaukee County and the final locations and ground surface elevations were obtained by SIGMA and subsequently provided to GESTRA.

After each sampling, a soil sample was retained and placed in a jar and recorded for type, color, consistency, and moisture, sealed and then transported to the laboratory for further review and testing, if required. The retained soil samples were classified by a geotechnical engineer using the Unified Soil Classification System and the Field Book for Describing and Sampling Soils, USDA, NRCS, 2002 for boring SB-1. A chart describing the classification systems used is included in the Appendix of this report. The engineer then assigned laboratory testing suited to extract important index properties of the soil layers. These tests included moisture contents, organic contents, unconfined compressive strength, unit weight, and Atterberg Limits and results are presented in Appendix II of this report.

3.4 Subsurface Soil Condition

The results of the field and laboratory tests and observations are depicted on the individual test boring logs included in the Appendix of this report. Soils were grouped together based on similar observed properties and stratification lines were estimated by the reviewing engineer based on the available data and experience. The actual in-situ changes between layers may differ slightly and may be more gradual than depicted on the boring logs. Subsurface and groundwater conditions can vary between borehole locations and in areas not explored by GESTRA.

In general, the test borings indicated irregular presence of deeper fill layers (5 ½ to 13 feet) especially at the northwest project area (impacted area), southwest project area (detention pond), central parking area (pavement borings PB-2 and PB-3), and east foothill area next to slope (ERB-1 and ERB-2). Shallower fill thickness was generally found in the west central planned pavement area (up to 6 feet). The existing fill/ possible fill material encountered varied throughout the borings performed and included clay, sand, silt, gravel and various other material including organic soil (SB-1, WRB-3, WRB-5), wood (WRB-1, WRB-4), and possible foundry sand (WRB-5). The cohesive fill material mainly consisted of lean clay and sandy lean clay with moisture contents of the samples tested that ranged between 16% and 26%. Table 1A summarizes the thickness of fill where observed in the test borings.

Below the fill material or surficial topsoil at borings TB-1 and PB-4, native lean/silty/sandy clay in a stiff to very stiff condition or sand/silty sand/sandy silt in a loose to medium dense condition were observed. The moisture content of samples of the native clayey soils ranged between 12 % and 24%.

Table 1A: Summary of Subsurface Conditions

Test Boring Location	Existing Ground Elevation (ft)	Approximate Depth* of Possible Fill/ Fill (ft)	Predominate Native Soils
BB-1	762.6	1	Sand, lean clay, silty clay
ERB-1	781.6	13	Clayey sand, silty sand
ERB-2	782.7	6	Lean clay, silty/lean clay
PB-1	766.1	3	Lean/silty clay, lean clay, silt
PB-2	773.8	10 ½	Sandy lean clay
PB-3	773.0	6	Silt, lean clay
PB-4	787.2	NE	Topsoil (1 ft), silty sand
SB-1	772.6	14	Silt, silty sand, lean clay
TB-1	800.9	NE	Topsoil (4 in), lean clay, silty clay, silt
WRB-1	767.9	10 ½	Lean clay
WRB-2	767.9	NE	Sandy silty clay, sandy silt, silty/lean clay
WRB-3	769.7	5 ½	Sand, silt, lean clay

Test Boring Location	Existing Ground Elevation (ft)	Approximate Depth* of Possible Fill/ Fill (ft)	Predominate Native Soils
WRB-4	773.1	10 ½	Lean/silty clay
WRB-5	797.8	11 ½	Sandy lean clay

*Depth is estimated based on samples collected; however, actual transition of fill and native soil may vary throughout the site.

NE = Not Encountered

It is important to note that the soil observations and soil layer thickness estimates were made in small diameter boreholes. Therefore, it should be understood that thicker or thinner deposits of the individual strata are likely to be encountered within other portions of the project. Furthermore, the estimation of strata thickness, such as topsoil or fill, at a particular location can differ from person to person due to a sometimes indistinct transition between the soils encountered. Additionally, it must be recognized that in the absence of foreign substances and/or debris within the soil samples obtained, it is sometimes difficult to distinguish between natural soils and clean soil fill.

3.5 Groundwater Observations

Groundwater measurements were attempted during and at the completion of the drilling operations. Groundwater was encountered within some of the borings and was at varying depths when observed. Table 1B summarizes groundwater levels observed during and after drilling.

Table 1B: Summary of Groundwater Observations

Boring Location	Groundwater During Drilling		Groundwater After Drilling		Cave In After Drilling	
	Depth (feet)	Elevation (feet)	Depth (feet)	Elevation (feet)	Depth (feet)	Elevation (feet)
BB-1	11.5	751.1	17.0	745.6	NMR	--
TB-1	32.0	768.9	37.0	763.9	NMR	--
SB-1	18.0	754.6	20.0	752.6	NMR	--
PB-1	NE	--	20.0	746.1	22	744.6
PB-2	NE	--	NE	--	13	760.8
PB-3	NE	--	NE	--	9	764.0
PB-4	NE	--	NE	--	NMR	--
ERB-1	17.0	764.6	22	759.6	25	756.6
ERB-2	12.0	770.7	NE	--	12	770.7
WRB-1	NE	--	NE	--	13	754.9
WRB-2	7.0	760.9	7.0	760.9	NMR	--
WRB-3	6.0	763.7	10.0	759.7	NMR	--

WRB-4	6.0	767.1	5.0	768.1	NMR	--
WRB-5	NE	--	NE	--	18.5	779.3

NE – Not Encountered
NMR – No Measurement Recorded

Groundwater level fluctuations may occur with time and seasonal changes due to variations in precipitation, evaporation, surface water runoff and local dewatering. Installation and monitoring of an observation well would be required to assess a true groundwater elevation. Perched water pockets at a higher elevation may also be encountered during wet weather periods, particularly with the varying elevations and presence of fill. Also, seasonal fluctuations of the water level should be anticipated.

4.0 ANALYSIS AND RECOMMENDATIONS

4.1 Discussions of Geotechnical Concerns

The items described in this section should be evaluated as part of the design and development of the site. These items are not the only concerns for the project, but should be considered along with the other recommendations presented in this report.

Limitations of the Geotechnical Exploration – The geotechnical scope was limited due to site access issues and the subsurface conditions are expected to vary as evidenced by the conditions encountered in our borings and the previous fill and or earthwork completed at the site. The retaining wall area on the east side has limited accessibility for our drill rigs due to sloped and wooded site conditions. Access was also limited for the parking lot entrance/exit road on the north and detention pond on the south which are heavily wooded areas. For the existing east side slope, our scope was limited one deep boring because of access on top of slope that was through the Milwaukee County Zoo. Existing fill material was visually observed around borings PB-2 and ERB-1 and the boring locations and depths were selected to attempt to identify the fill type and depth. Other areas with indications of previous fill work were present, but not accessible to our drilling equipment.

We have identified this issue to assist the owner, designer and contractor in understanding that variability should be anticipated and the borings completed cannot represent all subsurface conditions present. Without additional exploration, it should be understood that there is an increased chance beyond a typical project that unforeseen constructability issues or other soil related issues may arise during earthwork. Some of these issues may include additional soil correction costs, difficulty reusing site material, and variations in the site subsurface conditions which could impact design assumptions. We identified areas that may benefit from additional exploration in other sections of this report. To avoid excessive costs for creating access to additional exploration locations, the additional exploration work may need to be performed after site clearing has been completed.

Design Build Features May Require Additional Geotechnical Information – GESTRA understands the design of the retaining walls and planned slope construction or reconstruction are the responsibility of a contractor. This includes the regrading of the existing slope on the east side of the property, evaluation of stability for any slope impacted during construction, as well as internal, external and bearing evaluation of the proposed retaining walls. GESTRA's scope was limited to providing soil parameters based on the soil conditions encountered. As previously

discussed, the exploration scope was limited due to access and variability of the site conditions. Therefore, the designer for the retaining walls and slopes may benefit from additional geotechnical information because the information presented in this report is widely spaced in some areas and indicates significant variation in soil conditions.

4.2 Site Preparation and Grading

The general site preparation should start with removal of exposed concrete/asphalt, pavement/slabs, debris, vegetation, and topsoil. Existing structures should be completely removed. Unsuitable soils such as buried topsoil, vegetation, roots, debris, deleterious material, soil that contains significant amounts of organics that are encountered during excavation for the pavement subgrade, building, detention pond and retaining walls should be removed. In addition, all unused utilities that may be present should be properly removed or abandoned. Material removed from the project site should be disposed in accordance with all applicable federal, state, and local regulations. Soil should not be stockpiled near or adjacent to excavations.

The existing fill encountered indicated variability in the type of soil and relative strength and no information is available as to the placement or compaction of the fill material. Therefore, based on the information available, it is our opinion that any new building foundations and slabs should not be directly supported within or above the existing fill due to the potential of differential settlement. Supporting the proposed retaining wall above existing fill should be the determined by the retaining wall designer and suitability of the existing fill in any slope construction should be determined by the party responsible for evaluating the slope stability. The pavement areas may be supported by the existing non-organic fill, but the owner must understand the potential for additional risks that may include additional earthwork preparation costs and reduced pavement life. Additional site preparation measures are recommended in this report to assist in mitigating, but not eliminating, the potential risks. However, if the potential risk and are not acceptable, alternate site preparation methods such as removal and replacement may be required.

The following recommendations assume the existing non-organic fill material will remain in the pavement subgrade. Prior to new fill placement, soils that are soft, wet, disturbed, unstable or otherwise unsuitable should be disked, dried, and re-compacted if weather permits, or removed and replaced with engineered fill.

In the building and pavement areas after the site preparation described above and before base material is placed, a proof roll is recommended with a minimum 20 ton tri-axle dump truck, or like machinery imparting similar static loading on the soil and moving at no more than walking speed. A geotechnical engineer or their designated representative should be present during the proof roll in order to identify soft or unstable areas, if any, and subsequently recommend remediation procedures.

Based on our understanding of the project, excavation and fills greater than 5 feet will be required to attain subgrade elevation over portions of the site. Engineered fill should be unfrozen and free of organics, wood, construction debris, lumps, and/or other harmful materials. As a general rule for new fill placement, the lift thickness should not exceed 12 inches for granular soils and 9 inches for cohesive soil and the maximum particle size should be limited to 25% of the lift thickness. Engineered fill placed within the building pad, below foundations or in the pavement subgrade/base course should be compacted to a minimum of 95% of the Modified

Proctor maximum dry density value. Structural soil fill should be laterally expanded by a minimum of five feet beyond the edges of the new building and pavement areas, and an additional foot horizontally for each vertical foot of new fill to be placed to provide adequate lateral confinement. The inorganic site soils free of any deleterious material and debris that would be removed from excavations could be reused as structural fill; however, moisture conditioning of the material will be necessary and sifting or separation to remove unsuitable material prior to placement will be necessary. The contractor is responsible for determining proper means, method and project planning associated with reusing site material. Recommendation for fill material for the retaining walls and earthwork for slope construction should be determined by the designer as well as lateral extent of structural fill for the retaining wall and slopes.

The information presented in this report may be used to evaluate the site conditions for construction, but the contractor is responsible for determining site preparation means and methods required to complete the project. An aggressive construction schedule or construction during seasons with limited drying time may require considering alternate subgrade preparation methods such as extensive excavation and replacement of unstable subgrade material, utilizing a geotextile fabric prior to new fill placement, incorporating a granular sub-base layer to attempt to limit the amount of soil correction performed, or utilizing fly ash subgrade stabilization.

New fill placed as part of the site earthwork will impose new loading and lead to potential settlement associated with the underlying soils. Estimated primary settlement based on the soil conditions at pavement boring PB-3 may range from 3 inches to 5 inches if planned depths of new fill material are between 10 feet and 18 feet. This settlement estimate excludes the self-settlement of new fill material above existing grade which is discussed in the following paragraph.

When thicker areas of clayey fill are placed there is an increased potential for excessive total or differential settlement of structures, pavements and utilities as a result of secondary compression or hydrocompression of the new fill. This settlement would be in addition to the settlement that is a result of the new building or structure loading or weight of fill on the underlying soils. Estimating settlement as a result of secondary compression of the fill is difficult and dependent on several variables including the moisture content of the fill, thickness of the fill, type of soil, and amount of time the fill material has been in place. In our opinion, if the new fill depth in retaining wall or pavement areas is 15 feet or greater, additional measures might be considered for the development to limit the potential for secondary compression or hydrocompression of the new fill. Based on the Rough Grading Package provided to GESTRA, the primary locations of deeper planned new fill area are northwest quadrant of northern parking lot. To mitigate the potential for additional excessive settlement related to secondary compression of clayey fill, the following options may be considered.

- Early placement of clayey engineered fill – the fill could be placed and monitored with settlement plates to establish the amount and timing of the settlement prior to construction of the retaining wall or pavements.
- Increasing the required compaction – the lower half of the fill sequence for clayey soil could be required to be compacted to 100% of the Modified Proctor value and the remaining fill compacted to 95% of the Modified Proctor value. This option would

decrease the potential for settlement, but monitoring of settlement is still recommended if the fill thickness is greater than 15 feet.

- Utilizing granular fill – the lower half of the fill sequence could consist of well graded sand with gravel with 15% or less fine material compacted to 95% of the Modified Proctor value. Consolidation of granular fill material under new weight occurs more rapidly than clayey soils. This option may allow for construction without monitoring of settlement.

Previous environmental issues have been reported for this site. The presence of environmentally affected soils or groundwater can result in construction difficulties and delays, requiring additional excavation, trucking, special disposal, and backfilling. The costs associated with these activities can be substantial. Additional recommendations with regard to construction issues associated with affected soils are not included herein and are the responsibility of others.

4.3 Building Foundations

The design finished floor elevations of the proposed buildings vary between elevations 762 feet and 764 feet and we assumed the building shallow spread foundations are expected to be bear at elevation 759 feet or lower. At that elevation in boring BB-1, medium dense sand underlain by stiff to very stiff lean clay were encountered. In our opinion the planned shallow foundations can be designed for an allowable bearing capacity of up to 2,500 pounds per square foot (psf) for these native soils encountered. It should be noted that the closest accessible location for BB-1 was outside the planned building footprints. Additional exploration may be warranted to confirm the soils conditions in the area of the buildings for final design.

Where unsuitable soils are encountered at the foundation elevation, soil correction should consist of additional excavation to remove the unsuitable soils. If the over-excavation is being filled with engineered fill, we recommend the over-excavation be widened at a minimum 1H:1V ratio from the edge of the foundation. The over-excavation can then be filled to grade with suitable engineered fill consisting of a well graded granular material placed in lifts not exceeding 12 inches and compacted to at least 95% of the Modified Proctor density (ASTM D1557). Alternatively, lean concrete with a minimum compressive strength of 1,000 psi could be used to fill the over-excavation to grade and lateral over-excavation will not be required.

The depth of excavation required to expose suitable bearing material may vary between and beyond the areas explored by GESTRA. Due to the similarity of some of the native soil and fill material, we strongly recommend that a GESTRA field representative be present to observe and evaluate the suitability of the soils at the planned foundation subgrade elevations at the time of construction and to verify that the excavations extend through any unsuitable materials to a competent bearing stratum.

The shallow foundation design should incorporate a minimum strip footing width of 18 inches and column pad width of 24 inches, even if the allowable bearing capacity has not been fully utilized. All perimeter foundations should bear a minimum of 48 inches below grade for heated structures and 60 inches for unheated structures in order to protect the structure from frost heave. We recommend that foundations also be suitably reinforced in order to compensate for the effects of minor differential movements due to subsurface soil variations.

If the recommendations as stated in this report are used in the design and construction of the proposed building, it is our opinion that total settlements will be less than 1 inch.

4.4 Building Floor Slab Recommendations

Assuming the building slabs on grade are lightly loaded (150 psf or less), the slabs may be supported above the existing native site soils (silty sand or lean clay). For the subgrade material evaluated and prepared according to the recommendations in this report, we recommend that a subgrade reaction modulus of 100 pounds per square inch per inch of deflection (pci) be used in the design of the floor slabs on grade assuming at least a portion of the slab subgrade will consist of the existing clayey soils. This value assumes a 1 foot plate is used to determine the modulus and should be adjusted for the size of the floor slab and confinement effect. We recommend that the floor slabs be suitably reinforced and designed to be separate from the foundation system in order to allow for independent movements. Additional earthwork may be required to remove unsuitable soil in the building slab areas.

We recommend the installation of a capillary moisture break to be placed directly below building slabs. It should consist of at least 6 inches of clean sand or gravel with a maximum particle size of 1 inch containing no more than 5% passing the number 200 sieve (fines) and follow the recommendations of ACI 302.1, Section 4.1. If the floor slab is to include floor coverings, we recommend that the manufacturer be consulted to verify the proper incorporation of a vapor retarder. If a vapor retarder is used, we recommend it be placed in accordance with ACI 302.1 Section 3.2 and should meet the requirements of ASTM E1745. The vapor retarder should include proper sealing at penetrations, overlap at joints, and sealing at the interface of the wall and slab and may require an adequate cushion material to prevent damage

4.5 Retaining Walls

According to the Rough Grading Package plan provided by SIGMA, retaining walls are planned along the north, west and east boundaries of parking lot. GESTRA understands the retaining wall construction will require fill on the north project area and both excavation and fill on the south project area. This retention system will be subjected to lateral loads imposed by the retained soil and the lateral loads from the traffic or construction activities. The design back slope angle should be considered in the design, especially on east side of cut type walls.

The lateral earth pressure acting on retaining walls is dependent on the nature and density of the soil behind the wall, the amount of lateral wall movement that can occur as backfill is placed, and the inclination of the backfill. Walls that are free to yield at least one-thousandth of the height of the wall are in an “active” condition and an active earth pressure condition will develop.

Table 2A: Preliminary Design Active Earth Pressure for the North Fill Area**

Type of Retaining Material*	Angle of friction, (φ') degree	Unit weight (γ), pcf	Active Earth Pressure Coefficient, K_a
Clayey fill	28	130	0.36
Sandy fill	30	125	0.33

*Behind the reinforced granular fill area of planned modular block walls
**Backfill grade is assumed to be flat behind walls

Table 2B: Preliminary Design Active Earth Pressure for the South Cut Area

Location of Retaining Wall	Type of Retaining Material*	Angle of friction, (φ') degree	Unit weight (γ), pcf	Active Earth Pressure Coefficient, K_a
West Side	Clayey Soil	28	130	0.36
East Side	Clayey Soil	28	130	0.58#

*Behind the reinforced granular fill area of planned modular block walls
#Backfill grade is assumed to be 1V:2H sloped behind walls. Value should be modified for other backslope geometries.

These values are considered preliminary and general based on the soils conditions encountered. The actual earth pressure used should be determined by the designer and may require alternate values based on the wall configuration, soil type and planned construction. The lateral load from surface (traffic/construction activities) loads should also be considered in the retaining wall design. Retaining walls should also include proper drainage and grading to prevent the accumulation of water within retained soils or behind any walls or facing constructed.

Internal and external stability evaluation of retaining walls is outside of the scope of services for GESTRA on this project. GESTRA is providing the following shear strength parameters of base soils per each wall boring location (Tables 3A through 3G) for use by others in preliminary external and overall stability checks on the planned retaining wall sections (overturning, sliding, bearing and global stability). The actual values used should be determined by the designer and may require alternate values based on the wall configuration, soil type and planned construction.

As previously discussed, access to some areas of the site during our exploration was limited. Please note that the two soil borings ERB-1 and ERB-2 for the east retaining walls do not provide the typical amount of soil borings for retaining wall design for a wall of this length due to limited site accessibility for exploration equipment. Thus, conservative soil parameters are provided for the wall base soils and we recommend the party responsible for performing the retaining wall design consider additional exploration to finalize the retaining wall design planned on the east side of project area.

Table 3A: Estimated Soil Parameters for Retaining Wall Base Soils (ERB-1)

Observed Soil Type	Approximate Bottom Elevation (feet)	Estimated Soil Unit Weight (pcf)	Undrained		Drained	
			Cohesion, c (psf)	Friction Angle, degree	Cohesion, c (psf)	Friction Angle, degree
Dumped Fill (Clayey)	768.5	120	1,000	-	-	26
Loose to M. dense Clayey Sand	763.5	120	-	28	-	28
Medium dense Sand	752.5	125	--	30	-	30
Stiff Silty Clay	<751.5	130	2,000	-	-	30

Table 3B: Estimated Soil Parameters for Retaining Wall Base Soils (ERB-2)

Observed Soil Type	Approximate Bottom Elevation (feet)	Estimated Soil Unit Weight (pcf)	Undrained		Drained	
			Cohesion, c (psf)	Friction Angle, degree	Cohesion, c (psf)	Friction Angle, degree
Fill (Clayey)	777	125	1,000	-	-	26
Stiff to V. Stiff Lean Clay	770	130	2,500	-	-	30
M. Stiff to V. Stiff Silt/Clay	< 767	130	2,000	-	-	30

Table 3C: Estimated Soil Parameters for Retaining Wall Base Soils (WRB-1)

Observed Soil Type	Approximate Bottom Elevation (feet)	Estimated Soil Unit Weight (pcf)	Undrained		Drained	
			Cohesion, c (psf)	Friction Angle, degree	Cohesion, c (psf)	Friction Angle, degree
Possible Fill (Sandy/ Clayey)	757.5	120	1,500	-	-	28
Stiff Lean Clay	< 753	130	2,000	-	-	30

Table 3D: Estimated Soil Parameters for Retaining Wall Base Soils (WRB-2)

Observed Soil Type	Approximate Bottom Elevation (feet)	Estimated Soil Unit Weight (pcf)	Undrained		Drained	
			Cohesion, c (psf)	Friction Angle, degree	Cohesion, c (psf)	Friction Angle, degree
Sandy Silty Clay	764	125	1,000	-	-	28
Loose to M. Dense Sandy Silt	757.5	120	-	28	-	28
Stiff Silty/Lean Clay	755	130	2,000	-	-	30
M. Dense Sandy Silt	<753	125	-	30	-	30

Table 3E: Estimated Soil Parameters for Retaining Wall Base Soils (WRB-3)

Observed Soil Type	Approximate Bottom Elevation (feet)	Estimated Soil Unit Weight (pcf)	Undrained		Drained	
			Cohesion, c (psf)	Friction Angle, degree	Cohesion, c (psf)	Friction Angle, degree
Fill (Aggregate)	767	135	-	33	-	33
Fill (Clayey)	764	125	1,000	-	-	26
Loose to M. dense Silty Sand	759	120	-	28	-	28
Stiff to V. Stiff Lean Clay	< 755	130	2,000	-	-	30

Table 3F: Estimated Soil Parameters for Retaining Wall Base Soils (WRB-4)

Observed Soil Type	Approximate Bottom Elevation (feet)	Estimated Soil Unit Weight (pcf)	Undrained		Drained	
			Cohesion, c (psf)	Friction Angle, degree	Cohesion, c (psf)	Friction Angle, degree
Fill (Sandy)	763	125	-	28	-	28
Stiff to V. Stiff Silty/Lean Clay	< 758	130	2,000	-	-	30

Table 3G: Estimated Soil Parameters for Retaining Wall Base Soils (WRB-5)

Observed Soil Type	Approximate Bottom Elevation (feet)	Estimated Soil Unit Weight (pcf)	Undrained		Drained	
			Cohesion, c (psf)	Friction Angle, degree	Cohesion, c (psf)	Friction Angle, degree
Fill (Clayey)	794	125	1,500	-	-	28
Stiff to V. Stiff Lean Clay (Possible Fill)	786.5	130	2,000	-	-	30
Stiff to V. Stiff Sandy Clay	<778	130	2,000	-	-	30

New fill placed as part of the site earthwork will impose new loading and lead to potential settlement associated with the underlying soils. Primary settlement associated with the load from new fill on the soils below retaining walls was estimated from 1 inch to 2 inches for east wall based on boring log ERB-2 and from 2 inches to 4 inches for the west walls based on boring log WRB-4 for the maximum retaining wall heights for the east and west sides that are planned at 10 feet and 18 feet, respectively. Please note this settlement estimates excludes the potential for secondary compression or hydrocompression of new fill material above wall base grade.

4.6 Surface Parking Lot Pavement

This Wisconsin Asphalt Pavement Association (WAPA) Design Guide was used to provide the pavement section recommendations for the proposed Bliffert Site Parking Lot. Based on the overall size of the planned parking lot, we assumed a Traffic Class 2 for the parking lot. Based on the existing fill materials and native clayey soils encountered, GESTRA recommends that "poor soils" (estimated CBR value between 2 and 5, SSV = 2.5) conditions should be assumed as the subgrade soils. Table 4 includes recommendations for the hot mix asphalt pavement and base course thickness for the main parking lot. This recommendation assumes that the subgrade

will be prepared following the recommendations provided in this report and the traffic assumptions are valid.

Table 4: Pavement Design Recommendations for Parking Lot

Pavement Layer Type	Thickness, inches	Material Type	WisDOT Specifications
Hot Mix Asphalt	4	HMA Mix E-0.3	Section 460
Base Course (Dense Graded)	9	1¼ inch Crushed Stone	Section 305

The main entrance/exit drive and parking stalls will likely experience different traffic volumes than the main drives in the parking lot. As a result, consideration could be given to increasing the pavement section in the main entrance/exit drive and decreasing the pavement section in the area of parking stalls that will not be subjected to repeated traffic.

Table 5 summarizes the existing elevations, planned elevation and possible soil subgrade at each pavement boring. Excluding the locations where new fill is required to attain plan grades, the soils encountered at the anticipated subgrade elevations at boring locations PB-1, PB-2, ERB-1, WRB-2, and WRB-5 would like require soil correction.

Table 5: Summary of Pavement Borings

Boring	Existing Ground Elevation (feet)	Planned Grade (feet)	Anticipated Soil Subgrade Material
PB-1	766.1	764	Silty Sand (Possible Fill) or Lean Clay
PB-2	773.8	773	Existing Sandy Lean Clay Fill
PB-3	773	784	New fill
PB-4	787.2	786	Silty Sand
ERB-1	781.6	770	Existing Sandy Lean Clay Fill
ERB-2	782.7	792	New fill
WRB-2	767.9	764	Sandy Silty Clay
WRB-3	769.7	777	New fill
WRB-4	773.1	790.5	New fill
WRB-5	797.8	795	Existing Sandy Lean Clay Fill

One of the important considerations in designing a high quality and durable pavement is providing adequate drainage. Drainage design for the proposed pavement section is outside of the scope of GESTRA for this project. It is important that bird baths (leeching basins) and surface waves are not created during construction of the HMA layer. A proper slope should be allowed and drainage should be provided along the edges of pavements, behind retaining walls and around catch basins to prevent the accumulation of free water within the base course, which

otherwise may result in subgrade softening and pavement deterioration under exposure and repeated traffic conditions.

All pavements require regular maintenance and repair in order to maintain the serviceability of the pavement. These repairs and maintenance are due to normal wear and tear of the pavement surface and are required in order to extend the serviceability life of the pavement. However, after 10 years of service, a normal pavement structure is likely to deteriorate to a point where pavement rehabilitation may be required to maintain the serviceability. The deterioration is more likely if the pavement is constructed over poor subgrade soils or in area of higher traffic volumes.

4.7 Detention Pond Recommendation

GESTRA reviewed boring SB-1 following the general guidelines of the WDNR Conservation Practice Standard 1001 for the design of Wet Detention Ponds and classified the soils collected per USCS and the Field Book for Describing and Sampling Soils, USDA, NRCS, 2002. The existing soil conditions were compared to the specifications for Type B liner (proposed for this project) as provided in Appendix D (Pond Liner Design, Decision Flowchart) of the WDNR Standard 1001 to determine if the natural soils were suitable for use as clay liner material.

Based on the borings and lab testing performed, the native sandy soil that was encountered from approximate elevation 758.6 feet to 749.6 feet does not meet the requirements for a Type B liner. The following general recommendations are for the construction of the stormwater basin as a wet detention pond with a Type B liner and are in part developed based on the information available in the Wisconsin Department of Safety and Professional Services Chapter SPS 382.365 and 360.30 and Appendix D of Technical Standard 1001 (Type B liner). The final design and construction should meet the requirements of Technical Standard 1001.

As a minimum, the base, sides and berms at elevations up to the required design high water level should be constructed out of clay soils with the following properties:

- an average plasticity index (PI) of 7 or more with none less than 5,
- an average liquid limit (LL) of 16 or greater with none less than 14,
- a minimum of 50% of the soil by weight finer than the #200 sieve,
- a minimum of 90% of the soil by weight finer than the #4 sieve, and
- in-place hydraulic conductivity of $1x10^{-6}$ cm/second or less.

The clay liner soils should be compacted using a sheepsfoot (or similar type) compactor to a minimum of 90% of the Modified Proctor dry density value and at a moisture content approximately 2% wet of optimum as determined by ASTM D-1557. This material should be compacted in maximum 6-inch loose lifts and the compacted clay should be free of organics, cobbles, boulders, debris and any other unsuitable soils. The clay shall be disked or otherwise mechanically processed before compaction to break up clods so that the maximum clod size is 4 inches. The resulting clay liner should have a minimum thickness of 2 feet.

The water levels encountered in boring SB-1 were 754.6 feet during drilling and 752.6 after the completion of drilling. The water level is indicative of the conditions at the time of drilling. The contractor should consider this water level for their construction planning and understand that

water level may vary seasonally. Therefore, construction of the detention pond liner should include provisions for dewatering during construction and preventing surface water from entering the pond construction area.

The contractor is responsible for identifying a single source of suitable clay soil on site or locating a source of import soil to meet the liner design requirements. In lieu of a clay soil liner, alternate liners such as HDPE or PPL as defined in Technical Standard 1001 could be considered.

As previously discussed, the access to the detention pond area during our exploration was limited. The single soil boring SB-1 is less than the typical amount of soil borings for a detention pond design. Therefore, additional exploration and evaluation is recommended once the area has been cleared and is accessible to soil exploration equipment.

Additional quality assurance testing is recommended during construction to confirm the material being placed meets the project requirements. The final design should consider the existing groundwater elevation and potential impact on the liner design. Refer to NRCS Wisconsin Construction Specification 300 – Clay Liners for additional information pertaining to the placement and compaction of clay liner material.

4.8 Slope Boring and Soil Parameters

As previously identified, the design and evaluation of planned slopes, existing slopes or slopes altered by retaining wall construction is outside the scope of our services. Exploration was planned to collect information about the existing conditions and provide general soil parameters for the slope evaluation by others. Two slope borings were originally proposed, but the second boring was cancelled due to limited accessibility inside the County Zoo. For completed boring (TB-1), the soil encountered mainly consisted of native stiff clay. The following Table 6 provides the recommended properties for the soil encountered in TB-1 for use by others in preliminary analysis.

As previously discussed, access to some areas of the site during our exploration was limited. Please note that the single soil boring TB-1 likely does not represent the soil conditions present along the entire area of possible slope reconstruction. Thus, we recommend the party responsible for performing the slope evaluation and design consider additional exploration to obtain additional soil information for their design purpose.

Table 6: Estimated Soil Parameters for Slope Stability Check (TB-1)

Observed Soil Type	Approximate Bottom Elevation (feet)	Estimated Soil Unit Weight (pcf)	Undrained		Drained	
			Cohesion, c (psf)	Friction Angle, degree	Cohesion, c (psf)	Friction Angle, degree
V. Stiff Lean Clay	788	135	3,500	-	50	30
Stiff to V. Stiff Lean Clay	768	130	2,500	-	-	30
Loose to M. dense Sandy Silt	759	125	-	28	-	28
Stiff Silty/Lean Clay	<751	125	3,000	-	-	30

4.9 Seismic Site Classification

Site soils were assigned a site class in accordance with the International Building Code (IBC) classification system. Based on the native soil conditions observed and assuming these are consistent or better to a depth of 100 feet, it is our opinion that the appropriate classification for the site is class D. Based on site class D, and mapped spectral response acceleration S_s and S_1 for the site area, the site coefficient F_a and F_v from the International Building Code are 1.6 and 2.4, respectively.

4.10 Construction Material Testing Program

In our opinion, the type and size of the project proposed should have a comprehensive construction material testing program in order to ensure the quality of the foundation installation, soil compaction, and concrete and asphalt materials. We recommend that a geotechnical engineering firm be retained during the construction of the foundation system in order to determine that soil suitable for the design bearing capacity has been exposed. In the building pad areas, we recommend that 1 density test per 2,500 square feet and every 1 foot of fill be performed during placement and compaction of engineered fill or base course material. In pavement areas, we recommend that 1 density test per 5,000 square feet for every 1 foot of engineering fill is performed. Subgrade soils should be proof rolled prior to new fill and base course placement. A Modified Proctor test should be performed on any prospective engineered fill material to determine the optimum moisture content at the maximum dry density.

4.11 Additional Construction Considerations

The detailed means and methods of excavation and construction should be determined by the contractor and approved by the owner. Based on the specific site information, geotechnical exploration results and requirements for the proposed structures, the following issues should be taken into consideration during construction.

Dewatering

Groundwater was observed at a various depths in the pavement, stormwater basin, building and retaining wall borings and ranged from about 5 to 20 feet below ground surface at the time of the exploration (approximate elevation 746 feet to elevation 761 feet), but was not encountered in all the boring locations. Based on the planned finish floor elevation and the depths anticipated for foundation construction, excavation work for the planned building is anticipated to remain above the groundwater level. Review of the preliminary design information for the parking lot indicated that the remainder of the water levels encountered is likely lower than the planned grades. However, perched or trapped water within the existing fill soils may be also encountered during excavation work and deeper excavations such as utilities may encounter water in portions of the site. Based on the presence of predominantly cohesive soils, typical sump and pump techniques should be adequate to remove most water encountered during excavation work on this site.

The water level encountered in the detention pond boring SB-1 is discussed previously in this report. The temporary water level (764 feet to 768 feet) encountered in the slope boring TB-1 was lower than base elevations of fill type walls planned on the east side (from 774 feet to 781 feet). However, accurate water level measurement on the east slope will be required for the retaining wall and slope design, temporary excavation, and drainage design behind cut type wall.

Excavation Stability

Caving is a common issue for excavation side walls during construction, especially within existing fill and granular soils. An excavation plan should be developed and the length of excavation left open should be limited to prevent caving soil from covering the suitable bearing soils. The contractor must comply with the federal, state, local and updated OSHA regulations during excavation and in retention system design to ensure excavation safety.

OSHA has instituted strict standards for temporary construction excavations. These standards are outlined in 29 CFR Part 1926 Subpart P. Excavations within unstable soil conditions or extending five feet or more in depth should be adequately sloped or braced according to these standards. Excavation safety is the responsibility of the contractor. Material stockpiles or heavy equipment should not be placed, or operate near, the edge of the excavations. The actual stable slope angle should be determined during construction by the contractor and will depend upon the loading, soil, and groundwater conditions encountered.

Weather Implications

The subgrade soil or the soil at foundation level might become unstable with exposure to adverse weather such as rain, snow and freezing temperatures. Unstable areas due to weather exposure may require an additional undercut or stabilization and the representative of the geotechnical engineer should assist with the determination of the depth of additional undercut or stabilization required based on observation of the field condition.

Soil Sensitivity

Soil at the construction site will be exposed to moisture and disturbance from construction traffic, construction equipment and human factors. Since the near surface soils encountered are considered sensitive to moisture, every effort should be made to provide and maintain adequate drainage across the site during construction, and to minimize ponding on the subgrade. Foundations, floor slabs and pavement should be constructed immediately after the review of the representative geotechnical engineer.

Standard of Care

Our exploration was limited to evaluating subsurface soil and groundwater conditions pertaining to the proposed project. GESTRA did not perform any environmental, chemical, or hydrogeologic testing as these were not part of our work scope.

This report should be made available in its entirety to bidding contractors for information purposes. The soil borings and site sketch should not be detached from this report. Our report is not valid if used for purposes other than what is described in the report.

All OSHA regulations such as those regarding proper sloping and temporary shoring of excavations should be followed during the entire construction process.

GESTRA has presented our professional opinions in this report in the form of recommendations. Our opinions are based on our understanding of current project information and related accepted engineering practices at the time of this report. Other than this, no warranty is implied or intended.

Sincerely,

GESTRA Engineering, Inc.

Report Prepared By:

Sangho Lee

Sangho Lee, PE
Senior Engineer

Report Reviewed By:

Douglas Dettmers

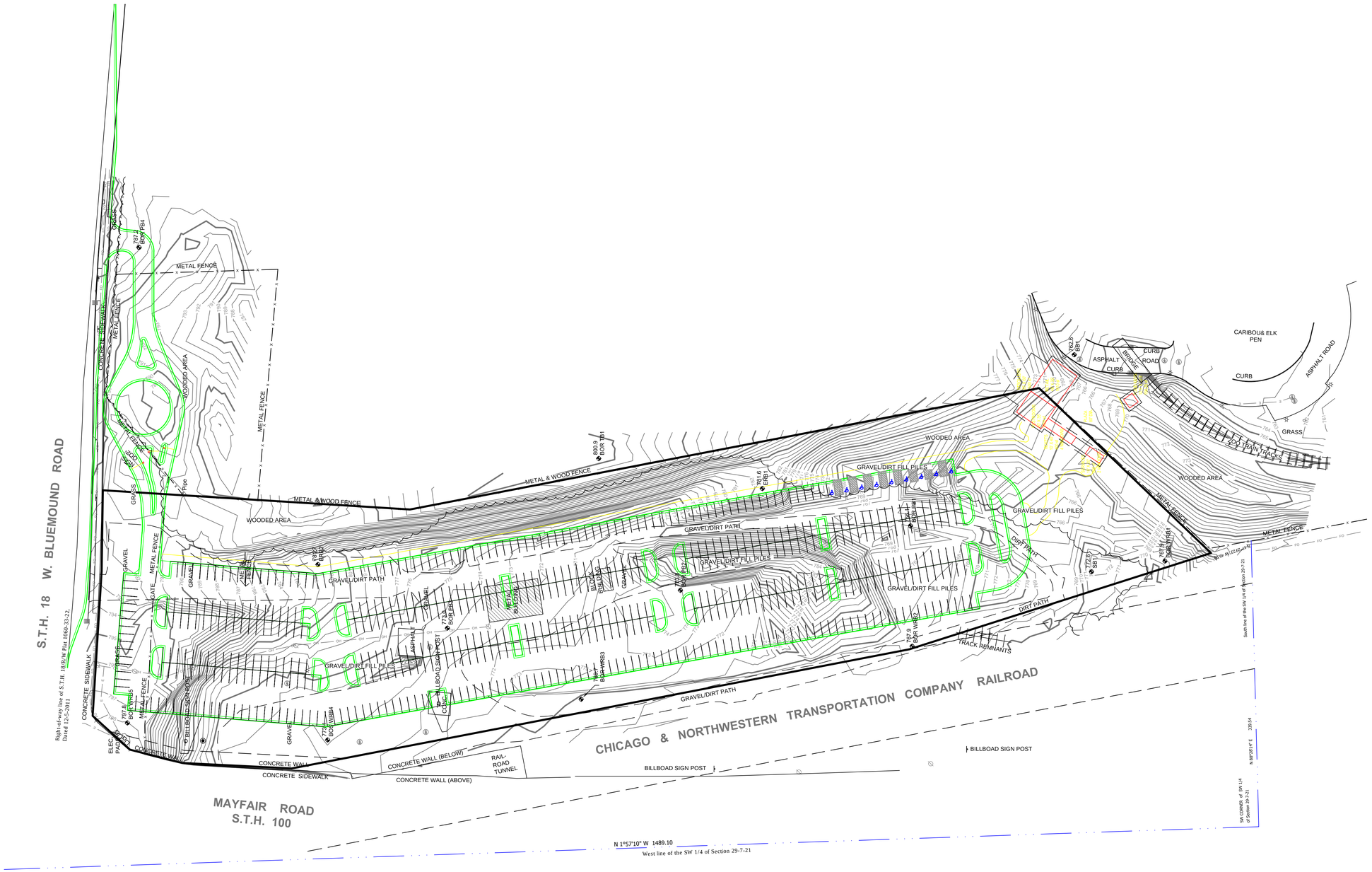
Douglas Dettmers, P.E.
Senior Engineer

Appendix I

Project Vicinity Map
Boring Layout Map – "Topographic Survey" provided by SIGMA
Boring Log Nomenclature
Soil Boring Logs
Soil Evaluation Form for SB-1
Dynamic Cone Penetrometer Test for PB-4

NORTH

Project Name & Location: Bliffert Site Parking Lot Milwaukee, Wisconsin	Project No.: 14133-10	Drawing Title: Project Vicinity Map	Drawn By: NS	GESTRA GESTRA Engineering, Inc. 1626 W. Fond du Lac Avenue Milwaukee, WI 53205 Phone: (414) 933-7444 Fax: (414) 933-7844 www.gestrainc.com
	Drawing No.: 1 of 1	Scale: Not scaled	Checked By: SHL	
			Date: November 5, 2014	



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LEGEND

- SECTION 1/4 SECTION LINE
- PROPERTY LINE
- EASEMENT
- CHAIN LINK FENCE
- GUARD RAIL
- METAL FENCE
- WOOD FENCE
- TREE LINE
- OVERHEAD UTILITY LINE
- ELECTRIC
- TELEPHONE
- FIBER OPTIC
- CABLE TV
- SANITARY SEWER
- FORCE MAIN
- STORM SEWER
- WATER MAIN
- GAS
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- MANHOLE
- CATCH BASIN
- CATCH BASIN (ROUND)
- ROOF DRAIN
- HYDRANT
- WATER VALVE
- GAS VALVE
- UTILITY POLE
- GUY WIRE
- GUY POLE
- GAS METER
- ELECTRIC METER
- UTILITY PEDESTAL
- HANDHOLE
- TRAFFIC SIGNAL
- IRON PIPE FOUND/SET
- REBAR FOUND/SET
- CHISELED CROSS FOUND/SET
- PK NAIL FOUND/SET
- SPIKE/NAIL
- MONUMENT
- BENCHMARK
- SIGN
- DECIDUOUS TREE (Diameter)
- CONIFEROUS TREE (Diameter)
- BUSH
- POST
- SOIL BORING
- MONITORING WELL
- CULVERT END
- LIGHT POLE

BLIFFERT LOT
10733 W. BLUEMOUND ROAD
MILWAUKEE, WISCONSIN

TOPOGRAPHIC SURVEY

BEARING REFERENCE
ELEVATION DATUM

0 60' 120'

GENERAL NOTES:

1. THE UNDERGROUND UTILITY INFORMATION SHOWN ON THIS DRAWING IS BASED ON FIELD LOCATIONS AND/OR RECORDS FURNISHED BY MUNICIPALITIES AND UTILITY COMPANIES. THE LOCATION AND ACCURACY OF WHICH CANNOT BE GUARANTEED. THERE MAY BE ADDITIONAL UNDERGROUND UTILITY INSTALLATIONS WITHIN THE PROJECT AREA THAT ARE NOT SHOWN.
2. VERIFY ACTUAL LOCATIONS AND INVERTS IN THE FIELD. ANY POTENTIAL ERRORS, OMISSIONS, OR DISCREPANCIES SHALL BE BROUGHT TO THE ATTENTION OF THE ENGINEER PRIOR TO PROCEEDING WITH CONSTRUCTION.
3. DRAWING IS BASED ON FIELD SURVEY COMPLETED BY B. ROZITE FROM 10-21-2014 THROUGH 10-28-2014.
4. VERTICAL DATUM FOR THE PROJECT SURVEY IS NGVD 1929. BENCHMARK FOR THE PROJECT SURVEY IS THE CONCRETE MONUMENT WITH BRASS CAP AT THE W 1/4 CORNER OF SECTION 29-7-21 HAVING AN ELEVATION OF 762.69 AS PUBLISHED BY SEWRPC.
5. HORIZONTAL DATUM IS WISCONSIN STATE PLANE COORDINATE SYSTEM, SOUTH ZONE, NAD 1927 WITH THE WEST LINE OF THE SOUTHWEST 1/4 OF SECTION 29-7-21 BEARING N 1°57'10" W.

NO.	REVISION	DATE	BY

DRWNG NO. 14930-V-010.dwg

DRAWN BY: B.M.R.

DATE: 10-29-2014

PROJECT NO: 14930

CHECKED BY:

APPROVED BY:

SHEET NO.:

1 OF 1

THE UNDERGROUND UTILITY INFORMATION SHOWN ON THIS MAP IS BASED ON FIELD MARKINGS AND INFORMATION FURNISHED BY UTILITY COMPANIES AND THE LOCAL MUNICIPALITY. WHILE THIS INFORMATION IS BELIEVED TO BE RELIABLE, ITS ACCURACY AND COMPLETENESS CANNOT BE GUARANTEED.

GENERAL NOTES

DRILLING AND SAMPLING SYMBOLS

SYMBOL	DEFINITION
HSA	Hollow Stem Auger
RWB	Rotary Wash Boring (Mud Drilling)
_FA	4", 6" or 10" Diameter Flight Auger
_HA	2", 4" or 6" Hand Auger
_DC	2 1/2" , 4" , 5" or 6" Steel Drive Casing
_RC	Size A, B, or N Rotary Casing
PD	Pipe Drill or Cleanout Tube
CS	Continuous Split Spoon Sampling
DM	Drill Mud
JW	Jetting Water
SS	2" O.D. Split Spoon Sample
_L	2 1/2" or 3 1/2" O.D. SB Liner Sample
ST	3" Thin Walled Tube Sample (Shelby Tube)
3TP	3" Thin Walled Tube (Pitcher Sampler)
_TO	2" or 3" Thin Walled Tube (Osterberg Sampler)
W	Wash Sample
B	Bag Sample
P	Test Pit Sample
_Q	BQ, NQ, or PQ Wireline System
_X	AX, BX, or NX Double Tube Barrel
CR	Core Recovery – Percent
NSR	No Sample Recovered, classification based on action of drilling, equipment and/or material noted in drilling fluid or on sampling bit.
NMR	No Measurement Recorded, primarily due to presence of drilling or coring fluid.
▽	Water Level Symbol

TEST SYMBOLS

SYMBOL	DEFINITION
MC	Moisture Content - % of Dry Wt. – ASTM D 2216
OC	Organic Content - % of Dry Wt. – ASTM D 2974
DD	Dry Density – Pounds Per Cubic Foot
LL, PL	Liquid and Plastic Limit – ASTM D 4318

Additional Insertions

Qu	Unconfined Comp. Strength-psf – ASTM D 2166
Qp	Penetrometer Reading – Tons/Square Foot
Ts	Torvane Reading – Tons/Square Foot
G	Specific Gravity – ASTM D 854
SL	Shrinkage Limits – ASTM D 427
OC	Organic Content – Combustion Method
SP	Swell Pressure - Tons/Square Foot
PS	Percent Swell
FS	Free Swell – Percent
pH	Hydrogen Ion Content. Meter Method
SC	Sulfate Content – Parts/ Million, same as mg/L
CC	Chloride Content - Parts/ Million, same as mg/L
C*	One Dimensional Consolidation – ASTM D 2453
Qc*	Triaxial Compression
D.S.*	Direct Shear – ASTM D 3080
K*	Coefficient of Permeability – cm/sec
D*	Dispersion test
DH*	Double Hydrometer – ASTM D 4221
MA*	Particle Size Analysis – ASTM D 422
R	Laboratory Receptivity, in ohm – cm – ASTM G 57
E*	Pressuremeter Deformation Modulus – TSF
PM*	Pressuremeter Test
VS*	Field Vane Shear – ASTM D 2573
IR*	Infiltrometer Test – ASTM D 3385
RQD	Rock Quality Designation – Percent

*See attached data sheet or graph

WATER LEVEL

Water levels shown on the boring logs are the levels measured in the borings at the time and under the conditions indicated. In sand, the indicated levels may be considered reliable ground water levels. In clay soil, it may not be possible to determine the ground water level within the normal time required for test borings, except where lenses or layers of more pervious waterbearing soil are present. Even then, an extended period of time may be necessary to reach equilibrium. Therefore, the position of the water level symbol for cohesive or mixed texture soils may not indicate the true level of the ground water table. Perched water refers to water above an impervious layer, thus impeded in reaching the water table. The available water level information is given at the bottom of the log sheet.

DESCRIPTIVE TERMINOLOGY

DENSITY TERM	"N" VALUE
Very Loose	0-4
Loose	4-10
Medium Dense	10-30
Dense	30-50
Very Dense	Over 50

CONSISTENCY TERM	Unconfined Compressive Strength, (tsf)	"N" VALUE
Very Soft	<0.25	0-2
Soft	0.25 - 0.49	2-4
Medium Stiff	0.5 - 0.99	4-8
Stiff	1.0 - 1.99	8-16
Very Stiff	2.0 - 3.99	16-30
Hard	4.0+	Over 30

Standard "N" Penetration: Blows per Foot of a 140 Pound Hammer Falling 30 inches on a 2 inch OD Split Barrel Sampler

Lamination	Up to 1/2" thick stratum
Layer	1/2" to 6" thick stratum
Lens	1/2" to 6" discontinuous stratum
Varved	Alternating laminations
Dry	Powdery, no noticeable water
Moist	Below saturation
Wet	Saturated, above liquid limit
Water bearing	Pervious soil below water

RELATIVE GRAVEL PROPORTIONS

CONDITION	TERM	RANGE
Coarse Grained Soils	trace of gravel	2-14%
	with gravel	15-49%
Fine Grained Soils		
15-29% + No. 200	trace of gravel	2-14%
15-29% + No. 200	with gravel	15-29%
30% + No. 200	trace of gravel	2-14%
30% + No. 200	with gravel	15-24%
30% + No. 200	gravelly	25-49%

RELATIVE SIZES

Boulder	Over 12"
Cobble	3" - 12"
Gravel	
Coarse	3/4" - 3"
Fine	#4 – 3/4"
Sand	
Coarse	#4 - #10
Medium	#10 - #40
Fine	#40- #200
Silt & Clay	- # 200, Based on Plasticity

SOILS CLASSIFICATION FOR ENGINEERING PURPOSES

ASTM Designation: D 2487 - 83

(Based on Unified Soil Classification System)

SOIL ENGINEERING

		Criteria for Assigning GroupSymbols and Group Names Using Laboratory Tests [A]		Soil Classification[B] Group Symble	Group Name
Coarse-Grained Soils More than 50% retained on No. 200 sieve	Gravels More than 50% coarse fraction retained on No. 4 sieve	Clean Gravels Less Less than 5% fines [C]	Cu≥ 4 and 1≤ Cc ≤3[E]	GW	Well graded gravel [F]
			Cu< 4 and/or 1> Cc >3[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 sandss Less than 5% fines [D]	Cu≥ 6 and 1≤ Cc ≤3[E]	SW	Well graded sand [I]
			Cu< 6 and/or 1> Cc >3[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 on or above " A" line	CL	Lean clay [K.L.M]
			PI<4 or plots below " A " line	ML	Silt [K.L.M]
		organic	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OL	Organic clay [K.L.M.N] Organic Silt [K.L.M.O]
	Silts and Clays Liquid Limit 50 or more	inorganic	PI plots on or above " A " line	CH	Fat clay [K.L.M]
			PI plots below " A " line	MH	Elastic silt [K.L.M]
		Organic	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OH	Organic clay [K.L.M.P] Organic Silt [K.L.M.Q]
Highly organic Soils		Primarily organic matter, dark in color, and organic odor		PT	Peat
Fibric Peat > 67% Fibers		Hemic Peat 33 % - 67 % Fibers		sapric	Peat < 33% Fibers

[A] Based on the material passing the 3-in (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] $Cu = \frac{D_{60}}{D_{10}}$ $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

[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 hatched area, soil is a CL_ML silty clay
If soil contains 15 to 29% plus No. 200, add, "with sand" or " with gravel", whichever is predominent

[L] If soil contains ≥ 30% plus No.200, predominantly sand, add "sandy" to the group name

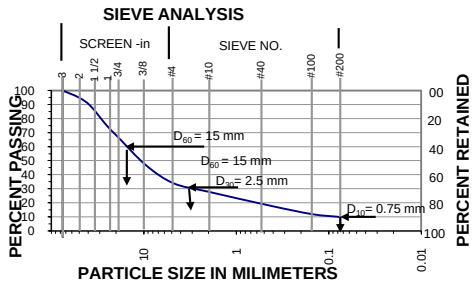
[M] If soil contains ≥ 30% plus No.200, predominantly gravel add "gravelly" to the group name

[N] PI ≥4 and plots on or above "A" Line

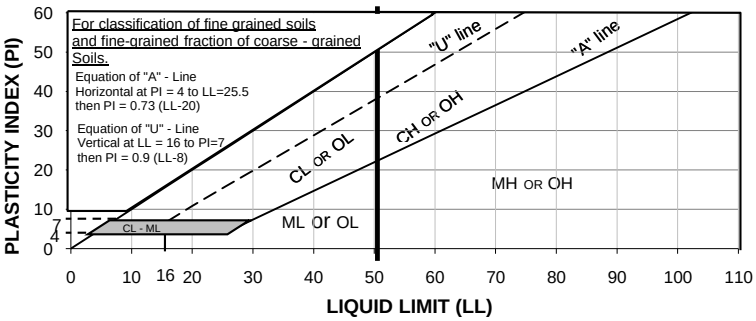
[O] PI < 4 or plots below "A" Line

[P] PI plots on or above "A" Line

[Q] PI plots below "A" Line



$Cu = \frac{D_{60}}{D_{10}} = \frac{15}{0.075} = 200$ $C_c = \frac{(D_{30})^2}{D_{60} X D_{10}} = \frac{(2.5)^2}{15X\ 0.075} = 5.6$



Geotechnical -Structural- Pavement - Construction Materials

SOILS CLASSIFICATION FOR ENGINEERING PURPOSES

(Based on U.S. Dept. of Agriculture & Natural Resources Conservation Service)

SOIL ENGINEERING

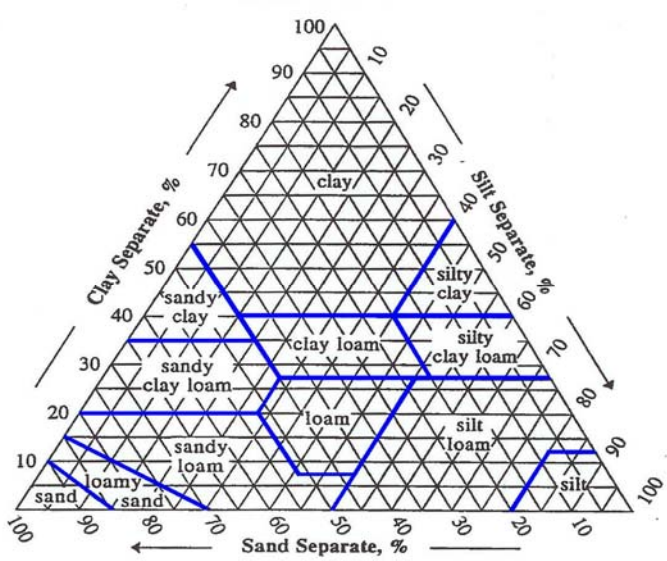
		Criteria for Assigning GroupSymbols and Group Names Using Laboratory Tests		Soil Classification: Group Symble	Soil Classification: Group Name
Coarse-Grained Soils More than 15% retained on No. 10 sieve	Rock Fragments	≥ 15% but < 35% rock fragments	> 25"	BY	Boulders
			10" < 25"	ST	Stones
			3" < 10"	CB	Cobbles
	Gravels	≥ 15% but < 35% gravel	3/4" < 3"	CGR	Coarse Gravel
			# 4 < 3/4"	MGR	Medium Gravel
			# 10 < # 4	FGR	Fine Gravel
Sands	Texture class based on Texture Triangle	Use rock fragment modifiers if > 15% retained on # 10	# 18 < # 10	VCOS	Very Coarse Sand
			# 35 < # 18	COS	Coarse Sand
			# 60 < # 35	S	Sand
			# 140 < # 60	FS	Fine Sand
			# 300 < # 140	VFS	Very Fine Sand
Fine-Grained Soils 50% or more passes the No. 300 sieve	Silts and Clays Texture class based on Texture Triangle	Use rock fragment modifiers if > 15% retained on # 10	.02 mm < .05 mm		Coarse Silt
			.002 mm < .02 mm		Fine Silt
			.0002 mm < .002 mm		Coarse Clay
			< .0002 mm		Fine Clay

[F] Use Field Book for Describing and Sampling Soils V 2.0

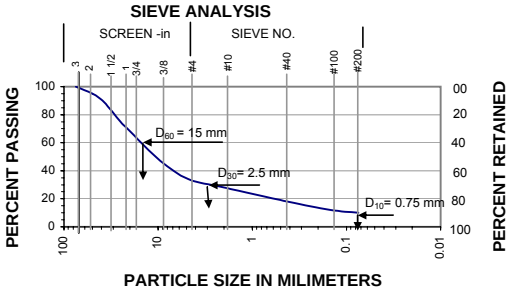
Texture Classes [F]	Code
Loamy Coarse Sand	LCOS
Loamy Sand	LS
Loamy Fine Sand	LFS
Loamy Very Fine Sand	LVFS
Coarse Sandy Loam	COSL
Sandy Loam	SL
Fine Sandy Loam	FSL
Very Fine Sandy Loam	VFSL
Loam	L
Silt Loam	SIL
Silt	SI
Sandy Clay Loam	SCL
Clay Loam	CL
Silty Clay Loam	SICL
Sandy Clay	SC
Silty Clay	SIC
Clay	C

15 < 35 %	size adjective
35 < 60 %	Very (size adj.)
60 < 90 %	Extremely (size adj.)

Texture Triangle



SIEVE ANALYSIS



SOIL BORING LOG

GESTRA
Gestra Engineering Inc.
1626 W. Fond du Lac Avenue
Milwaukee, WI 53205
Phone: 414-933-7444, Fax: 414-933-7844

PROJECT NAME	Bliffert Site Parking Lot
DATE DRILLING STARTED	10/15/2014
PROJECT LOCATION	Milwaukee, WI
DATE DRILLING ENDED	10/15/2014
BORING NUMBER	BB-1
PROJECT NUMBER	14133-10
DRILLING RIG	CME 75 (International)
BORING DRILLED BY	FIRM: Gestra CREW CHIEF: A. Woerpel
FIELD LOG	J. Collins
LAB LOG / QC	S. Lee
NORTHING	
EASTING	
DRILLING METHOD	3¼" HSA
SURFACE ELEVATION	762.6 ft

Number and Type	Recovery (in)	Blow Counts	N - Value	Depth (ft)	Elevation	Soil Description and Geological Origin for Each Major Unit	USCS Classification	Unconfined Comp. Strength (Q_u or Q_p) (tsf)	Liquid Limit	Plasticity Index	Moisture Content (%)	Comments
						ASPHALT (3.5") 0.3 (762.3)						
						CONCRETE (7") 0.9 (761.7)						
SS - 1	16	7 8 9	17			SAND WITH GRAVEL, brown, moist, medium dense 3 (759.6)	SP					
SS - 2	18	4 6 6	12	5	757.6	SAND, brown, moist, medium dense	SP					
SS - 3	18	3 5 6	11			7 (755.6)						
SS - 4	18	3 6 7	13	10	752.6	LEAN CLAY, brown, moist, very stiff Color change to gray in 8.5'	CL	3.50	23	11		
SS - 5	16	5 9 11	20			11.5 (751.1) SAND WITH GRAVEL, gray, wet, medium dense 13 (749.6)	SP					
SS - 6	16	6 7 13	20	15	747.6	SILTY CLAY, gray, moist, very stiff to hard, trace sand		3.00	20	7		
SS - 7	18	6 7 15	22					3.0-4.0			18	
SS - 8	18	6 8 10	18	20	742.6	Trace gravel at 18.5'	CL-ML	4.50			15	
SS - 9	18	4 9 17	26	25	737.6	25 (737.6)		4.00			11	

End of Boring at 25.0 ft.

WATER & CAVE-IN OBSERVATION DATA

▽	WATER ENCOUNTERED DURING DRILLING: 11.5 ft.	CAVE DEPTH AT COMPLETION: NMR	WET ☐ DRY ☐
▼	WATER LEVEL AT COMPLETION: 17 ft.	CAVE DEPTH AFTER 0 HOURS: NMR	WET ☐ DRY ☐
▼	WATER LEVEL AFTER 0 HOURS: NMR	NE = Not Encountered; NMR = No Measurement Recorded	

NOTE: Stratification lines between soil types represent the approximate boundary; gradual transition between in-situ soil layers should be expected.

SOIL BORING LOG

Gestra Engineering Inc.
1626 W. Fond du Lac Avenue
Milwaukee, WI 53205
Phone: 414-933-7444, Fax: 414-933-7844

PROJECT NAME	Bliffert Site Parking Lot
DATE DRILLING STARTED	10/15/2014
PROJECT LOCATION	Milwaukee, WI
DATE DRILLING ENDED	10/15/2014
BORING NUMBER	ERB-1
PROJECT NUMBER	14133-10
DRILLING RIG	CME 550
BORING DRILLED BY	FIRM: Gestra CREW CHIEF: M. Panfil
FIELD LOG	D. Harris
LAB LOG / QC	S. Lee
NORTHING	
EASTING	
DRILLING METHOD	3¼" HSA
SURFACE ELEVATION	781.6 ft

Number and Type	Recovery (in)	Blow Counts	N - Value	Depth (ft)	Elevation	Soil Description and Geological Origin for Each Major Unit	USCS Classification	Graphic	Well Diagram	Unconfined Comp. Strength (Q_u or Q_p) (tsf)	Liquid Limit	Plasticity Index	Moisture Content (%)	Comments
						LEAN CLAY, brown, moist, trace sand and plastic, (FILL)								
SS - 1	15	3 4 3	7				CL						20	
SS - 2	0	0 0 1	1	5	776.6									
						5.5 (776.1)								
						SANDY LEAN CLAY, brown to gray, moist, trace gravel, (FILL)								
SS - 3	10	0 2 1	3								32	18	19	
SS - 4	8	0 0 0	0	10	771.6		CL						16	
SS - 5	18	1 2 4	6										26	
						13 (768.6)								
						CLAYEY SAND, brown, moist, very stiff								
SS - 6	18	2 4 5	9	15	766.6	With a 6" thick clay seam at 14'								
							SC							
SS - 7	18	3 4 8	12			Wet at 17'								
						18 (763.6)								
						SILTY SAND, brown, wet, medium dense								
SS - 8	18	3 5 6	11	20	761.6									
							SM							
SS - 9	18	10 13 16	29	25	756.6									

WATER & CAVE-IN OBSERVATION DATA

▽	WATER ENCOUNTERED DURING DRILLING: 17 ft.	CAVE DEPTH AT COMPLETION: 25 ft.	WET ☐ DRY ☐
▼	WATER LEVEL AT COMPLETION: 22 ft.	CAVE DEPTH AFTER 0 HOURS: NMR	WET ☐ DRY ☐
▼	WATER LEVEL AFTER 0 HOURS: NMR	NE = Not Encountered; NMR = No Measurement Recorded	

NOTE: Stratification lines between soil types represent the approximate boundary; gradual transition between in-situ soil layers should be expected.

Gestra Engineering Inc.
1626 W. Fond du Lac Avenue
Milwaukee, WI 53205
Phone: 414-933-7444, Fax: 414-933-7844

SOIL BORING LOG

PROJECT NAME: Bliffert Site Parking Lot	DATE DRILLING STARTED: 10/15/2014	BORING NUMBER: **ERB-1**	
PROJECT LOCATION: Milwaukee, WI	DATE DRILLING ENDED: 10/15/2014	PROJECT NUMBER: 14133-10	
		DRILLING RIG: CME 550	
BORING DRILLED BY: FIRM: Gestra, CREW CHIEF: M. Panfil	FIELD LOG: D. Harris	NORTHING	DRILLING METHOD: 3¼" HSA
	LAB LOG / QC: S. Lee	EASTING	SURFACE ELEVATION: 781.6 ft

Number and Type	Recovery (in)	Blow Counts	N - Value	Depth (ft)	Elevation	Soil Description and Geological Origin for Each Major Unit	USCS Classification	Graphic	Well Diagram	Unconfined Comp. Strength (Q_u or Q_p) (tsf)	Liquid Limit	Plasticity Index	Moisture Content (%)	Comments
						SILTY SAND, brown, wet, medium dense	SM							
						29 (752.6)								
SS - 10	18	4 3 20	23			SILTY CLAY, gray, very moist to wet, medium dense	CL-ML				20	9	17	
				30	751.6	30 (751.6)								
						End of Boring at 30.0 ft.								
				35	746.6									
				40	741.6									
				45	736.6									
				50	731.6									

WATER & CAVE-IN OBSERVATION DATA

WATER ENCOUNTERED DURING DRILLING: 17 ft.	CAVE DEPTH AT COMPLETION: 25 ft.	WET ☐ DRY ☐
WATER LEVEL AT COMPLETION: 22 ft.	CAVE DEPTH AFTER 0 HOURS: NMR	WET ☐ DRY ☐
WATER LEVEL AFTER 0 HOURS: NMR	NE = Not Encountered; NMR = No Measurement Recorded	

NOTE: Stratification lines between soil types represent the approximate boundary; gradual transition between in-situ soil layers should be expected.

SOIL BORING LOG

Gestra Engineering Inc.
1626 W. Fond du Lac Avenue
Milwaukee, WI 53205
Phone: 414-933-7444, Fax: 414-933-7844

PROJECT NAME: Bliffert Site Parking Lot	DATE DRILLING STARTED: 10/15/2014	PAGE NUMBER: 1 of 1	BORING NUMBER: **ERB-2**
PROJECT LOCATION: Milwaukee, WI	DATE DRILLING ENDED: 10/15/2014	PROJECT NUMBER: 14133-10	DRILLING RIG: CME 550
BORING DRILLED BY: FIRM: Gestra, CREW CHIEF: M. Panfil	FIELD LOG: D. Harris	NORTHING	DRILLING METHOD: 3¼" HSA
	LAB LOG / QC: S. Lee	EASTING	SURFACE ELEVATION: 782.7 ft

Number and Type	Recovery (in)	Blow Counts	N - Value	Depth (ft)	Elevation	Soil Description and Geological Origin for Each Major Unit	USCS Classification	Graphic	Well Diagram	Unconfined Comp. Strength (Q_u or Q_p) (tsf)	Liquid Limit	Plasticity Index	Moisture Content (%)	Comments
						SANDY LEAN CLAY, brown to gray, moist, trace gravel, with sand seams, (FILL)								
SS - 1	15	5 13 10	23				CL						15	
SS - 2	18	5 7 10	17	5	777.7								10	
						5.5 (777.2)								
						LEAN CLAY, gray, moist, stiff to very stiff								
SS - 3	18	3 9 8	17							2.0			15	
SS - 4	18	5 7 10	17	10	772.7		CL			1.0-3.5 **(2.6)**			16	γ_d = 120.3 pcf γ_T = 139.2 pcf
SS - 5	18	3 5 17	22							3.00				
						12 (770.7)								
						SANDY SILT, gray, wet, medium dense	ML							
						13 (769.7)								
						LEAN CLAY, gray, moist to very moist, stiff to very stiff								
SS - 6	18	8 11 7	18	15	767.7		CL			1.0-3.5			19	
						15 (767.7)								
						End of Boring at 15.0 ft.								
				20	762.7									
				25	757.7									

WATER & CAVE-IN OBSERVATION DATA

WATER ENCOUNTERED DURING DRILLING: 12 ft.		CAVE DEPTH AT COMPLETION: 12 ft.	WET ☐ DRY ☐
WATER LEVEL AT COMPLETION: NE		CAVE DEPTH AFTER 0 HOURS: NMR	WET ☐ DRY ☐
WATER LEVEL AFTER 0 HOURS: NMR		NE = Not Encountered; NMR = No Measurement Recorded	

NOTE: Stratification lines between soil types represent the approximate boundary; gradual transition between in-situ soil layers should be expected.

SOIL BORING LOG

Gestra Engineering Inc.
1626 W. Fond du Lac Avenue
Milwaukee, WI 53205
Phone: 414-933-7444, Fax: 414-933-7844

PROJECT NAME	Bliffert Site Parking Lot
DATE DRILLING STARTED	10/15/2014
PROJECT LOCATION	Milwaukee, WI
DATE DRILLING ENDED	10/15/2014
BORING NUMBER	PB-1
PROJECT NUMBER	14133-10
DRILLING RIG	CME 550
BORING DRILLED BY	FIRM: Gestra CREW CHIEF: M. Panfil
FIELD LOG	D. Harris
LAB LOG / QC	S. Lee
NORTHING	
EASTING	
DRILLING METHOD	3¼" HSA
SURFACE ELEVATION	766.1 ft

Number and Type	Recovery (in)	Blow Counts	N - Value	Depth (ft)	Elevation	Soil Description and Geological Origin for Each Major Unit	USCS Classification	Graphic	Well Diagram	Unconfined Comp. Strength (Q_u or Q_p) (tsf)	Liquid Limit	Plasticity Index	Moisture Content (%)	Comments
						SILTY SAND, brown, very moist, medium dense, trace gravel, (possible fill)								
SS - 1	15	4 6 8	14				SM							
						3 (763.1)								
						LEAN CLAY, brown, moist, very stiff								
SS - 2	18	3 9 9	18	5	761.1		CL			2.0-3.0			27	
SS - 3	18	5 4 6	10			7 (759.1)				2.25-2.5			15	
						SILTY CLAY, gray, moist, stiff to very stiff								
SS - 4	18	3 4 7	11	10	756.1		CL-ML			1.0-1.5			16	
SS - 5	18	2 2 5	7							1.5-3.5			18	
						13 (753.1)								
						LEAN CLAY, gray, moist, stiff to hard								
SS - 6	18	2 3 6	9	15	751.1		CL			3.0-4.5+			21	
SS - 7	18	4 6 8	14			Trace gravel in sample SS-7				1.0-3.5			23	
						18 (748.1)								
						SILT, gray, moist, medium dense to very dense								
SS - 8	18	7 11 16	27	20	746.1		ML							
SS - 9	18	12 29 31	60	25	741.1	25 (741.1)								

End of Boring at 25.0 ft.

WATER & CAVE-IN OBSERVATION DATA

WATER ENCOUNTERED DURING DRILLING: NE		CAVE DEPTH AT COMPLETION: 22 ft.	WET ☐ DRY ☐
WATER LEVEL AT COMPLETION: 20 ft.		CAVE DEPTH AFTER 0 HOURS: NMR	WET ☐ DRY ☐
WATER LEVEL AFTER 0 HOURS: NMR		NE = Not Encountered; NMR = No Measurement Recorded	

NOTE: Stratification lines between soil types represent the approximate boundary; gradual transition between in-situ soil layers should be expected.

SOIL BORING LOG

Gestra Engineering Inc.
1626 W. Fond du Lac Avenue
Milwaukee, WI 53205
Phone: 414-933-7444, Fax: 414-933-7844

PROJECT NAME	Bliffert Site Parking Lot
DATE DRILLING STARTED	10/15/2014
PROJECT LOCATION	Milwaukee, WI
DATE DRILLING ENDED	10/15/2014
BORING NUMBER	PB-2
PROJECT NUMBER	14133-10
DRILLING RIG	CME 550
BORING DRILLED BY	FIRM: Gestra CREW CHIEF: M. Panfil
FIELD LOG	D. Harris
LAB LOG / QC	S. Lee
NORTHING	
EASTING	
DRILLING METHOD	3¼" HSA
SURFACE ELEVATION	773.8 ft

Number and Type	Recovery (in)	Blow Counts	N - Value	Depth (ft)	Elevation	Soil Description and Geological Origin for Each Major Unit	USCS Classification	Graphic	Well Diagram	Unconfined Comp. Strength (Q_u or Q_p) (tsf)	Liquid Limit	Plasticity Index	Moisture Content (%)	Comments
SS - 1	16	1 2 3	5			SANDY LEAN CLAY, brown, moist, trace gravel, (FILL)					29	14	15	
SS - 2	5	1 0 1	1	5	768.8		CL						14	
SS - 3	2	9 8 16	24										11	
SS - 4	18	2 10 18	28	10	763.8	Color changed to gray at 9'							13	
						10.5 (763.3)								
SS - 5	18	2 3 7	10			SANDY LEAN CLAY, gray, moist, stiff to hard, trace gravel	CL			1.0-4.0			12	
SS - 6	18	4 10 20	30	15	758.8	Trace silt in sample SS-6				2.50			12	
						15 (758.8)								
						End of Boring at 15.0 ft.								
				20	753.8									
				25	748.8									

WATER & CAVE-IN OBSERVATION DATA

WATER ENCOUNTERED DURING DRILLING: NE		CAVE DEPTH AT COMPLETION: 13 ft.	WET ☐ DRY ☐
WATER LEVEL AT COMPLETION: NE		CAVE DEPTH AFTER 0 HOURS: NMR	WET ☐ DRY ☐
WATER LEVEL AFTER 0 HOURS: NMR		NE = Not Encountered; NMR = No Measurement Recorded	

NOTE: Stratification lines between soil types represent the approximate boundary; gradual transition between in-situ soil layers should be expected.

SOIL BORING LOG

GESTRA
Gestra Engineering Inc.
1626 W. Fond du Lac Avenue
Milwaukee, WI 53205
Phone: 414-933-7444, Fax: 414-933-7844

PROJECT NAME: Bliffert Site Parking Lot	DATE DRILLING STARTED: 10/16/2014	PAGE NUMBER: 1 of 1	BORING NUMBER: PB-3
PROJECT LOCATION: Milwaukee, WI	DATE DRILLING ENDED: 10/16/2014	PROJECT NUMBER: 14133-10	DRILLING RIG: CME 550
BORING DRILLED BY: FIRM: Gestra, CREW CHIEF: M. Panfil	FIELD LOG: D. Harris	NORTHING	DRILLING METHOD: 3¼" HSA
	LAB LOG / QC: S. Lee	EASTING	SURFACE ELEVATION: 773 ft

Number and Type	Recovery (in)	Blow Counts	N - Value	Depth (ft)	Elevation	Soil Description and Geological Origin for Each Major Unit	USCS Classification	Graphic	Well Diagram	Unconfined Comp. Strength (Q_u or Q_p) (tsf)	Liquid Limit	Plasticity Index	Moisture Content (%)	Comments
SS - 1	4	10 11 12	23			SILTY SAND, brown, moist, trace gravel, (FILL)	SM							
						3 (770)								
						LEAN CLAY, gray, moist, trace gravel, odor, (FILL)								
SS - 2	18	3 2 3	5	5	768.0		CL				29	12	20	
						6 (767)								
						SILT, some silty clay, brown, moist, stiff								
SS - 3	18	1 3 2	5				ML/CL-ML			1.25-1.5	17	3	22	
						8 (765)								
						LEAN CLAY, brown to gray, moist, stiff to very stiff								
SS - 4	18	2 5 6	11	10	763.0	10 (763)	CL			1.0-2.0			15	
						End of Boring at 10.0 ft.								
				15	758.0									
				20	753.0									
				25	748.0									

WATER & CAVE-IN OBSERVATION DATA

WATER ENCOUNTERED DURING DRILLING: NE		CAVE DEPTH AT COMPLETION: 9 ft.	WET ☐ DRY ☐
WATER LEVEL AT COMPLETION: NE		CAVE DEPTH AFTER 0 HOURS: NMR	WET ☐ DRY ☐
WATER LEVEL AFTER 0 HOURS: NMR		NE = Not Encountered; NMR = No Measurement Recorded	

NOTE: Stratification lines between soil types represent the approximate boundary; gradual transition between in-situ soil layers should be expected.

GESTRA
Gestra Engineering Inc.
1626 W. Fond du Lac Avenue
Milwaukee, WI 53205
Phone: 414-933-7444, Fax: 414-933-7844

SOIL BORING LOG

PROJECT NAME: Bliffert Site Parking Lot		DATE DRILLING STARTED: 10/17/2014	BORING NUMBER: PB-4
PROJECT LOCATION: Milwaukee, WI		DATE DRILLING ENDED: 10/17/2014	PROJECT NUMBER: 14133-10
			DRILLING RIG:
BORING DRILLED BY: FIRM: Gestra, CREW CHIEF: M. Panfil	FIELD LOG: D. Harris	LATITUDE:	DRILLING METHOD: Hand Auger
	LAB LOG / QC: S. Lee	LONGITUDE:	SURFACE ELEVATION: 787.2 ft

Number and Type	Recovery (in)	Blow Counts	N - Value	Depth (ft)	Elevation	Soil Description and Geological Origin for Each Major Unit	USCS/USDA Classification	Graphic	Well Diagram	Unconfined Comp. Strength (Q_u or Q_p) (tsf)	Liquid Limit	Plasticity Index	Moisture Content (%)	Comments
HA - 1						TOPSOIL, clay and silt, dark brown, with organics and sand 1 (786.2)	CL							
HA - 2						SITLY SAND, brown, moist 1.8 (785.4)	SP							Borehole caved in due to sand collapsing at 22"
						End of Boring at 1.8 ft.								
					785.0									
				5										
					780.0									
				10										

WATER & CAVE-IN OBSERVATION DATA

WATER ENCOUNTERED DURING DRILLING: NE		CAVE DEPTH AT COMPLETION: NMR	WET ☐ DRY ☐
WATER LEVEL AT COMPLETION: NE		CAVE DEPTH AFTER 0 HOURS: NMR	WET ☐ DRY ☐
WATER LEVEL AFTER 0 HOURS: NMR		NE = Not Encountred; NMR = No Measurement Recorded	

NOTE: Stratification lines between soil types represent the approximate boundary; gradual transition between in-situ soil layers should be expected.

SOIL BORING LOG

Gestra Engineering Inc.
1626 W. Fond du Lac Avenue
Milwaukee, WI 53205
Phone: 414-933-7444, Fax: 414-933-7844

PROJECT NAME: Bliffert Site Parking Lot	DATE DRILLING STARTED: 10/13/2014	PAGE NUMBER: 1 of 1	BORING NUMBER: SB-1
PROJECT LOCATION: Milwaukee, WI	DATE DRILLING ENDED: 10/13/2014	PROJECT NUMBER: 14133-10	DRILLING RIG: CME 550
BORING DRILLED BY: FIRM: Gestra, CREW CHIEF: M. Panfil	FIELD LOG: D. Harris	NORTHING	DRILLING METHOD: 3¼" HSA
	LAB LOG / QC: S. Lee	EASTING	SURFACE ELEVATION: 772.6 ft

Number and Type	Recovery (in)	Blow Counts	N - Value	Depth (ft)	Elevation	Soil Description and Geological Origin for Each Major Unit	USCS Classification	Graphic	Well Diagram	Unconfined Comp. Strength (Q_u or Q_p) (tsf)	Liquid Limit	Plasticity Index	Moisture Content (%)	Comments
						SILTY SAND, brown, moist, trace gravel, (FILL)								
SS - 1	10	4 6 5	11				SM							
SS - 2	12	2 7 17	24	5	767.6	Trace organic matter in SS-2								
						5.5 (767.1)								
						SILTY CLAY, brown mottled, moist, (FILL)								
SS - 3	16	6 10 6	16				CL-ML						11	
						8 (764.6)								
						SILTY CLAY, black and gray, moist, trace gravel, (FILL)								
SS - 4	18	4 5 5	10	10	762.6		CL-ML						25	
						10.5 (762.1)								
						SANDY LEAN CLAY, black mottled brown with dark gray, moist, (FILL)								
SS - 5	15	4 5 6	11				CL						17	LOI = 3.1%
						14 (758.6)								
SS - 6	18	6 11 8	19	15	757.6	SILT WITH SAND, brown, moist, medium dense	ML							Sieve analysis on silt portion Gravel = 0.0% Sand = 20.3% P200 =79.7%
						18 (754.6)								
						SILTY SAND, brown, wet, medium dense								
SS - 7	18	7 6 8	14	20	752.6		SM							
						23 (749.6)								
						LEAN CLAY, gray, moist, stiff to very stiff, silt seams								
SS - 8	18	3 4 6	10	25	747.6	25 (747.6)	CL			1.0-2.5	38	23		

End of Boring at 25.0 ft.

WATER & CAVE-IN OBSERVATION DATA

WATER ENCOUNTERED DURING DRILLING: 18 ft.		CAVE DEPTH AT COMPLETION: NMR	WET ☐ DRY ☐
WATER LEVEL AT COMPLETION: 20 ft.		CAVE DEPTH AFTER 0 HOURS: NMR	WET ☐ DRY ☐
WATER LEVEL AFTER 0 HOURS: NMR		NE = Not Encountered; NMR = No Measurement Recorded	

NOTE: Stratification lines between soil types represent the approximate boundary; gradual transition between in-situ soil layers should be expected.

SOIL BORING LOG

Gestra Engineering Inc.
1626 W. Fond du Lac Avenue
Milwaukee, WI 53205
Phone: 414-933-7444, Fax: 414-933-7844

PROJECT NAME	Bliffert Site Parking Lot
DATE DRILLING STARTED	10/15/2014
PROJECT LOCATION	Milwaukee, WI
DATE DRILLING ENDED	10/15/2014
BORING NUMBER	TB-1
PROJECT NUMBER	14133-10
DRILLING RIG	CME 75 (International)
BORING DRILLED BY	FIRM: Gestra CREW CHIEF: A. Woerpel
FIELD LOG	J. Collins
LAB LOG / QC	S. Lee
NORTHING	
EASTING	
DRILLING METHOD	3¼" HSA
SURFACE ELEVATION	800.9 ft

Number and Type	Recovery (in)	Blow Counts	N - Value	Depth (ft)	Elevation	Soil Description and Geological Origin for Each Major Unit	USCS Classification	Graphic	Well Diagram	Unconfined Comp. Strength (Q_u or Q_p) (tsf)	Liquid Limit	Plasticity Index	Moisture Content (%)	Comments
						TOPSOIL (4") 0.3 (800.6)								
SS - 1	18	3 7 9	16			LEAN CLAY, brown mottled, moist, hard, trace silt	CL			4.5				
						3.5 (797.4)								
SS - 2	18	6 9 10	19	5	795.9	LEAN CLAY WITH GRAVEL, brown, moist, very stiff to hard				4.00	26	12		
SS - 3	18	6 10 13	23				CL-ML			2.5-4.5				
						9 (791.9)								
SS - 4	18	4 6 10	16	10	790.9	LEAN CLAY, brown mottled, moist, very stiff, trace silt and gravel				3.0-3.5				
SS - 5	18	9 7 15	22				CL			3.0-3.5			13	
						13 (787.9)								
SS - 6	18	4 6 6	12	15	785.9	LEAN CLAY, gray, moist, very stiff, trace sand and gravel				2.5-4.5			10	
SS - 7	18	2 4 5	9							2.0-3.0			13	
SH - 8	23			20	780.9		CL							
SS - 9	18	6 7 7	14	25	775.9	Sand lenses in sample SS-9				2.50			13	

WATER & CAVE-IN OBSERVATION DATA

WATER ENCOUNTERED DURING DRILLING: 32 ft.		CAVE DEPTH AT COMPLETION: NMR	WET ☐ DRY ☐
WATER LEVEL AT COMPLETION: 37 ft.		CAVE DEPTH AFTER 0 HOURS: NMR	WET ☐ DRY ☐
WATER LEVEL AFTER 0 HOURS: NMR		NE = Not Encountered; NMR = No Measurement Recorded	

NOTE: Stratification lines between soil types represent the approximate boundary; gradual transition between in-situ soil layers should be expected.

SOIL BORING LOG

Gestra Engineering Inc.
1626 W. Fond du Lac Avenue
Milwaukee, WI 53205
Phone: 414-933-7444, Fax: 414-933-7844

PROJECT NAME: Bliffert Site Parking Lot	DATE DRILLING STARTED: 10/15/2014	BORING NUMBER: TB-1	
PROJECT LOCATION: Milwaukee, WI	DATE DRILLING ENDED: 10/15/2014	PROJECT NUMBER: 14133-10	
		DRILLING RIG: CME 75 (International)	
BORING DRILLED BY: FIRM: Gestra, CREW CHIEF: A. Woerpel	FIELD LOG: J. Collins	NORTHING	DRILLING METHOD: 3¼" HSA
	LAB LOG / QC: S. Lee	EASTING	SURFACE ELEVATION: 800.9 ft

Number and Type	Recovery (in)	Blow Counts	N - Value	Depth (ft)	Elevation	Soil Description and Geological Origin for Each Major Unit	USCS Classification	Graphic	Well Diagram	Unconfined Comp. Strength (Q_u or Q_p) (tsf)	Liquid Limit	Plasticity Index	Moisture Content (%)	Comments
						LEAN CLAY, gray, moist, very stiff, trace sand and gravel								
SH - 10	15			30	770.9		CL							
						33 (767.9)								
						SILT, gray, wet, medium dense	ML							
						34 (766.9)								
SS - 11	18	4 12 14	26	35	765.9	SILTY CLAY, brown, moist, medium dense	CL-ML						25	Sample 11A, Sample 11B, Sample 11C
						34.5 (766.4)								
						SAND WITH GRAVEL, brown, moist, medium dense	SP							
						36.8 (764.1)								
						SANDY SILT, gray, wet, loose	ML							
SS - 12	18	3 3 4	7	40	760.9	39.5 (761.4)				3.00				
						SILT, gray, moist, loose, trace sand	ML							
						41.8 (759.1)								
						SILTY CLAY, gray, moist, very stiff	CL-ML							
SS - 13	18	3 6 7	13	45	755.9					3.00			17	
						46.8 (754.1)								
						SILT, gray, wet, medium dense	ML							
SS - 14	18	4 6 10	16	50	750.9	49.5 (751.4)				3.00				
						LEAN CLAY, gray, moist, very stiff	CL							
						50 (750.9)								

End of Boring at 50.0 ft.

WATER & CAVE-IN OBSERVATION DATA

WATER ENCOUNTERED DURING DRILLING: 32 ft.		CAVE DEPTH AT COMPLETION: NMR	WET ☐ DRY ☐
WATER LEVEL AT COMPLETION: 37 ft.		CAVE DEPTH AFTER 0 HOURS: NMR	WET ☐ DRY ☐
WATER LEVEL AFTER 0 HOURS: NMR		NE = Not Encountered; NMR = No Measurement Recorded	

NOTE: Stratification lines between soil types represent the approximate boundary; gradual transition between in-situ soil layers should be expected.

SOIL BORING LOG

Gestra Engineering Inc.
1626 W. Fond du Lac Avenue
Milwaukee, WI 53205
Phone: 414-933-7444, Fax: 414-933-7844

PROJECT NAME	Bliffert Site Parking Lot
DATE DRILLING STARTED	10/13/2014
PROJECT LOCATION	Milwaukee, WI
DATE DRILLING ENDED	10/13/2014
BORING NUMBER	**WRB-1**
PROJECT NUMBER	14133-10
DRILLING RIG	CME 550
BORING DRILLED BY	FIRM: Gestra CREW CHIEF: M. Panfil
FIELD LOG	D. Harris
LAB LOG / QC	S. Lee
NORTHING	
EASTING	
DRILLING METHOD	3¼" HSA
SURFACE ELEVATION	767.9 ft

Number and Type	Recovery (in)	Blow Counts	N - Value	Depth (ft)	Elevation	Soil Description and Geological Origin for Each Major Unit	USCS Classification	Graphic	Well Diagram	Unconfined Comp. Strength (Q_u or Q_p) (tsf)	Liquid Limit	Plasticity Index	Moisture Content (%)	Comments
						SILTY SAND, brown, moist, trace gravel, (FILL)								
SS - 1	12	6 15 18	33				SM							
						3 (764.9)								
						LEAN CLAY, brown, moist, stiff to hard, (FILL)								
SS - 2	18	5 4 4	8	5	762.9					1.0-4.5+				
SS - 3	15	16 11 11	22				CL-ML			1.0-4.5+	27	14		
SS - 4	16	10 10 11	21	10	757.9	With 3" of plywood or board and black organic matter in sample SS-4				1.0-4.5+			18	LOI = 3.9% (soil portion of SS-4)
						10.5 (757.4)								
						LEAN CLAY, brown, moist, stiff to very stiff								
SS - 5	18	3 4 5	9				CL			1.0-2.25				
SS - 6	18	3 4 6	10	15	752.9	15 (752.9)				2.25-2.5			24	
						End of Boring at 15.0 ft.								
				20	747.9									
				25	742.9									

WATER & CAVE-IN OBSERVATION DATA

▽	WATER ENCOUNTERED DURING DRILLING: NE		CAVE DEPTH AT COMPLETION: 13 ft.	WET ☐ DRY ☐
▼	WATER LEVEL AT COMPLETION: NE	■	CAVE DEPTH AFTER 0 HOURS: NMR	WET ☐ DRY ☐
▼	WATER LEVEL AFTER 0 HOURS: NMR		NE = Not Encountered; NMR = No Measurement Recorded	

NOTE: Stratification lines between soil types represent the approximate boundary; gradual transition between in-situ soil layers should be expected.

SOIL BORING LOG

Gestra Engineering Inc.
1626 W. Fond du Lac Avenue
Milwaukee, WI 53205
Phone: 414-933-7444, Fax: 414-933-7844

PROJECT NAME: Bliffert Site Parking Lot	DATE DRILLING STARTED: 10/13/2014	PAGE NUMBER: 1 of 1	BORING NUMBER: WRB-2
PROJECT LOCATION: Milwaukee, WI	DATE DRILLING ENDED: 10/13/2014	PROJECT NUMBER: 14133-10	DRILLING RIG: CME 45
BORING DRILLED BY: FIRM: Gestra, CREW CHIEF: M. Panfil	FIELD LOG: D. Harris	NORTHING	DRILLING METHOD: 2¼" HSA
	LAB LOG / QC: S. Lee	EASTING	SURFACE ELEVATION: 767.9 ft

Number and Type	Recovery (in)	Blow Counts	N - Value	Depth (ft)	Elevation	Soil Description and Geological Origin for Each Major Unit	USCS Classification	Graphic	Well Diagram	Unconfined Comp. Strength (Q_u or Q_p) (tsf)	Liquid Limit	Plasticity Index	Moisture Content (%)	Comments
						SANDY SILTY CLAY, brown, moist, medium stiff to very stiff								
SS - 1	15	10 6 5	11				CL-ML			0.5-2.0				
						4 (763.9)								
SS - 2	16	7 9 11	20	5	762.9	CLAYEY SAND, brown, moist, medium dense, with a 4" thick wet sand seam	SC							
						5.5 (762.4)								
						SANDY SILT, brown, moist to wet, medium dense								
SS - 3	18	4 5 5	10				ML							
SS - 4	18	5 4 6	10	10	757.9									
						10.5 (757.4)								
						SILTY TO LEAN CLAY, brown, moist, very stiff, trace gravel								
SS - 5	18	7 7 9	16				CL			2.0-2.5			17	
						13 (754.9)								
						SANDY SILT, gray, wet, medium dense								
SS - 6	18	4 4 6	10	15	752.9	15 (752.9)	ML							
						End of Boring at 15.0 ft.								
				20	747.9									
				25	742.9									

WATER & CAVE-IN OBSERVATION DATA

WATER ENCOUNTERED DURING DRILLING: 7 ft.	CAVE DEPTH AT COMPLETION: NMR	WET ☐ DRY ☐
WATER LEVEL AT COMPLETION: 7 ft.	CAVE DEPTH AFTER 0 HOURS: NMR	WET ☐ DRY ☐
WATER LEVEL AFTER 0 HOURS: NMR	NE = Not Encountered; NMR = No Measurement Recorded	

NOTE: Stratification lines between soil types represent the approximate boundary; gradual transition between in-situ soil layers should be expected.

SOIL BORING LOG

Gestra Engineering Inc.
1626 W. Fond du Lac Avenue
Milwaukee, WI 53205
Phone: 414-933-7444, Fax: 414-933-7844

PROJECT NAME: Bliffert Site Parking Lot	DATE DRILLING STARTED: 10/13/2014	PAGE NUMBER: 1 of 1	BORING NUMBER: WRB-3
PROJECT LOCATION: Milwaukee, WI	DATE DRILLING ENDED: 10/13/2014	PROJECT NUMBER: 14133-10	DRILLING RIG: CME 45
BORING DRILLED BY: FIRM: Gestra, CREW CHIEF: M. Panfil	FIELD LOG: D. Harris	NORTHING	DRILLING METHOD: 2¼" HSA
	LAB LOG / QC: S. Lee	EASTING	SURFACE ELEVATION: 769.7 ft

Number and Type	Recovery (in)	Blow Counts	N - Value	Depth (ft)	Elevation	Soil Description and Geological Origin for Each Major Unit	USCS Classification	Graphic	Well Diagram	Unconfined Comp. Strength (Q_u or Q_p) (tsf)	Liquid Limit	Plasticity Index	Moisture Content (%)	Comments
						AGGREGATE, gravel, some clay, (FILL)								
SS - 1	0	50/0												
						3 (766.7)								
						GRAVEL WITH SAND AND CLAY, black, moist, trace gravel, (FILL)								
SS - 2	10	5 3 2	5	5	764.7		CL						38	LOI = 4.1% on SS-2 clay
						5.5 (764.2)								
						SAND, gray, wet, medium dense								
SS - 3	15	3 5 7	12				SP							
						8 (761.7)								
						SILT, gray, wet, loose								
SS - 4	18	2 2 2	4	10	759.7		ML							
						10.5 (759.2)								
						LEAN CLAY, gray, moist, stiff to very stiff								
SS - 5	18	4 5 7	12				CL			1.0-2.25			14	
SS - 6	18	3 5 6	11	15	754.7					1.5-3.5			17	
						15 (754.7)								
						End of Boring at 15.0 ft.								
				20	749.7									
				25	744.7									

WATER & CAVE-IN OBSERVATION DATA

▽	WATER ENCOUNTERED DURING DRILLING: 6 ft.	CAVE DEPTH AT COMPLETION: NMR	WET ☐ DRY ☐
▼	WATER LEVEL AT COMPLETION: 10 ft.	CAVE DEPTH AFTER 0 HOURS: NMR	WET ☐ DRY ☐
▼	WATER LEVEL AFTER 0 HOURS: NMR	NE = Not Encountered; NMR = No Measurement Recorded	

NOTE: Stratification lines between soil types represent the approximate boundary; gradual transition between in-situ soil layers should be expected.

SOIL BORING LOG

Gestra Engineering Inc.
1626 W. Fond du Lac Avenue
Milwaukee, WI 53205
Phone: 414-933-7444, Fax: 414-933-7844

PROJECT NAME: Bliffert Site Parking Lot	DATE DRILLING STARTED: 10/16/2014	PAGE NUMBER: 1 of 1	BORING NUMBER: **WRB-4**
PROJECT LOCATION: Milwaukee, WI	DATE DRILLING ENDED: 10/16/2014	PROJECT NUMBER: 14133-10	DRILLING RIG: CME 550
BORING DRILLED BY: FIRM: Gestra, CREW CHIEF: M. Panfil	FIELD LOG: D. Harris	NORTHING	DRILLING METHOD: 3¼" HSA
	LAB LOG / QC: S. Lee	EASTING	SURFACE ELEVATION: 773.1 ft

Number and Type	Recovery (in)	Blow Counts	N - Value	Depth (ft)	Elevation	Soil Description and Geological Origin for Each Major Unit	USCS Classification	Graphic	Well Diagram	Unconfined Comp. Strength (Q_u or Q_p) (tsf)	Liquid Limit	Plasticity Index	Moisture Content (%)	Comments
						CLAYEY SILTY SAND, brown, moist, trace gravel, (FILL)								
SS - 1	10	19 15 12	27				SM						15	
						3 (770.1)								
						SAND, black, moist, trace gravel and wood, gas odor, (FILL)								
SS - 2	13	4 6 8	14	5	768.1								14	
							SP							
SS - 3	5	13 10 7	17										15	
						8 (765.1)								
						SANDY SILT, dark gray, wet, medium dense, trace gravel, trace organic matter								
SS - 4	3	12 10 6	16	10	763.1		ML						29	LOI = 5.7%
						10.5 (762.6)								
						LEAN CLAY, gray, moist, stiff to very stiff								
SS - 5	18	2 4 3	7				CL			1.0-2.0	29	13	21	
						13 (760.1)								
						SILTY CLAY, gray, moist, very stiff								
SS - 6	18	6 7 8	15	15	758.1	15 (758.1)	CL-ML			2.0-2.5			15	
						End of Boring at 15.0 ft.								
				20	753.1									
				25	748.1									

WATER & CAVE-IN OBSERVATION DATA

WATER ENCOUNTERED DURING DRILLING: 6 ft.	CAVE DEPTH AT COMPLETION: NMR	WET ☐ DRY ☐
WATER LEVEL AT COMPLETION: 5 ft.	CAVE DEPTH AFTER 0 HOURS: NMR	WET ☐ DRY ☐
WATER LEVEL AFTER 0 HOURS: NMR	NE = Not Encountered; NMR = No Measurement Recorded	

NOTE: Stratification lines between soil types represent the approximate boundary; gradual transition between in-situ soil layers should be expected.

SOIL BORING LOG

Gestra Engineering Inc.
1626 W. Fond du Lac Avenue
Milwaukee, WI 53205
Phone: 414-933-7444, Fax: 414-933-7844

PROJECT NAME: Bliffert Site Parking Lot	DATE DRILLING STARTED: 10/16/2014	PAGE NUMBER: 1 of 1	BORING NUMBER: **WRB-5**
PROJECT LOCATION: Milwaukee, WI	DATE DRILLING ENDED: 10/16/2014	PROJECT NUMBER: 14133-10	DRILLING RIG: CME 550
BORING DRILLED BY: FIRM: Gestra, CREW CHIEF: M. Panfil	FIELD LOG: D. Harris	NORTHING	DRILLING METHOD: 3¼" HSA
	LAB LOG / QC: S. Lee	EASTING	SURFACE ELEVATION: 797.8 ft

Number and Type	Recovery (in)	Blow Counts	N - Value	Depth (ft)	Elevation	Soil Description and Geological Origin for Each Major Unit	USCS Classification	Graphic	Well Diagram	Unconfined Comp. Strength (Q_u or Q_p) (tsf)	Liquid Limit	Plasticity Index	Moisture Content (%)	Comments
						TOPSOIL (2") 0.2 (797.6)								
SS - 1	2	9 14 15	29			SANDY LEAN CLAY, dark brown, trace gravel, trace organic matter, (FILL) 3.5 (794.3)	CL						22	
SS - 2	18	6 12 22	34	5	792.8	LEAN CLAY WITH SAND, brown, moist, stiff to very stiff, (POSSIBLE FILL)	CL			1.0-2.5			13	
SS - 3	18	5 7 11	18							1.0-1.5			13	
SS - 4	12	8 10 12	22	10	787.8	Ribboning in SS-4 11.5 (786.3)							13	
SS - 5	18	2 4 6	10			SANDY LEAN CLAY, gray, stiff to very stiff, trace gravel; Ribboning in SS-5	CL			1.0-1.5			13	
SS - 6	18	2 4 7	11	15	782.8					1.0-3.0			13	
SS - 7	18	4 8 8	16							2.0-2.5			14	
SS - 8	18	2 6 8	14	20	777.8	20 (777.8)				1.0-2.0			14	
						End of Boring at 20.0 ft.								
				25	772.8									

WATER & CAVE-IN OBSERVATION DATA

WATER ENCOUNTERED DURING DRILLING: NE		CAVE DEPTH AT COMPLETION: 18.5 ft.	WET ☐ DRY ☐
WATER LEVEL AT COMPLETION: NE		CAVE DEPTH AFTER 0 HOURS: NMR	WET ☐ DRY ☐
WATER LEVEL AFTER 0 HOURS: NMR		NE = Not Encountered; NMR = No Measurement Recorded	

NOTE: Stratification lines between soil types represent the approximate boundary; gradual transition between in-situ soil layers should be expected.

Wis. Dept. of Safety and Professional Services
Division of Industry Services

SOIL EVALUATION - STORM

in accordance with SPS 382.365 and 385, Wis. Adm. Code

Attach complete site plan on paper not less than 8 1/2 x 11 inches in size. Plan must include, but not limited to: vertical and horizontal reference point (BM), direction and percent slope, scale, or dimensions, north arrow, and BM referenced to nearest road.

Please print all information.

Personal information you provide may be used for secondary purposes (Privacy Law, s. 15.04 (1) (m)).

County: Milwaukee
Parcel I.D.: 4109999111
Reviewed by:
Date:

Property Owner: Milwaukee County
Property Location: Govt. Lot ¼ SW ¼ S 29 T 7 N R 21 E
Property Owner's Mailing Address: 10001 W. Bluemound Road
Lot #:
Block #:
Subd. Name or CSM#:

City	State	Zip Code	Phone Number
Milwaukee	WI	53226	414-256-5402

☒ City ☐ Village ☐ Town
Nearest Road: Milwaukee

Drainage area _____ ☐ sq. ft. ☐ acres

Optional:

Test Site Suitable for (check all that apply)

☐ Irrigation ☐ Bioretention trench ☐ Trench(es)
☐ Rain Garden ☐ Grassed swale ☐ Reuse
☐ Infiltration Trench ☐ SDS (> 15' wide) ☐ Other _____

Hydraulic Application Test Method:

☐ Morphological Evaluation
☐ Double-Ring Infiltrometer
☒ Other (specify) WDNR 1002

SB-1 Obs. # ☒ Boring ☐ Pit Ground surface elev. 769.7 ft. Depth to limiting factor _____ in.

Horizon	Depth in.	Dominant Color Munsell	Redox Description Qu. Sz. Cont. Color	Texture	Structure Gr. Sz. Sh.	Consistence	Roots Qu. Sz.	%Rock Frag.	Hydraulic App. Rate Inches/Hr
Fill	0-36	10 YR 5/4		GRLS	0 gr	d (lo)		15	3.60
Fill	36-66	10 YR 2/2		SL	0 gr	d (lo)		<10	0.50
Fill	66-126	10 YR 6/4		SCL	m	m (fi)		<5	0.11
Fill	126-168	10 YR 2/2		SCL	m	m (fr)		<5	0.11
B	168-216	10 YR 5/4		FSL	m	m (vfr)		<5	0.50
B	216-276	10 YR 5/6		LS	0 gr	m (lo)		<5	1.63
B	276-	10 YR 4/2		CL	m	m (fr)		<5	0.03

Obs. # ☐ Boring ☐ Pit Ground surface elev. _____ ft. Depth to limiting factor _____ in.

Horizon	Depth in.	Dominant Color Munsell	Redox Description Qu. Sz. Cont. Color	Texture	Structure Gr. Sz. Sh.	Consistence	Roots Qu. Sz.	%Rock Frag.	Hydraulic App. Rate Inches/Hr

CST/PSS Name (Please Print): Jeffrey Bruesewitz
Signature:
CST/PSS Number:
Address: 1626 W. Fond du Lac Ave, Milwaukee, WI 53205
Date Evaluation Conducted: 10/28/2014
Telephone Number: 414-933-7444

GESTRA
…The Standard in Geo-Engineering

DCP Test

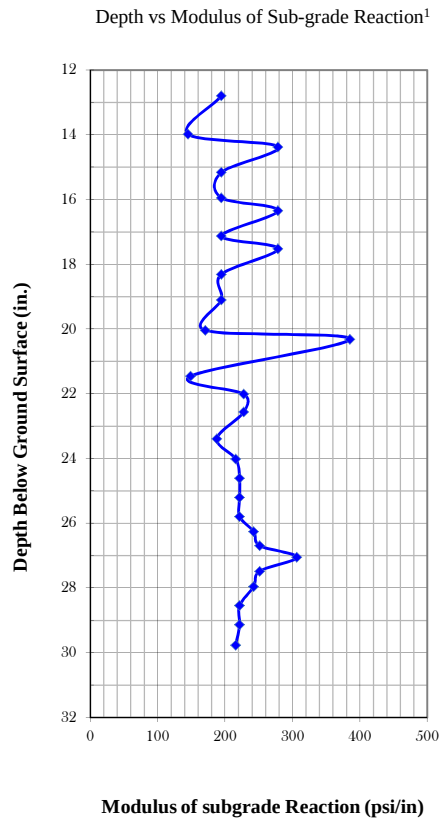
GESTRA Engineering, Inc
1626 West Fond Du Lac Ave.
Milwaukee, WI 53206
Ph: (414) 933 7444 Fax: (414) 933 7845

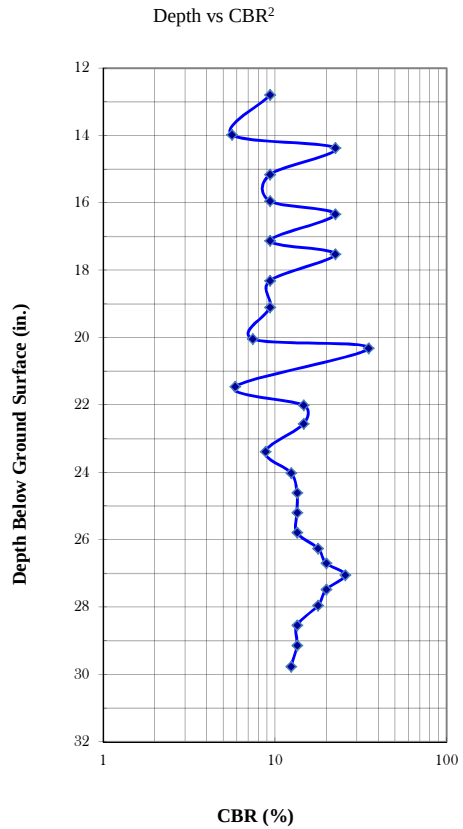
Project Name:	Bliffert Site Parking Lot	Project Location :	Milwaukee, WI	Date:	October 17, 2014
Project No:	14133-10	Borehole:	PB-4	Report To:	SIGMA

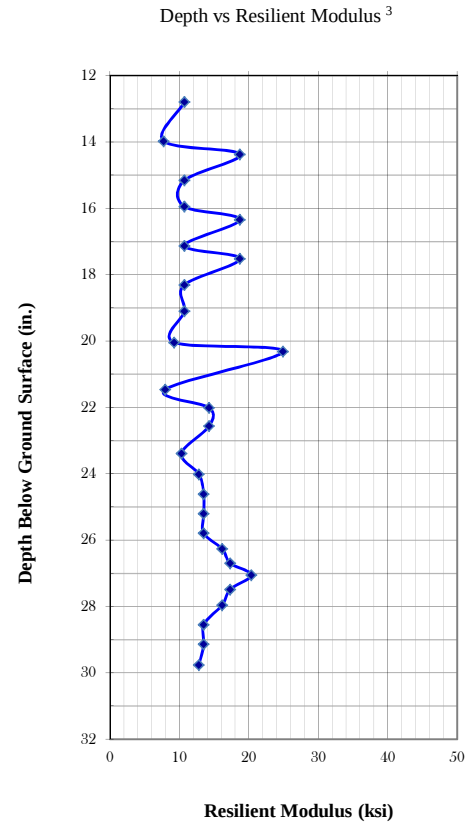
Pavement Section

Asphalt Thickness: NA inch Concrete Thickness: NA inch Base Course Thickness: NA inch Other: NA inch

Summary of DCP Test Results







Remarks:

Reference:

1 Generated using Fig. 10, page- 16, " Design of Concrete Airport Pavement", Portland Cement Association, 1973

2 Generated using correlation recommended by WisDOT Facilities Development Manual 14-25-15 (2008)

3 Mechanistic-Empirical Pavement Design Guide (MEPDG) Documentation, National Cooperative Highway Research Program, 2007

Reviewed by: Sangho Lee
Gestra Engineering, Inc

Appendix II

Laboratory Test Results

GESTRA Engineering, Inc
1626 W. Fond du Lac Avenue
Milwaukee, WI 53205
Phone: (414) 933-7444; Fax: (414) 933-7844

Laboratory Test Results of
Moisture Content, Organic Content, and Density of Soil

Project Name:	Bliffert Site Parking Lot	Date:	November 3, 2014
Project Number:	14133-10	Report To:	The Sigma Group
Project Location:	Milwaukee Co., WI		
ASTM Designation:	**D2216, D 2974**		

Boring Number	BB-1	BB-1	BB-1					
Sample Number	7	8	9					
Cup Number	P-10	P-4	V-8					
Weight of Cup (g)	24.04	25.62	23.32					
Weight of Wet Soil and Cup (g)	56.29	48.97	53.62					
Weight of Dry Soil and Cup (g)	51.41	45.95	50.59					
Weight of Soil and Cup After Burn (g)								
Weight of Sample for Density (lbs)								
Diameter (in)								
Length(in)								
Moisture Content (%)	17.8	14.9	11.1					
Organic Content (%)								
Wet Density (pcf)								
Dry Density (pcf)								

Boring Number								
Sample Number								
Cup Number								
Weight of Cup (g)								
Weight of Wet Soil and Cup (g)								
Weight of Dry Soil and Cup (g)								
Weight of Soil and Cup After Burn (g)								
Weight of Sample for Density (lbs)								
Diameter (in)								
Length(in)								
Moisture Content (%)								
Organic Content (%)								
Wet Density (pcf)								
Dry Density (pcf)								

Performed by BJB Reviewed by SHL

GESTRA Engineering, Inc
1626 W. Fond du Lac Avenue
Milwaukee, WI 53205
Phone: (414) 933-7444; Fax: (414) 933-7844

Laboratory Test Results of Atterberg Limits of Soil

Project Name:	Bliffert Site Parking Lot	Date:	October 20, 2014
Project Number:	14133-10	Client:	Sigma
Project Location:	Milwaukee, WI		
ASTM Designation:	**D4318**		

Sample Information

Type of Sample	Split Spoon
Boring Number	BB-1
Sample Number	4
Depth of Sample	8.5' - 10'

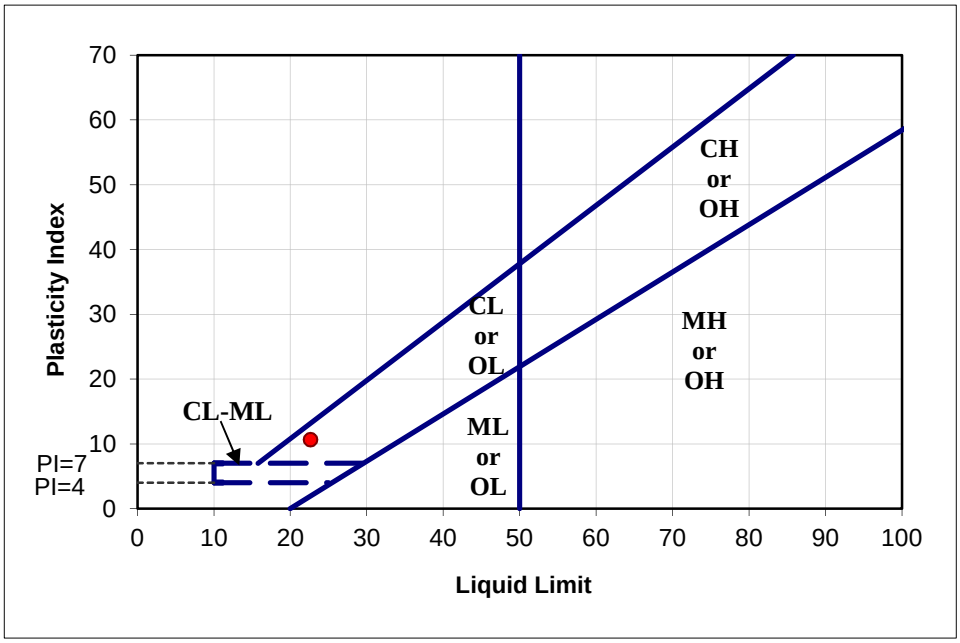
Determination of Liquid Limit

Cup Number	L-20	D-27	D-12
Weight of Cup (g)	14.08	14.31	14.44
Weight of Wet Soil and Cup (g)	38.84	37.06	36.52
Weight of Dry Soil and Cup (g)	34.41	32.85	32.32
Moisture Content (%)	21.8	22.7	23.5
Blow Counts	35	23	16

Determination of Plastic Limit

Cup Number	D-24	L-6
Weight of Cup (g)	7.25	7.18
Weight of Wet Soil and Cup (g)	13.23	14.49
Weight of Dry Soil and Cup (g)	12.59	13.69
Moisture Content (%)	12.0	12.3

Compilation of Test Results



Liquid Limit	23
Plastic Limit	12
Plasticity Index	11
USCS Symbol	**CL**

Performed by: NC

Reviewed By: SHL

GESTRA Engineering, Inc.

GESTRA Engineering, Inc
1626 W. Fond du Lac Avenue
Milwaukee, WI 53205
Phone: (414) 933-7444; Fax: (414) 933-7844

Laboratory Test Results of Atterberg Limits of Soil

Project Name:	Bliffert Site Parking Lot	Date:	October 20, 2014
Project Number:	14133-10	Client:	Sigma
Project Location:	Milwaukee, WI		
ASTM Designation:	**D4318**		

Sample Information

Type of Sample	Split Spoon
Boring Number	BB-1
Sample Number	6
Depth of Sample	13.5' - 15'

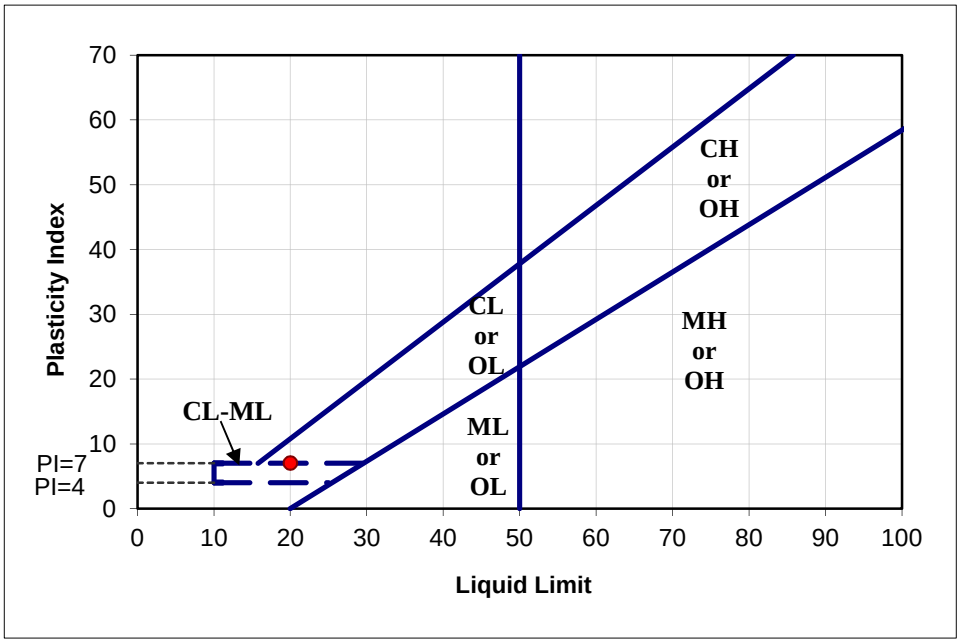
Determination of Liquid Limit

Cup Number	D-25	L-10	D-4
Weight of Cup (g)	13.92	14.48	14.48
Weight of Wet Soil and Cup (g)	35.28	36.75	39.45
Weight of Dry Soil and Cup (g)	31.79	33.05	35.21
Moisture Content (%)	19.5	19.9	20.5
Blow Counts	35	25	18

Determination of Plastic Limit

Cup Number	D-28	D-16
Weight of Cup (g)	7.44	7.32
Weight of Wet Soil and Cup (g)	13.52	16.12
Weight of Dry Soil and Cup (g)	12.82	15.13
Moisture Content (%)	13.0	12.7

Compilation of Test Results



Liquid Limit	20
Plastic Limit	13
Plasticity Index	7
USCS Symbol	**CL-ML**

Performed by: NC

Reviewed By: SHL

GESTRA Engineering, Inc.

GESTRA Engineering, Inc
1626 W. Fond du Lac Avenue
Milwaukee, WI 53205
Phone: (414) 933-7444; Fax: (414) 933-7844

Laboratory Test Results of
Moisture Content, Organic Content, and Density of Soil

Project Name:	Bliffert Site Parking Lot	Date:	October 16, 2014
Project Number:	14133-10	Report To:	The Sigma Group
Project Location:	Milwaukee Co., WI		
ASTM Designation:	**D2216, D 2974**		

Boring Number	ERB-1	ERB-1	ERB-1	ERB-1	ERB-1			
Sample Number	1	3	4	5	10			
Cup Number	A1	T10	Y4	T1	M2			
Weight of Cup (g)	25.88	25.29	25.25	26.60	26.95			
Weight of Wet Soil and Cup (g)	53.28	51.59	48.26	47.23	49.29			
Weight of Dry Soil and Cup (g)	48.63	47.35	45.02	42.97	46.03			
Weight of Soil and Cup After Burn (g)								
Weight of Sample for Density (lbs)								
Diameter (in)								
Length(in)								
Moisture Content (%)	20.4	19.2	16.4	26.0	17.1			
Organic Content (%)								
Wet Density (pcf)								
Dry Density (pcf)								

Boring Number	ERB-2	ERB-2	ERB-2	ERB-2	ERB-2			
Sample Number	1	2	3	4	6			
Cup Number	Q7	P4	Q9	P2	Y10			
Weight of Cup (g)	24.33	25.62	25.17	26.34	24.89			
Weight of Wet Soil and Cup (g)	63.34	54.36	53.15	57.57	58.11			
Weight of Dry Soil and Cup (g)	58.38	51.64	49.55	53.33	52.89			
Weight of Soil and Cup After Burn (g)								
Weight of Sample for Density (lbs)								
Diameter (in)								
Length(in)								
Moisture Content (%)	14.6	10.5	14.8	15.7	18.6			
Organic Content (%)								
Wet Density (pcf)								
Dry Density (pcf)								

Performed by BJB Reviewed by SHL

GESTRA Engineering, Inc
1626 W. Fond du Lac Avenue
Milwaukee, WI 53205
Phone: (414) 933-7444; Fax: (414) 933-7844

Laboratory Test Results of Atterberg Limits of Soil

Project Name:	Bliffert Site Parking Lot	Date:	November 14, 2014
Project Number:	14133-10	Client:	Sigma
Project Location:	Milwaukee Co, WI		
ASTM Designation:	**D4318**		

Sample Information

Type of Sample	Split Spoon
Boring Number	ERB-1
Sample Number	3
Depth of Sample	6' - 7.5'

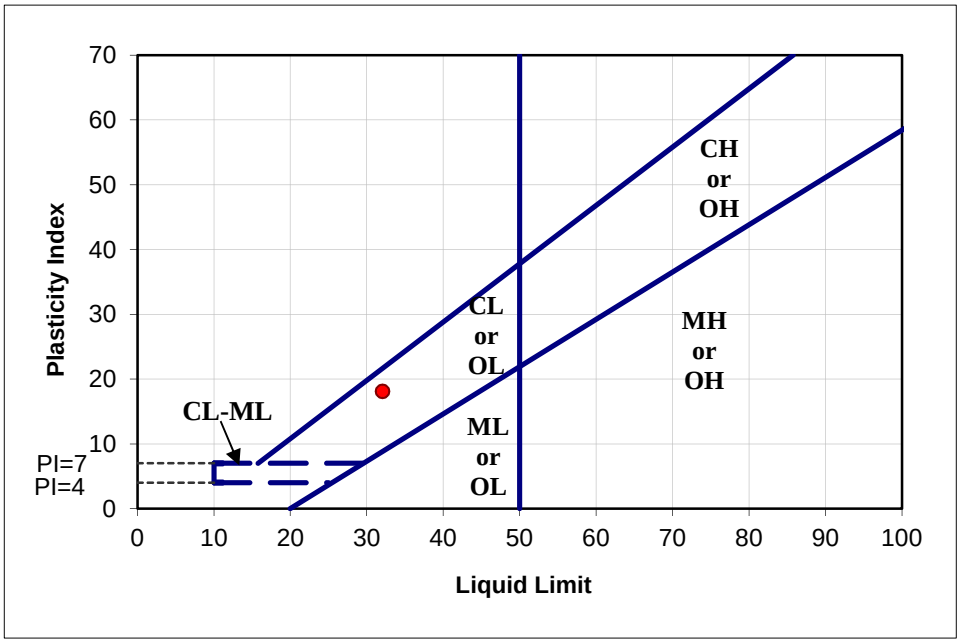
Determination of Liquid Limit

Cup Number	L-2	D-19	D-27
Weight of Cup (g)	14.24	14.24	14.28
Weight of Wet Soil and Cup (g)	36.85	32.08	33.96
Weight of Dry Soil and Cup (g)	31.63	27.73	28.97
Moisture Content (%)	30.0	32.2	34.0
Blow Counts	35	25	15

Determination of Plastic Limit

Cup Number	D-27	D-23
Weight of Cup (g)	7.16	7.28
Weight of Wet Soil and Cup (g)	14.02	14.42
Weight of Dry Soil and Cup (g)	13.16	13.52
Moisture Content (%)	14.3	14.4

Compilation of Test Results



Liquid Limit	32
Plastic Limit	14
Plasticity Index	18
USCS Symbol	**CL**

Performed by: NC

Reviewed By: SHL

GESTRA Engineering, Inc.

GESTRA Engineering, Inc
1626 W. Fond du Lac Avenue
Milwaukee, WI 53205
Phone: (414) 933-7444; Fax: (414) 933-7844

Laboratory Test Results of Atterberg Limits of Soil

Project Name:	Bliffert Site Parking Lot	Date:	October 20, 2014
Project Number:	14133-10	Client:	Sigma
Project Location:	Milwaukee, WI		
ASTM Designation:	**D4318**		

Sample Information

Type of Sample	Split Spoon
Boring Number	ERB-1
Sample Number	10
Depth of Sample	28.5' - 30'

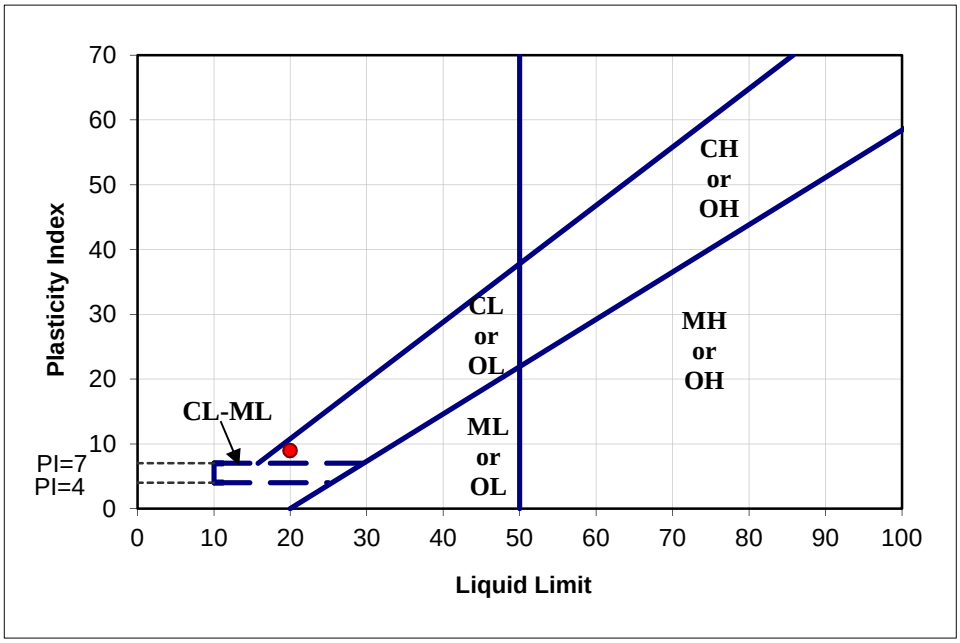
Determination of Liquid Limit

Cup Number	D-2	L-15	L-3
Weight of Cup (g)	14.78	14.34	14.39
Weight of Wet Soil and Cup (g)	37.49	37.59	38.48
Weight of Dry Soil and Cup (g)	33.81	33.75	34.36
Moisture Content (%)	19.3	19.8	20.6
Blow Counts	35	25	16

Determination of Plastic Limit

Cup Number	L-8	L-5
Weight of Cup (g)	7.20	7.35
Weight of Wet Soil and Cup (g)	14.10	13.81
Weight of Dry Soil and Cup (g)	13.39	13.15
Moisture Content (%)	11.5	11.4

Compilation of Test Results



Liquid Limit	20
Plastic Limit	11
Plasticity Index	9
USCS Symbol	**CL**

Performed by: NC

Reviewed By: SHL

GESTRA Engineering, Inc.

GESTRA Engineering, Inc
1626 W. Fond Du Lac Ave.
Milwaukee, WI 53205
Phone: (414) 933-7444, Fax: (414) 933-7844

Laboratory Test Results of Unconfined Compressive Strength of Soil

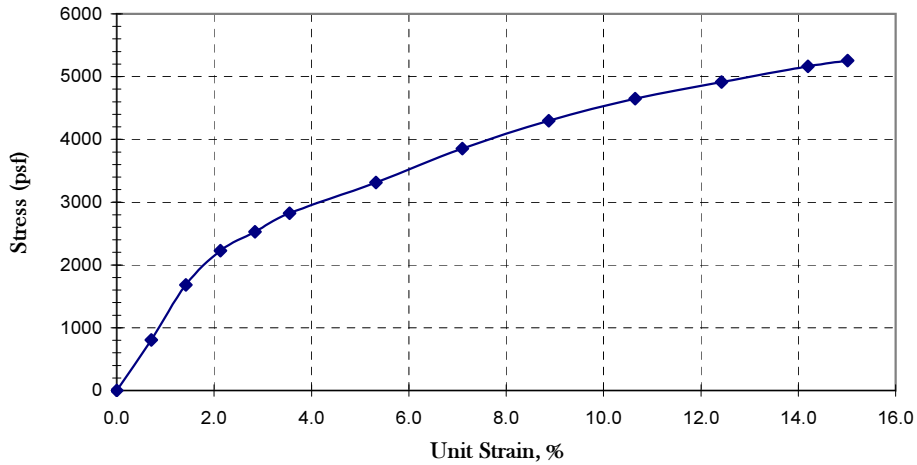
Project Name:	Bliffert Site Parking Lot	Date:	October 20, 2014
Project Number:	14133-10	Report To:	The Sigma Group
Project Location:	Milwaukee Co., WI		
ASTM Designation:	**D2166**		Updated on September 20, 2012

Test Data

Deformation dial reading (0.001 in.)	Sample stress (psf)
0	0
20	808
40	1684
60	2229
80	2529
100	2824
150	3312
200	3854
250	4299
300	4652
350	4915
400	5165
423	5254

Sample Information

Boring no.:	ERB-02	Diameter (in)	1.38
Sample no.:	4	Area (sq. in.):	1.50
Depth of Soil:	8.5'-10'	Height: (in.):	2.82
Description of Soil:	Lean clay trace grave and coarse sand, gray-brown, moist		
Strain Rate (in/min):	0.042		



UC Strength, Q_u (tsf)	**2.63**
Wet Density (pcf)	138.7
Dry Density (pcf)	119.9
Moisture Content (%)	15.7

Remarks

Performed By: BJB

Reviewed By: SHL
GESTRA Engineering, Inc.

GESTRA Engineering, Inc
1626 W. Fond du Lac Avenue
Milwaukee, WI 53205
Phone: (414) 933-7444; Fax: (414) 933-7844

Laboratory Test Results of
Moisture Content, Organic Content, and Density of Soil

Project Name:	Bliffert Site Parking Lot	Date:	November 3, 2014
Project Number:	14133-10	Report To:	The Sigma Group
Project Location:	Milwaukee Co., WI		
ASTM Designation:	**D2216, D 2974**		

Boring Number	PB-1	PB-1	PB-1	PB-1	PB-1	PB-1	PB-1	PB-1
Sample Number	2	3	4	5	6	7	8	9
Cup Number	T-10	T-1	M-2	Y-7	Q-6	P-1	R-1	Y-91
Weight of Cup (g)	25.29	26.58	26.92	27.20	23.96	24.44	25.46	26.18
Weight of Wet Soil and Cup (g)	47.80	53.02	50.80	56.93	49.93	51.48	39.29	52.92
Weight of Dry Soil and Cup (g)	42.97	49.68	47.47	52.48	45.39	46.36	37.18	50.61
Weight of Soil and Cup After Burn (g)								
Weight of Sample for Density (lbs)								
Diameter (in)								
Length(in)								
Moisture Content (%)	27.3	14.5	16.2	17.6	21.2	23.4	18.0	9.5
Organic Content (%)								
Wet Density (pcf)								
Dry Density (pcf)								

Boring Number	PB-2	PB-2	PB-2	PB-2	PB-2	PB-2		
Sample Number	1	2	3	4	5	6		
Cup Number	A-5	A-2	B-7	P-7	T-7	Y-10		
Weight of Cup (g)	26.83	24.20	27.29	27.76	23.42	24.88		
Weight of Wet Soil and Cup (g)	49.81	51.96	38.97	52.65	45.79	53.41		
Weight of Dry Soil and Cup (g)	46.84	48.51	37.82	49.85	43.37	50.26		
Weight of Soil and Cup After Burn (g)								
Weight of Sample for Density (lbs)								
Diameter (in)								
Length(in)								
Moisture Content (%)	14.8	14.2	10.9	12.7	12.1	12.4		
Organic Content (%)								
Wet Density (pcf)								
Dry Density (pcf)								

Performed by BJB Reviewed by SHL

GESTRA Engineering, Inc
1626 W. Fond du Lac Avenue
Milwaukee, WI 53205
Phone: (414) 933-7444; Fax: (414) 933-7844

Laboratory Test Results of
Moisture Content, Organic Content, and Density of Soil

Project Name:	Bliffert Site Parking Lot	Date:	October 20, 2014
Project Number:	14133-10	Report To:	The Sigma Group
Project Location:	Milwaukee Co., WI		
ASTM Designation:	**D2216, D 2974**		

Boring Number	PB-3	PB-3	PB-3					
Sample Number	2	3	4					
Cup Number	P5	B6	Y2					
Weight of Cup (g)	26.98	23.34	25.17					
Weight of Wet Soil and Cup (g)	57.70	49.86	52.45					
Weight of Dry Soil and Cup (g)	52.68	45.14	48.79					
Weight of Soil and Cup After Burn (g)								
Weight of Sample for Density (lbs)								
Diameter (in)								
Length(in)								
Moisture Content (%)	19.5	21.7	15.5					
Organic Content (%)								
Wet Density (pcf)								
Dry Density (pcf)								

Boring Number								
Sample Number								
Cup Number								
Weight of Cup (g)								
Weight of Wet Soil and Cup (g)								
Weight of Dry Soil and Cup (g)								
Weight of Soil and Cup After Burn (g)								
Weight of Sample for Density (lbs)								
Diameter (in)								
Length(in)								
Moisture Content (%)								
Organic Content (%)								
Wet Density (pcf)								
Dry Density (pcf)								

Performed by BJB Reviewed by SHL

GESTRA Engineering, Inc
1626 W. Fond du Lac Avenue
Milwaukee, WI 53205
Phone: (414) 933-7444; Fax: (414) 933-7844

Laboratory Test Results of Atterberg Limits of Soil

Project Name:	Bliffert Site Parking Lot	Date:	November 14, 2014
Project Number:	14133-10	Client:	Sigma
Project Location:	Milwaukee Co, WI		
ASTM Designation:	**D4318**		

Sample Information

Type of Sample	Split Spoon
Boring Number	PB-2
Sample Number	1
Depth of Sample	1' - 2.5'

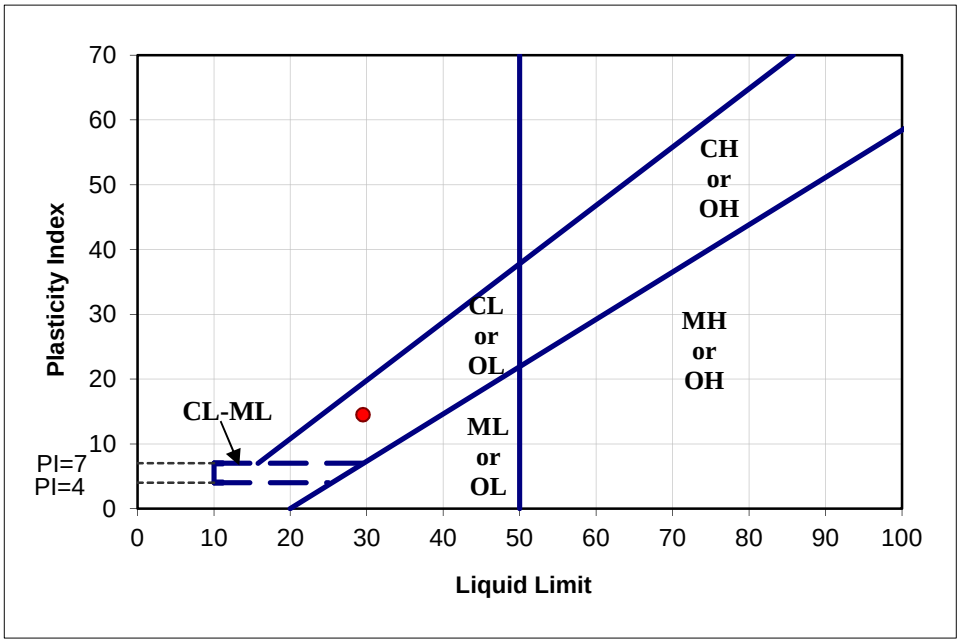
Determination of Liquid Limit

Cup Number	D-14	D-25	D-15
Weight of Cup (g)	14.27	13.94	14.42
Weight of Wet Soil and Cup (g)	32.77	33.27	34.86
Weight of Dry Soil and Cup (g)	28.76	28.88	29.95
Moisture Content (%)	27.7	29.4	31.6
Blow Counts	35	24	15

Determination of Plastic Limit

Cup Number	D-16	D-5
Weight of Cup (g)	7.32	7.26
Weight of Wet Soil and Cup (g)	14.31	13.62
Weight of Dry Soil and Cup (g)	13.42	12.81
Moisture Content (%)	14.6	14.6

Compilation of Test Results



Liquid Limit	29
Plastic Limit	15
Plasticity Index	14
USCS Symbol	**CL**

Performed by: NC

Reviewed By: SHL

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1626 W. Fond du Lac Avenue
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Phone: (414) 933-7444; Fax: (414) 933-7844

Laboratory Test Results of Atterberg Limits of Soil

Project Name:	Bliffert Site Parking Lot	Date:	November 14, 2014
Project Number:	14133-10	Client:	Sigma
Project Location:	Milwaukee Co, WI		
ASTM Designation:	**D4318**		

Sample Information

Type of Sample	Split Spoon
Boring Number	PB-3
Sample Number	2
Depth of Sample	3.5' - 5'

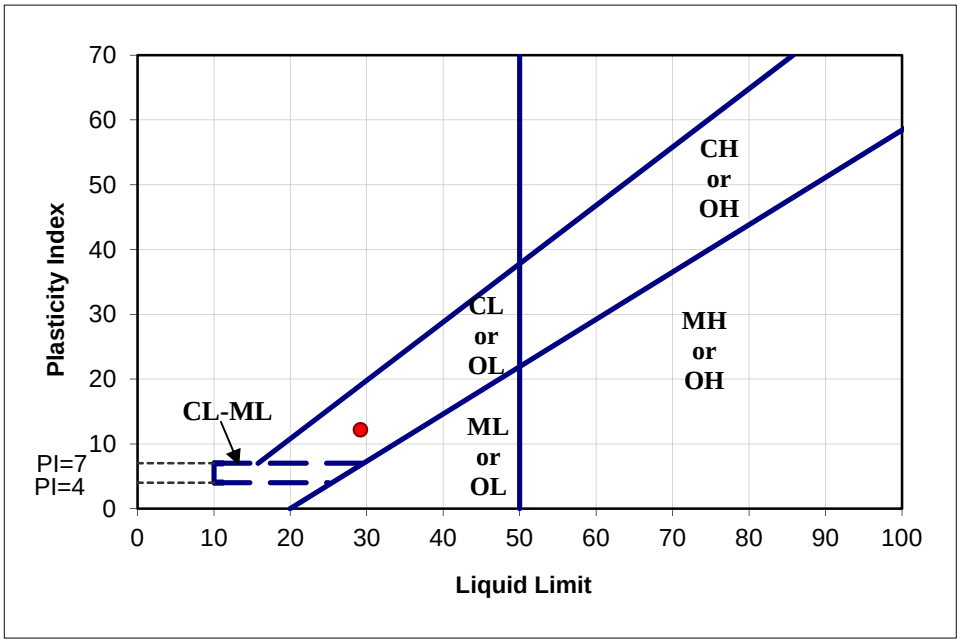
Determination of Liquid Limit

Cup Number	D-13	L-3	L-14
Weight of Cup (g)	14.38	14.35	14.09
Weight of Wet Soil and Cup (g)	38.62	36.50	35.56
Weight of Dry Soil and Cup (g)	33.35	31.51	30.53
Moisture Content (%)	27.8	29.1	30.6
Blow Counts	35	24	16

Determination of Plastic Limit

Cup Number	D-30	D-12
Weight of Cup (g)	7.23	7.28
Weight of Wet Soil and Cup (g)	13.09	14.81
Weight of Dry Soil and Cup (g)	12.24	13.72
Moisture Content (%)	17.0	16.9

Compilation of Test Results



Liquid Limit	29
Plastic Limit	17
Plasticity Index	12
USCS Symbol	**CL**

Performed by: NC

Reviewed By: SHL

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Laboratory Test Results of Atterberg Limits of Soil

Project Name:	Bliffert Site Parking Lot	Date:	October 21, 2014
Project Number:	14133-10	Client:	The Sigma Group
Project Location:	Milwaukee Co., WI		
ASTM Designation:	**D4318**		

Sample Information

Type of Sample	Split Spoon
Boring Number	PB 3
Sample Number	3
Depth of Sample	6'-7.5'

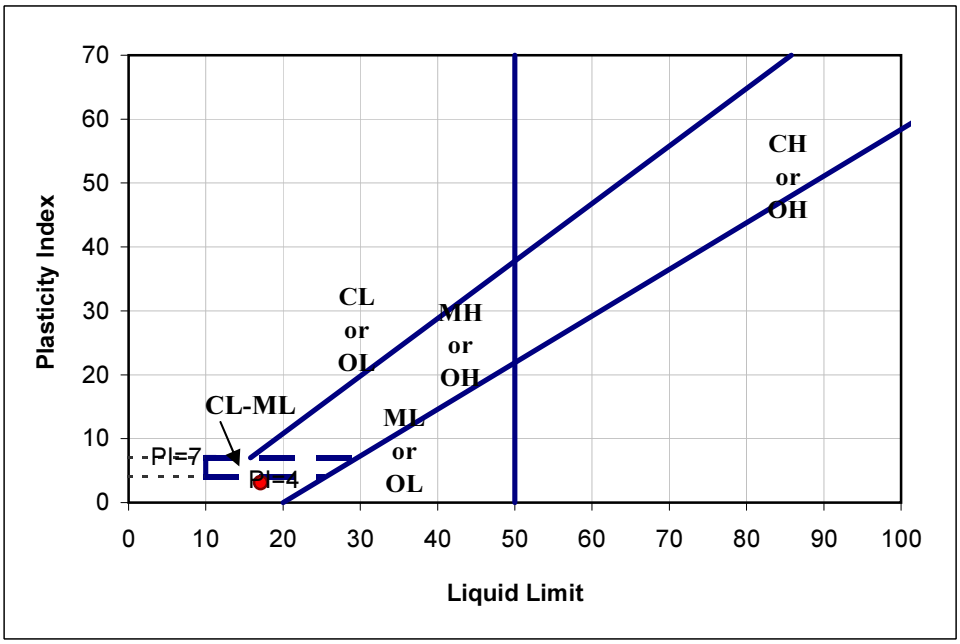
Determination of Liquid Limit

Cup Number	D4	L12	D2
Weight of Cup (g)	14.48	14.46	14.78
Weight of Wet Soil and Cup (g)	34.79	33.45	36.44
Weight of Dry Soil and Cup (g)	31.90	30.64	32.99
Moisture Content (%)	16.6	17.4	18.9
Blow Counts	28	23	16

Determination of Plastic Limit

Cup Number	D2	D9
Weight of Cup (g)	7.23	7.33
Weight of Wet Soil and Cup (g)	14.98	15.63
Weight of Dry Soil and Cup (g)	14.02	14.60
Moisture Content (%)	14.1	14.2

Compilation of Test Results



Liquid Limit	17
Plastic Limit	14
Plasticity Index	3
USCS Symbol	**ML**

Performed by: BJB

Reviewed By: SHL

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Laboratory Test Results of Atterberg Limits of Soil

Project Name:	Bliffert Site Parking Lot	Date:	October 21, 2014
Project Number:	14133-10	Client:	Sigma
Project Location:	Milwaukee, WI		
ASTM Designation:	**D4318**		

Sample Information

Type of Sample	Split Spoon
Boring Number	SB-2
Sample Number	8
Depth of Sample	23.5' - 25'

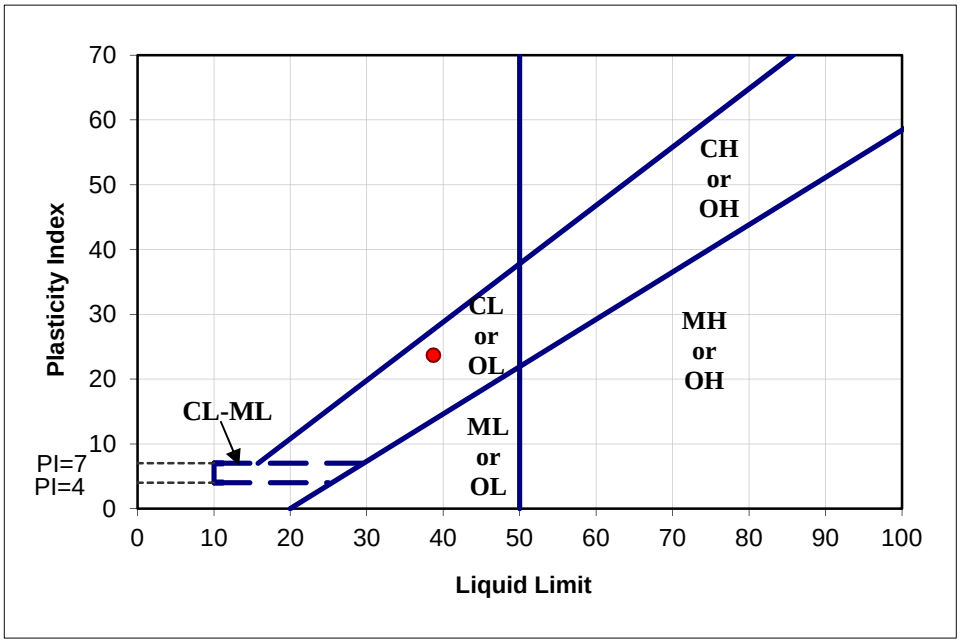
Determination of Liquid Limit

Cup Number	L-20	D-24	L-3
Weight of Cup (g)	14.05	14.18	14.38
Weight of Wet Soil and Cup (g)	36.13	35.26	35.18
Weight of Dry Soil and Cup (g)	30.21	29.46	29.08
Moisture Content (%)	36.6	38.0	41.5
Blow Counts	35	25	15

Determination of Plastic Limit

Cup Number	L-7	D-18
Weight of Cup (g)	7.37	7.33
Weight of Wet Soil and Cup (g)	13.43	15.43
Weight of Dry Soil and Cup (g)	12.62	14.35
Moisture Content (%)	15.4	15.4

Compilation of Test Results



Liquid Limit	39
Plastic Limit	15
Plasticity Index	24
USCS Symbol	**CL**

Performed by: NC

Reviewed By: SHL

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Laboratory Test Results of
Moisture Content, Organic Content, and Density of Soil

Project Name:	Bliffert Site Parking Lot	Date:	October 16, 2014
Project Number:	14133-10	Report To:	The Sigma Group
Project Location:	Milwaukee Co., WI		
ASTM Designation:	**D2216, D 2974**		

Boring Number	SB-1	SB-1	SB-1					
Sample Number	3	4	5					
Cup Number	P7	A 10	PC 107					
Weight of Cup (g)	27.76	25.19	61.40					
Weight of Wet Soil and Cup (g)	48.97	45.81	111.67					
Weight of Dry Soil and Cup (g)	46.95	41.65	104.27					
Weight of Soil and Cup After Burn (g)			102.92					
Weight of Sample for Density (lbs)								
Diameter (in)								
Length(in)								
Moisture Content (%)	10.5	25.3	17.3					
Organic Content (%)			3.1					
Wet Density (pcf)								
Dry Density (pcf)								

Boring Number								
Sample Number								
Cup Number								
Weight of Cup (g)								
Weight of Wet Soil and Cup (g)								
Weight of Dry Soil and Cup (g)								
Weight of Soil and Cup After Burn (g)								
Weight of Sample for Density (lbs)								
Diameter (in)								
Length(in)								
Moisture Content (%)								
Organic Content (%)								
Wet Density (pcf)								
Dry Density (pcf)								

Performed by ALM Reviewed by SHL

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Laboratory Test Results of Mechanical Analysis of Soil or Aggregate

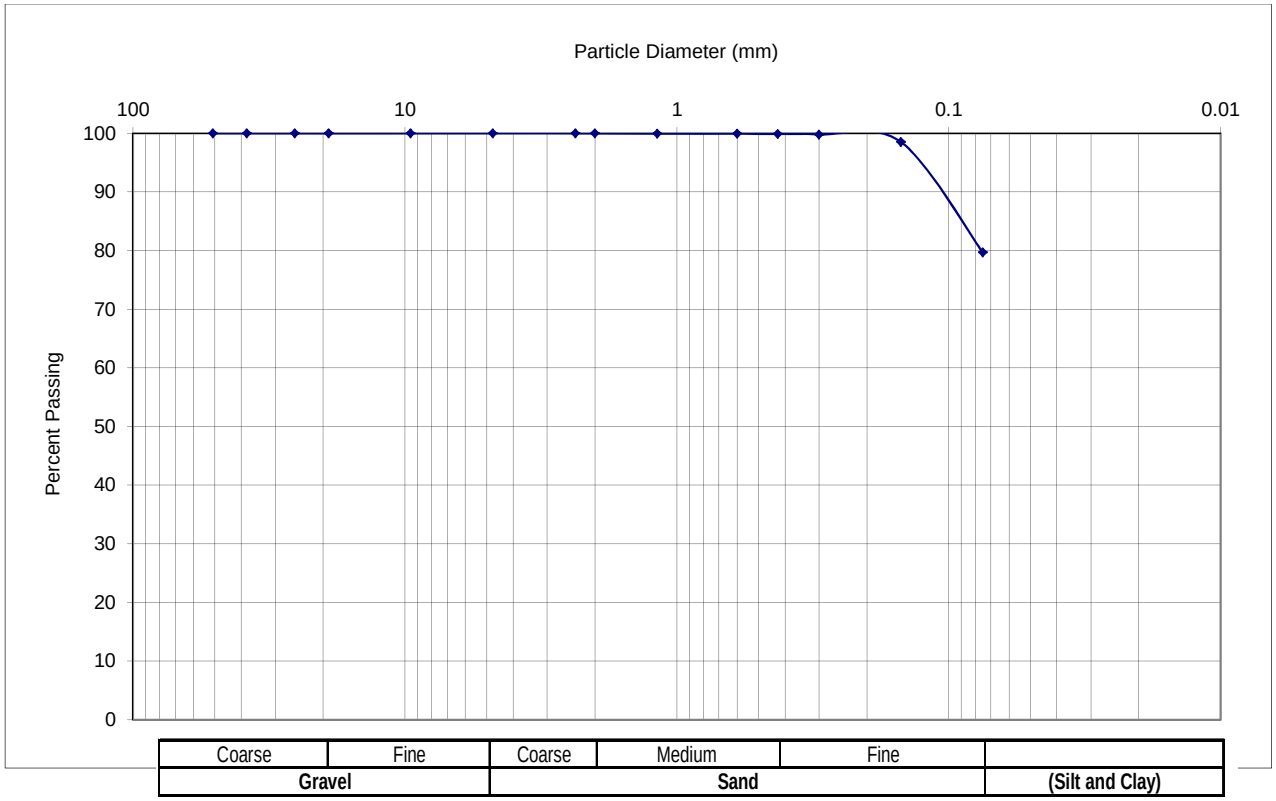
Project Name:	Bliffert Site Parking Lot	Date:	October 22, 2014
Project Number:	14133-10	Reported To:	The Sigma Group
Project Location:	Milwaukee Co.,WI		
ASTM Designation:	**C136, D422**		

Sample Information

Type of Sample:	Split Spoon	Sample Number:	6
Boring Number:	SB 1	Depth of Sample:	13.5'-15'

Mechanical Analysis Data

Sieve	Sieve Opening (mm)	Percent Passing (%)
2	50.8	100.0
1 1/2	38.1	100.0
1	25.4	100.0
3/4	19.05	100.0
3/8	9.525	100.0
#4	4.75	100.0
#8	2.36	100.0
#10	2	100.0
#16	1.18	99.9
#30	0.6	99.9
#40	0.425	99.9
#50	0.3	99.8
#100	0.15	98.5
#200	0.075	79.7



Moisture Content 19.9 %

Remarks: Gravel 0.0 % Sand 20.3 %
Passing #200 Sieve (Silt & Clay) 79.7 %

Performed by: BJB

Reviewed by: SHL
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Laboratory Test Results of
Moisture Content, Organic Content, and Density of Soil

Project Name:	Bliffert Site Parking Lot	Date:	October 16, 2014
Project Number:	14133-10	Report To:	The Sigma Group
Project Location:	Milwaukee Co., WI		
ASTM Designation:	**D2216, D 2974**		

Boring Number	TB-1	TB-1	TB-1	TB-1	TB-1	TB-1		
Sample Number	5	6	7	9	11B	13		
Cup Number	Y6	A6	A2	Y3	Q12	Q4		
Weight of Cup (g)	26.53	23.97	24.18	26.36	26.79	23.97		
Weight of Wet Soil and Cup (g)	46.78	44.59	44.31	46.62	47.03	47.08		
Weight of Dry Soil and Cup (g)	44.38	42.70	42.07	44.33	42.93	43.75		
Weight of Soil and Cup After Burn (g)								
Weight of Sample for Density (lbs)								
Diameter (in)								
Length(in)								
Moisture Content (%)	13.4	10.1	12.5	12.7	25.4	16.8		
Organic Content (%)								
Wet Density (pcf)								
Dry Density (pcf)								

Boring Number								
Sample Number								
Cup Number								
Weight of Cup (g)								
Weight of Wet Soil and Cup (g)								
Weight of Dry Soil and Cup (g)								
Weight of Soil and Cup After Burn (g)								
Weight of Sample for Density (lbs)								
Diameter (in)								
Length(in)								
Moisture Content (%)								
Organic Content (%)								
Wet Density (pcf)								
Dry Density (pcf)								

Performed by ALM Reviewed by SHL

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Laboratory Test Results of Atterberg Limits of Soil

Project Name:	Bliffert Site Parking Lot	Date:	October 17, 2014
Project Number:	14133-10	Client:	Sigma
Project Location:	Milwaukee, WI		
ASTM Designation:	**D4318**		

Sample Information

Type of Sample	Split Spoon
Boring Number	TB-1
Sample Number	2
Depth of Sample	3.5' - 5'

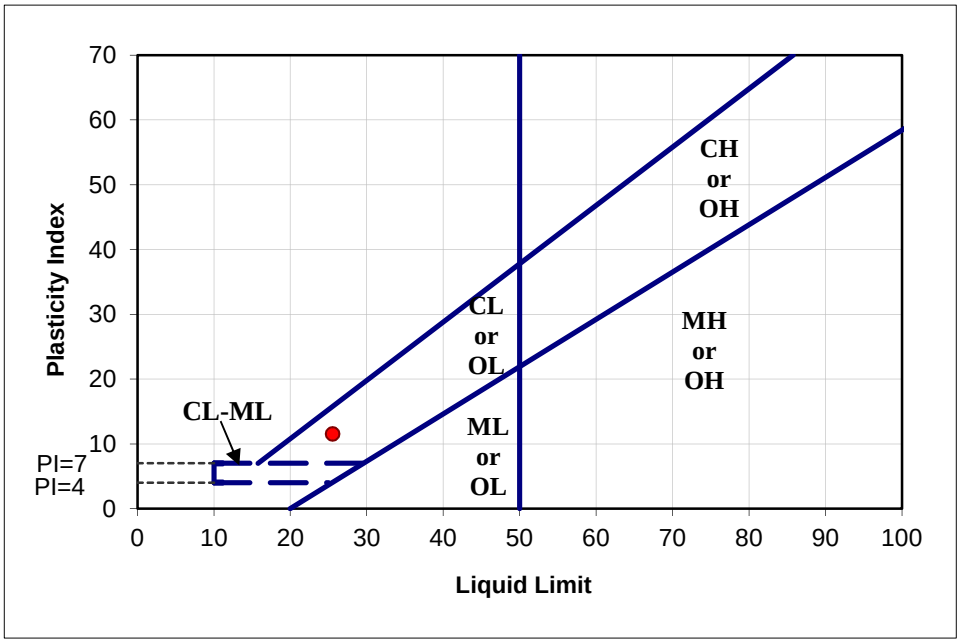
Determination of Liquid Limit

Cup Number	D-4	D-13	L-4
Weight of Cup (g)	14.49	14.36	14.29
Weight of Wet Soil and Cup (g)	34.72	33.87	33.65
Weight of Dry Soil and Cup (g)	30.70	29.88	29.59
Moisture Content (%)	24.8	25.7	26.5
Blow Counts	33	22	15

Determination of Plastic Limit

Cup Number	L-5	L-8
Weight of Cup (g)	7.35	7.19
Weight of Wet Soil and Cup (g)	13.97	14.15
Weight of Dry Soil and Cup (g)	13.17	13.32
Moisture Content (%)	13.7	13.5

Compilation of Test Results



Liquid Limit	26
Plastic Limit	14
Plasticity Index	12
USCS Symbol	**CL**

Performed by: NC

Reviewed By: SHL

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Laboratory Test Results of
Moisture Content, Organic Content, and Density of Soil

Project Name:	Bliffert Site Parking Lot	Date:	October 16, 2014
Project Number:	14133-10	Report To:	The Sigma Group
Project Location:	Milwaukee Co., WI		
ASTM Designation:	**D2216, D 2974**		

Boring Number	WRB-1	WRB-1						
Sample Number	4 CLAY	6						
Cup Number	PC D	B1						
Weight of Cup (g)	71.70	26.71						
Weight of Wet Soil and Cup (g)	122.31	47.87						
Weight of Dry Soil and Cup (g)	114.70	43.79						
Weight of Soil and Cup After Burn (g)	113.04							
Weight of Sample for Density (lbs)								
Diameter (in)								
Length(in)								
Moisture Content (%)	17.7	23.9						
Organic Content (%)	3.9							
Wet Density (pcf)								
Dry Density (pcf)								

Boring Number								
Sample Number								
Cup Number								
Weight of Cup (g)								
Weight of Wet Soil and Cup (g)								
Weight of Dry Soil and Cup (g)								
Weight of Soil and Cup After Burn (g)								
Weight of Sample for Density (lbs)								
Diameter (in)								
Length(in)								
Moisture Content (%)								
Organic Content (%)								
Wet Density (pcf)								
Dry Density (pcf)								

Performed by ALM Reviewed by SHL

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Laboratory Test Results of Atterberg Limits of Soil

Project Name:	Bliffert Site Parking Lot	Date:	October 21, 2014
Project Number:	14133-10	Client:	Sigma
Project Location:	Milwaukee, WI		
ASTM Designation:	**D4318**		

Sample Information

Type of Sample	Split Spoon
Boring Number	WRB-1
Sample Number	3
Depth of Sample	6' - 7.5'

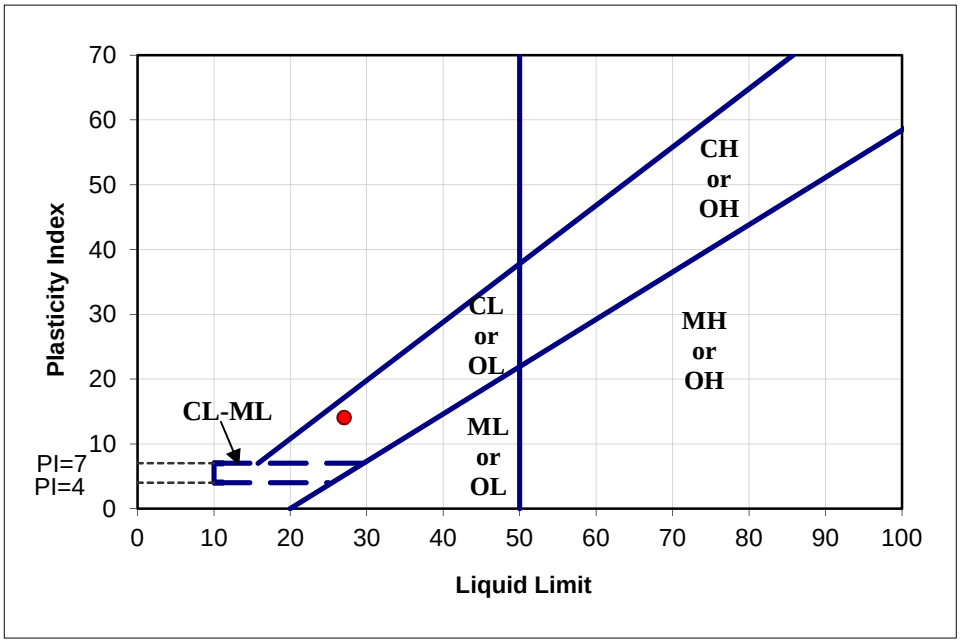
Determination of Liquid Limit

Cup Number	D-22	L-15	L-10
Weight of Cup (g)	14.45	14.34	14.48
Weight of Wet Soil and Cup (g)	34.90	37.85	38.00
Weight of Dry Soil and Cup (g)	30.72	32.79	32.82
Moisture Content (%)	25.7	27.4	28.2
Blow Counts	35	23	15

Determination of Plastic Limit

Cup Number	D-24	L-6
Weight of Cup (g)	7.24	7.19
Weight of Wet Soil and Cup (g)	13.44	16.16
Weight of Dry Soil and Cup (g)	12.72	15.07
Moisture Content (%)	13.1	13.8

Compilation of Test Results



Liquid Limit	27
Plastic Limit	13
Plasticity Index	14
USCS Symbol	**CL**

Performed by: NC

Reviewed By: SHL

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Laboratory Test Results of
Moisture Content, Organic Content, and Density of Soil

Project Name:	Bliffert Site Parking Lot	Date:	October 16, 2014
Project Number:	14133-10	Report To:	The Sigma Group
Project Location:	Milwaukee Co., WI		
ASTM Designation:	**D2216, D 2974**		

Boring Number	WRB-2							
Sample Number	5							
Cup Number	Y5							
Weight of Cup (g)	20.52							
Weight of Wet Soil and Cup (g)	41.24							
Weight of Dry Soil and Cup (g)	38.29							
Weight of Soil and Cup After Burn (g)								
Weight of Sample for Density (lbs)								
Diameter (in)								
Length(in)								
Moisture Content (%)	16.6							
Organic Content (%)								
Wet Density (pcf)								
Dry Density (pcf)								

Boring Number								
Sample Number								
Cup Number								
Weight of Cup (g)								
Weight of Wet Soil and Cup (g)								
Weight of Dry Soil and Cup (g)								
Weight of Soil and Cup After Burn (g)								
Weight of Sample for Density (lbs)								
Diameter (in)								
Length(in)								
Moisture Content (%)								
Organic Content (%)								
Wet Density (pcf)								
Dry Density (pcf)								

Performed by ALM Reviewed by SHL

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Laboratory Test Results of
Moisture Content, Organic Content, and Density of Soil

Project Name:	Bliffert Site Parking Lot	Date:	October 16, 2014
Project Number:	14133-10	Report To:	The Sigma Group
Project Location:	Milwaukee Co., WI		
ASTM Designation:	**D2216, D 2974**		

Boring Number	WRB-3	WRB-3	WRB-3					
Sample Number	2	5	6					
Cup Number	PC 103	V5	Q5					
Weight of Cup (g)	64.31	22.38	24.40					
Weight of Wet Soil and Cup (g)	115.68	42.65	45.33					
Weight of Dry Soil and Cup (g)	101.66	40.21	42.30					
Weight of Soil and Cup After Burn (g)	100.14							
Weight of Sample for Density (lbs)								
Diameter (in)								
Length(in)								
Moisture Content (%)	37.5	13.7	16.9					
Organic Content (%)	4.1							
Wet Density (pcf)								
Dry Density (pcf)								

Boring Number								
Sample Number								
Cup Number								
Weight of Cup (g)								
Weight of Wet Soil and Cup (g)								
Weight of Dry Soil and Cup (g)								
Weight of Soil and Cup After Burn (g)								
Weight of Sample for Density (lbs)								
Diameter (in)								
Length(in)								
Moisture Content (%)								
Organic Content (%)								
Wet Density (pcf)								
Dry Density (pcf)								

Performed by ALM Reviewed by SHL

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Laboratory Test Results of
Moisture Content, Organic Content, and Density of Soil

Project Name:	Bliffert Site Parking Lot	Date:	October 20, 2014
Project Number:	14133-10	Report To:	The Sigma Group
Project Location:	Milwaukee Co., WI		
ASTM Designation:	**D2216, D 2974**		

Boring Number	WRB-4	WRB-4	WRB-4	WRB-4	WRB-4	WRB-4		
Sample Number	1	2	3	4	5	6		
Cup Number	V4	M9	Q2	PC 701	A7	M6		
Weight of Cup (g)	23.89	26.88	24.22	47.88	25.10	24.00		
Weight of Wet Soil and Cup (g)	47.98	50.38	38.94	116.49	50.90	56.46		
Weight of Dry Soil and Cup (g)	44.90	47.52	36.97	101.15	46.41	52.20		
Weight of Soil and Cup After Burn (g)				98.09				
Weight of Sample for Density (lbs)								
Diameter (in)								
Length(in)								
Moisture Content (%)	14.7	13.9	15.5	28.8	21.1	15.1		
Organic Content (%)				5.7				
Wet Density (pcf)								
Dry Density (pcf)								

Boring Number								
Sample Number								
Cup Number								
Weight of Cup (g)								
Weight of Wet Soil and Cup (g)								
Weight of Dry Soil and Cup (g)								
Weight of Soil and Cup After Burn (g)								
Weight of Sample for Density (lbs)								
Diameter (in)								
Length(in)								
Moisture Content (%)								
Organic Content (%)								
Wet Density (pcf)								
Dry Density (pcf)								

Performed by BJB Reviewed by SHL

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Laboratory Test Results of Atterberg Limits of Soil

Project Name:	Bliffert Site Parking Lot	Date:	November 14, 2014
Project Number:	14133-10	Client:	Sigma
Project Location:	Milwaukee Co, WI		
ASTM Designation:	**D4318**		

Sample Information

Type of Sample	Split Spoon
Boring Number	WRB-4
Sample Number	5
Depth of Sample	11' - 12.5'

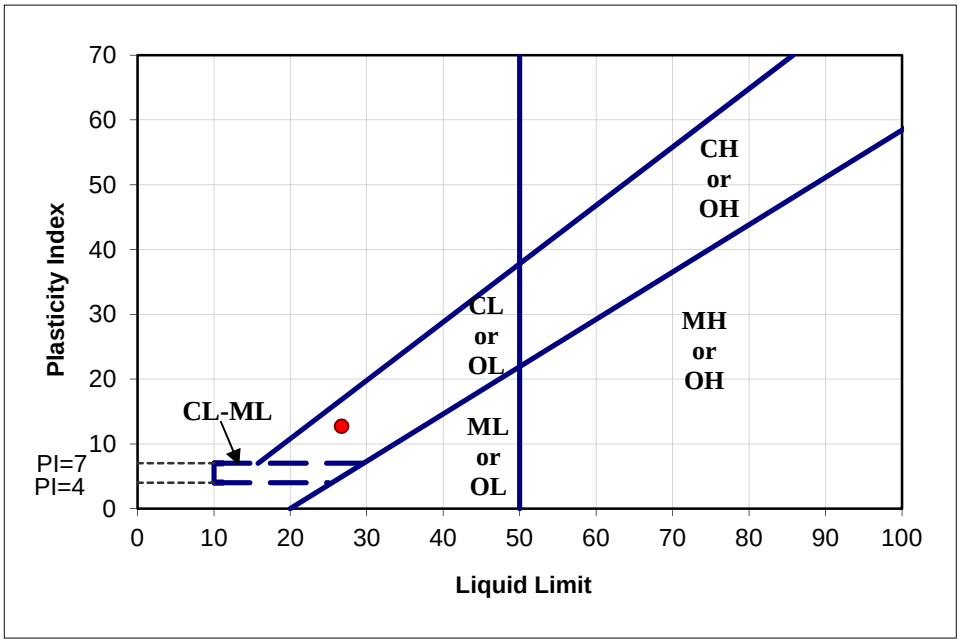
Determination of Liquid Limit

Cup Number	D-23	D-12	D-6
Weight of Cup (g)	14.31	14.38	14.55
Weight of Wet Soil and Cup (g)	34.92	32.53	33.23
Weight of Dry Soil and Cup (g)	30.76	28.69	29.14
Moisture Content (%)	25.3	26.8	28.0
Blow Counts	35	24	16

Determination of Plastic Limit

Cup Number	L-2	L-8
Weight of Cup (g)	7.36	7.19
Weight of Wet Soil and Cup (g)	15.02	13.26
Weight of Dry Soil and Cup (g)	14.08	12.53
Moisture Content (%)	14.0	13.7

Compilation of Test Results



Liquid Limit	27
Plastic Limit	14
Plasticity Index	13
USCS Symbol	**CL**

Performed by: NC

Reviewed By: SHL

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Phone: (414) 933-7444; Fax: (414) 933-7844

Laboratory Test Results of
Moisture Content, Organic Content, and Density of Soil

Project Name:	Bliffert Site Parking Lot	Date:	October 20, 2014
Project Number:	14133-10	Report To:	The Sigma Group
Project Location:	Milwaukee Co., WI		
ASTM Designation:	**D2216, D 2974**		

Boring Number	WRB-5	WRB-5	WRB-5	WRB-5	WRB-5	WRB-5	WRB-5	WRB-5
Sample Number	1	2	3	4	5	6	7	8
Cup Number	T2	Q8	B5	Y6	P2	B8	Q9	P3
Weight of Cup (g)	26.42	25.13	26.18	26.52	26.34	26.70	25.16	23.41
Weight of Wet Soil and Cup (g)	42.93	53.00	61.00	51.52	54.29	61.18	51.57	60.15
Weight of Dry Soil and Cup (g)	39.94	49.79	56.98	48.57	51.07	57.14	48.25	55.74
Weight of Soil and Cup After Burn (g)								
Weight of Sample for Density (lbs)								
Diameter (in)								
Length(in)								
Moisture Content (%)	22.1	13.0	13.1	13.4	13.0	13.3	14.4	13.6
Organic Content (%)								
Wet Density (pcf)								
Dry Density (pcf)								

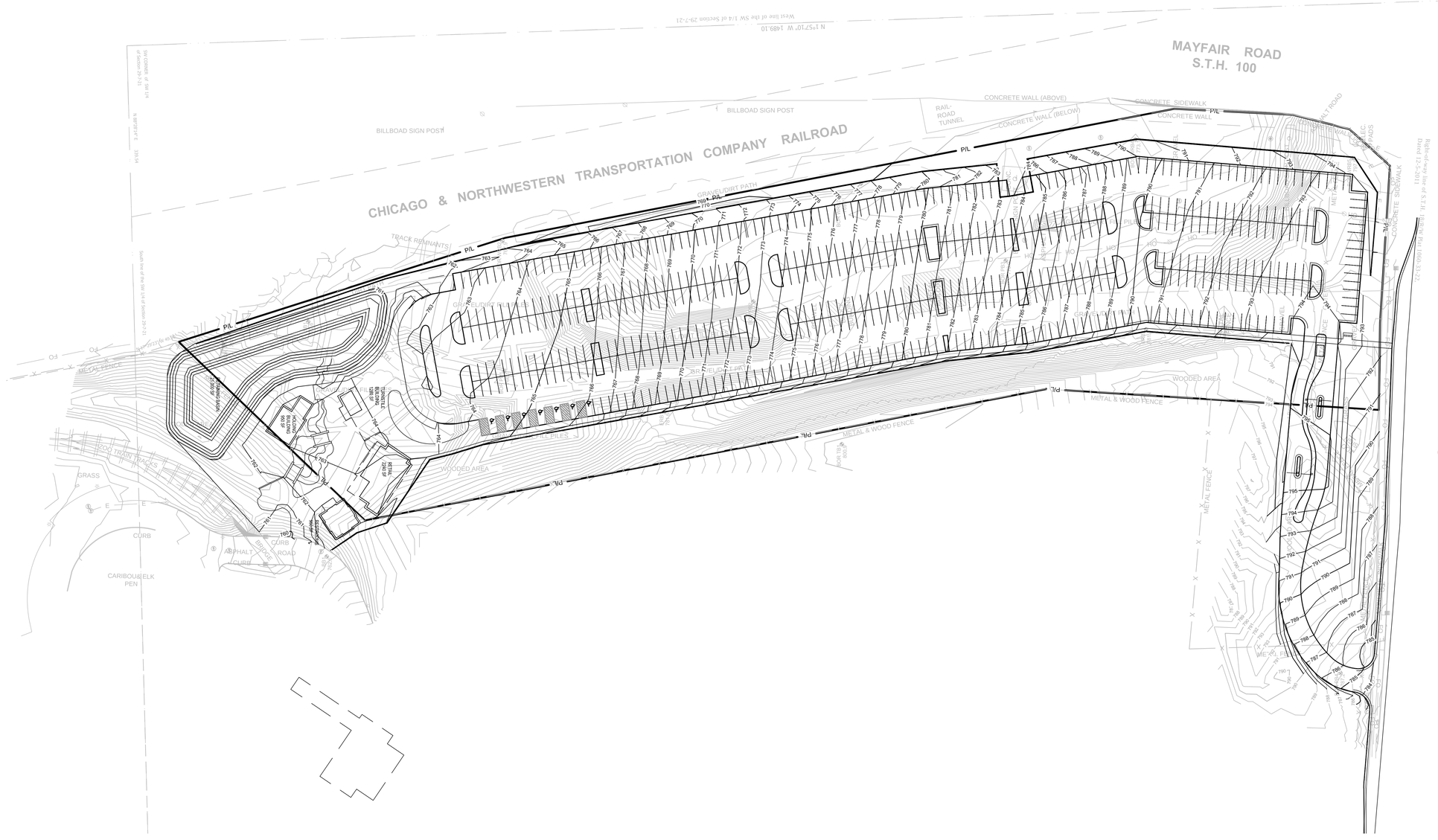
Boring Number								
Sample Number								
Cup Number								
Weight of Cup (g)								
Weight of Wet Soil and Cup (g)								
Weight of Dry Soil and Cup (g)								
Weight of Soil and Cup After Burn (g)								
Weight of Sample for Density (lbs)								
Diameter (in)								
Length(in)								
Moisture Content (%)								
Organic Content (%)								
Wet Density (pcf)								
Dry Density (pcf)								

Performed by BJB Reviewed by SHL

Appendix III

Preliminary Project Plan – “Rough Grading Package” provided by SIGMA

PRELIMINARY



GRAPHIC SCALE

0 50' 100'

LEGEND:

- 5 — EXISTING CONTOUR
- 5 — PROPOSED CONTOUR
- 100.50 T/C 100.00 BTM — PROPOSED CURB & GUTTER SPOT GRADE T/C: TOP OF CURB GRADE BTM: BOTTOM OF CURB GRADE
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Fax: 414-643-4210

NOT FOR CONSTRUCTION

REVISION NO.	REVISION DATE

Milwaukee County Zoo

West Parking Lot and Entrance Complex

Milwaukee, WI

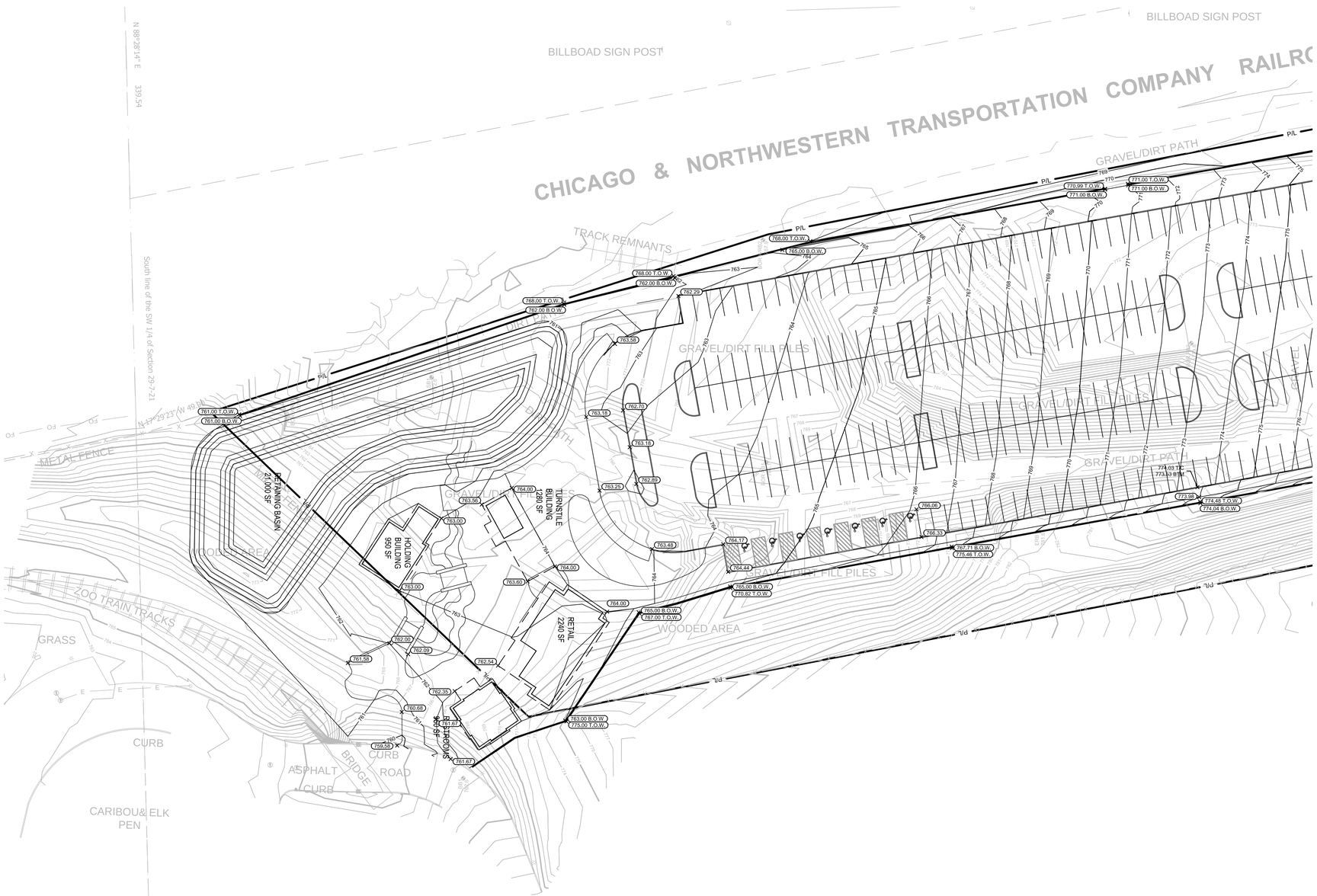
ROUGH GRADING PACKAGE

GRADING PLAN

DATE	November 19, 2014
DR. TPM	CK. CTC
PGAV 75919	CLIENT MCZ
SHEET NUMBER	C200

File: I:\PGAV Destinations\L4930 Bilfiert Parking Phase I Design\060 CAD\C - Civil\500 Production - Civil Plans\505-Grading Plan\L4930-500-GRADING-P.dwg

PRELIMINARY



GRAPHIC SCALE

0 30' 60'

LEGEND:

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5	PROPOSED CONTOUR
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REVISION NO.	REVISION DATE

Milwaukee County Zoo

West Parking Lot and Entrance Complex

Milwaukee, WI

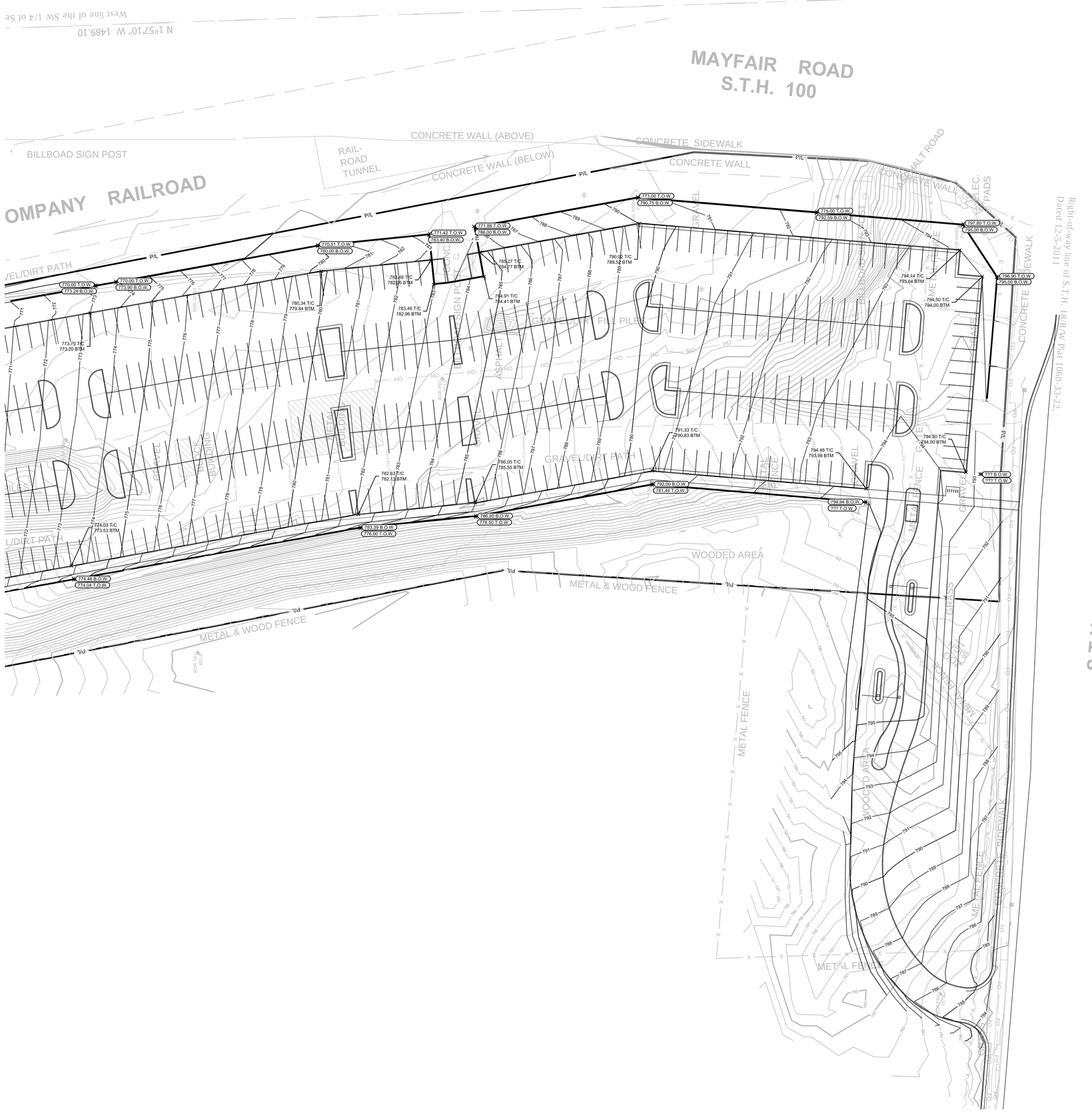
ROUGH GRADING PACKAGE

GRADING PLAN

DATE November 19, 2014	
DR TPM	CK CTC
PGAV 75919	CLIENT MCZ
SHEET NUMBER C201	

File: I:\PGAV Destinations\14930 Billfert Parking Phase I Design\060 CAD\C - Civil\500 Production - Civil Plans\505-Grading Plan\14930-500-GRADING-P.dwg

PRELIMINARY



GRAPHIC SCALE

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GRADING PLAN

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PGAV 75919	CLIENT MCZ
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SECTION 312319

DEWATERING

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes construction dewatering.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.

B. Environmental Contamination: Site is known to contain groundwater contaminated with benzene and PAH compounds above State of Wisconsin Enforcement Standards. Contaminated groundwater encountered shall be managed in accordance with all applicable State, Federal and Local laws and regulations. Coordinate any disposal of contaminated groundwater with the Project Manager: Philip Hung (414-315-4932) and the County Environmental Engineer: Tim Detzer (414-286-2988).

PART 3 - EXECUTION

3.01 PREPARATION

A. Provide temporary grading to facilitate dewatering and control of surface water.

B. Protect and maintain temporary erosion and sedimentation controls, which are shown on the plans.

3.02 INSTALLATION

A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.
   1. Space well points or wells at intervals required to provide sufficient dewatering.
   2. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.

B. Place dewatering system into operation to lower water to specified levels before excavating below ground-water level.

C. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails.

3.03 OPERATION

A. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed or until dewatering is no longer required.

B. Operate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.
   1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.
   2. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.

C. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches below overlying construction.

3.04 FIELD QUALITY CONTROL

A. Survey-Work Benchmarks: Resurvey benchmarks regularly during dewatering and maintain an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Architect if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

END OF SECTION

SECTION 312500

EROSION CONTROL

PART 1 - GENERAL

1.01 SCOPE

A. The work under this section consists of providing all work, materials, labor, equipment, and supervision necessary to provide and construct erosion control measures necessary to protect property and the environment. Included are the following topics:
   1. Part 1 - GENERAL
      a. Scope
      b. Related Work
      c. Submittals
      d. Erosion Control Plan
   2. Part 2 - MATERIALS
      a. General
      b. Straw Bale Barriers
      c. Silt Fence
      d. Erosion Mat
      e. Staples
   3. Part 3 - EXECUTION
      a. General
      b. Grading and Earthwork
      c. Drainage
      d. Tracking Control
      e. Maintenance

1.02 RELATED WORK

A. Applicable provisions of the Conditions of the Contract for Small Projects and the General Requirements for Small Projects govern work under this Section.
   1. 311000 – Site Clearing
   2. 312000 – Earthmoving

B. Provide erosion control in accordance with the following references:
   1. Wisconsin Construction Site Best Management Practice Handbook, current version as published by the WDNR ("Best Management Practice Handbook")
   2. Wisconsin Department of Natural Resources Storm Water Construction Technical Standards
   3. Erosion Control Product Acceptability List ("PAL"), current version as published by the WisDOT.
   4. Erosion Control Plan, Details and Notes included with construction document plan set.

C. Method of measurement and basis of payment sections in any referenced erosion control documents shall not apply to this contract.

D. These documents are available from: State of Wisconsin Document Sales and Distribution 202 South Thornton Avenue; P.O. Box 7840; Madison, WI 53707; 608-266-3358

1.03 SUBMITTALS

A. Submit shop drawings for the following erosion control features:
   1. Inlet Protection
   2. Erosion Mat

1.04 EROSION CONTROL PLAN

A. The A/E has prepared an erosion control plan for the project. The A/E will complete, apply for, and pay for a WPDES Stormwater Discharge Permit. The Contractor will provide the A/E with submittals for materials used to implement the erosion control plan, as well as any modifications to the erosion control plan that are necessary due to the Contractor's means and methods of construction.

B. Contractor shall comply with all the requirements of the erosion control plan, and if applicable, the WPDES Stormwater Discharge Permit for Erosion Control.

C. Contractor is responsible for obtaining erosion control permit from the City of Milwaukee.

PART 2 - MATERIALS

2.01 GENERAL

A. Erosion mats, soil stabilizers, and tackifiers shall be listed on the Product Acceptability List for Multi-Modal Applications ("PAL") as published by the Wisconsin Department of Transportation.

B. When the design or contract includes permanent erosion control or stormwater control features, the contractor may employ these items in his control of erosion and stormwater during his construction activities. However, these items shall be fully cleaned, restored, and in every way fully functioning for its intended permanent use prior to acceptance of the work.

2.02 STRAW BALE BARRIERS

A. Rectangular bales of hay or straw, tightly bound with twine, not wire.

2.03 SILT FENCE

A. Fence fabric shall comply with the requirements of Standard Specifications for Highway Construction 628.2.6, in 3 foot tall rolls, with 4' tall 2" x 2" nominal cross section hardwood posts spaced a maximum of 10' o.c. Silt fence shall be Mirafi, Trevira, Amoco, CFM, or approved equal.

2.04 EROSION MAT

A. A straw/coconut fiber mat encased in a heavy weight UV stabilized top net and light weight photodegradable bottom net. Erosion mat shall comply with the requirements of Class I; Type A erosion mat as defined by Standard Specifications for Highway Construction and the PAL. Erosion mat shall be American Excelsior, SI Geosolutions, Erosion Control Systems, North American Green, or approved equal.

2.05 STAPLES

A. Use staples conforming to Standard Specifications for Highway Construction 628.2.3 to anchor erosion mat. Staples shall be U-shaped of No. 9 gauge or heavier steel wire, or other approved materials, with a width of one to two inches, and a length of not less than 6 inches for firm soils and not less than 12 inches for loose soils.

PART 3 - E X E C U T I O N

3.01 GENERAL

A. Install erosion control measures as required by the erosion control plan and contract documents. Provide additional erosion control measures as dictated by Contractor's means and methods, or by differing site conditions. Notify Construction Representative of additional erosion control features that are provided, but not shown on the plan.

B. Contractor shall provide all erosion control measures necessary to protect property and the environment. Include all erosion control measures as required by the most stringent of applicable

sections of The Best Management Practice Handbook or Standard Specifications for Highway Construction.

C. Perform all work in accordance with manufacturer's instruction where these specifications do not specify a higher requirement.

3.02 GRADING AND EARTHWORK

A. Install all temporary or permanent erosion control measures prior to any onsite grading or land disturbances.

B. Clear only those areas designated for the placement of improvements or earthwork before placement of the final cover. Perform stripping of vegetation, grading, excavation, or other land disturbing activities in a logical sequence and manner which will minimize erosion. If possible, schedule construction for times of the year when erosion hazards are minimal.

C. Do not clear the site of topsoil, trees, and other natural ground covers before the commencement of construction. Retain natural vegetation and protect until the final ground cover is placed.

D. Do not stockpile soil within 25 feet of any roadway, parking lot, paved area, or drainage structure or channel. Provide temporary stabilization and control measures (seeding, mulching, covering, erosion matting, barrier fencing, etc.) for the protection of disturbed areas and soil piles which will remain unworried for a period of more than 14 consecutive calendar days.

E. Remove surplus excavation materials from the site immediately after rough grading. The disposal site for the surplus excavation materials shall also be subject to these erosion control requirements.

3.03 DRAINAGE

A. Minimize water runoff and retain or detain on-site whenever possible so as to promote settling of solids and groundwater recharge.

B. Convey drainage to the nearest adequate public facility. Do not discharge water in a manner that will cause erosion or sedimentation of the site or receiving facility.

C. Protect storm sewer inlets and catch basins in accordance with the erosion control plan, if provided. If not specified, protect inlets with straw bale barriers, silt fencing, filter basket, gabion stone weepers, or other equivalent methods approved by the A/E which provide the necessary erosion protection.

D. Divert roof drainage and runoff from all areas upslope of the site around areas to be disturbed or channel them through the site in a manner that will not cause erosion.

E. Minimize the pumping of sediments when dewatering. Discharge to a sedimentation basin or sedimentation vessel to reduce the discharge of sediments. Do not discharge water in a manner that will cause erosion or sedimentation of the site or receiving facility.

3.04 TRACKING CONTROL

A. Provide each entrance to the site with a stone tracking pad.

B. If necessary, provide a crushed aggregate paved parking area.

C. If applicable, wash water shall be discharged to sedimentation basins, sedimentation vessels, or other such control areas.

3.05 MAINTENANCE

A. Inspect all erosion control measures within 24 hours of the end of each rainfall event that exceeds 0.50” or daily during period of prolonged rainfall, or weekly during periods without rainfall. Immediately repair and/or replace any and all damaged, failed, or inadequate erosion control measures.

B. Maintain records of all inspections and any remedial actions taken.

C. Maintain stockpile stabilization measures as necessary after rainfall events and heavy winds. Replace tarps, re-seed, and reapply mulch, tackifiers and stabilizers as necessary.

D. Remove sediment from stormwater and erosion control structures, basins and vessels as necessary.

E. Repair or replace damaged inlet protection.

F. Replace or supplement stone tracking pads with additional stone when they become ineffective.

G. Remove by any sediment reaching a public or private roadway, parking lot, sidewalk, or other paved. Do not remove tracked sediments by flushing. Completely remove any accumulations not requiring immediate attention at least once daily at the end of the workday.

H. Frequently dispose of all waste and unused construction materials in licensed solid waste or wastewater facilities. Do not bury, dump, or discharge, any garbage, debris, cleaning wastes, toxic materials, or hazardous materials on the site, on the land surface or in detention basins, or otherwise allow materials to be carried off the site by runoff onto adjacent lands or into receiving waters or storm sewer systems.

END OF SECTION

SECTION 315000

EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes temporary excavation support and protection systems.

1.02 PERFORMANCE REQUIREMENTS

A. Design, furnish, install, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting soil and hydrostatic pressure and superimposed and construction loads if required for project execution.
   1. Provide professional engineering services needed to assume engineering responsibility, including preparation of Shop Drawings and a comprehensive engineering analysis by a qualified professional engineer.

1.03 SUBMITTALS

A. Shop Drawings for Information: Prepared by or under the supervision of a qualified professional engineer for excavation support and protection systems.
   1. Include Shop Drawings signed and sealed by the qualified professional engineer responsible for their preparation.

1.04 PROJECT CONDITIONS

A. Survey adjacent structures and improvements, employing a qualified professional engineer or land surveyor; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.
   1. During installation of excavation support and protection systems, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Architect if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 - PRODUCTS

2.01 MATERIALS

A. General: Provide materials that are either new or in serviceable condition.

B. Structural Steel: ASTM A 36/A 36M, ASTM A 690/A 690M, or ASTM A 992/A 992M.

C. Steel Sheet Piling: ASTM A 328/A 328M, ASTM A 572/A 572M, or ASTM A 690/A 690M; with continuous interlocks.

D. Wood Lagging: Lumber, mixed hardwood, nominal rough thickness of 3 inches.

E. Cast-in-Place Concrete: ACI 301, of compressive strength required for application.

F. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

PART 3 - EXECUTION

3.01 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.

B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

C. Monitor excavation support and protection systems daily during excavation progress and for as long as excavation remains open. Promptly correct bulges, breakage, or other evidence of movement to ensure that excavation support and protection systems remain stable.

D. Promptly repair damages to adjacent facilities caused by installing excavation support and protection systems.

3.02 REMOVAL AND REPAIRS

A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and bear soil and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils or damaging structures, pavements, facilities, and utilities.
   1. Remove excavation support and protection systems to a minimum depth of 48 inches below overlying construction and abandon remainder.
   2. Repair or replace, as approved by Architect, adjacent work damaged or displaced by removing excavation support and protection systems.

END OF SECTION

SECTION 321216

ASPHALT PAVING

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes hot-mix asphalt paving.

B. Related Sections:
   1. Section 312000 – Earth Moving

1.02 REFERENCES

A. State of Wisconsin Standard Specifications for Highway and Structure Construction, Latest Edition (WisDOT Standard Specifications for Highway and Structure Construction).

1.03 SUBMITTALS

A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.

B. Job-Mix Designs: Certification that mix meets or exceeds WisDOT Standard Specifications for Highway and Structure Construction.

C. Material certificates certifying compliance with WisDOT Standard Specifications for Highway and Structure Construction.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer shall be registered with and approved by the DOT of the state in which Project is located.

B. Regulatory Requirements: Comply with WisDOT Standard Specifications for Highway and Structure Construction, Latest Edition for asphalt paving work.

1.05 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if base course is wet or excessively damp or if the following conditions are not met:
   1. Asphalt Lower Layer Course, Tack Coat, Asphalt Upper Layer Course: Minimum surface temperature of 36 deg F and rising at time of placement.

B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces. Do not apply below the minimum pavement temperature as recommended by the manufacturer.

PART 2 - PRODUCTS

2.01 AGGREGATES

A. In accordance with Section 460.2.2 of the WisDOT Standard Specifications for Highway and Structure Construction, Latest Edition.

2.02 ASPHALT MATERIALS

A. In accordance with Chapter 455 of the WisDOT Standard Specifications for Highway and Structure Construction, Latest Edition.

2.03 PAVEMENT MARKING PAINT

A. Provide paint from the Wisconsin Department of Transportation's approved products list.
   1. Color: As indicated on the plans.

2.04 MIXES

A. Hot-Mix Asphalt: Asphaltic binder course and surface course shall be mixture E-1 complying with the WisDOT Standard Specifications for Highway and Structure Construction, Latest Edition.

PART 3 - EXECUTION

3.01 GENERAL

A. Asphalt concrete paving equipment, weather limitations, job-mix formula, mixing, construction methods, compaction, finishing, tolerance and protection shall conform to the requirements of the appropriate sections of the WisDOT Standard Specifications for Highway and Structure Construction, Latest Edition.

3.02 SURFACE PREPARATION

A. Proof-roll base course using heavy, pneumatic-tired rollers to locate areas that are unstable or that require further compaction.

B. Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared base course is ready to receive paving.
   1. Sweep loose granular particles from surface of unbound-aggregate base course. Do not dislodge or disturb aggregate embedded in compacted surface of base course.

3.03 HOT-MIX ASPHALT PLACING

A. Spread and finish asphaltic mixture in accordance with Section 450.3.2.5 of the WisDOT Standard Specifications for Highway and Structure Construction, Latest Edition

B. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.04 COMPACTION

A. Compact asphaltic pavement in accordance with Section 450.3.2.6 of the WisDOT Standard Specifications for Highway and Structure Construction, Latest Edition.

B. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

C. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.05 INSTALLATION TOLERANCES

A. Thickness: Compact each course to produce the thickness indicated within the following tolerances:
   1. Base Course: Plus or minus 1/2 inch.
   2. Surface Course: Plus 1/4 inch, no minus.

B. Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:
   1. Lower Layer: 1/4 inch.
   2. Upper Layer: 1/8 inch.
   3. Remove and replace all humps or depressions exceeding the specified tolerances

3.06 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Engineer.

B. Apply markings to a dry surface free from frost. Remove dust, dirt, oil, grease, gravel, debris or other material that may prevent bonding to the pavement.

C. Pavement marking paint in the West Zoo Parking Lot shall be in accordance with Section 649 of the Standard Specifications for Highway and Structure Construction in Wisconsin except that reflectorized glass beads shall be omitted. Apply paint as the manufacturer specifies with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at a minimum rate of 13 gallons/mile for a continuous 4” line.

D. Pavement markings in Bluemound Road shall be in accordance with Sections 646 and 647 of the Standard Specifications for Highway and Structure Construction in Wisconsin.

3.07 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and to prepare test reports.

B. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of repairs.

END OF SECTION

SECTION 321313

CEMENT CONCRETE PAVEMENT

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes exterior cement concrete pavement for the following:
   1. Site curbs and gutters
   2. Site walkways
   3. Site vehicular concrete paving
   4. Bluemound Road concrete paving

B. Related Sections
   1. Section 31 20 00 Earth Moving

1.02 REFERENCES

A. Wisconsin Standard Specifications for Highway and Structure Construction, Latest Edition

1.03 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Design Mixtures: For each concrete pavement mixture.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products who complies with ASTM C 94/C 94M requirements for production facilities and equipment and approved by the Wisconsin Department of Transportation.

B. ACI Publications: Comply with ACI 301, "Specification for Structural Concrete," unless modified by requirements in the Contract Documents.

PART 2 - PRODUCTS

2.01 CONCRETE MATERIALS:

A. Concrete Grade: Grade A or Grade A-2 conforming to Section 501.3.1.3 of the WisDOT Standard Specifications for Highway and Structure Construction, Latest Edition

B. Aggregates: Conform to Section 501 of the WisDOT Standard Specifications. Provide aggregates from a single source.

C. Water: ASTM C 94/C 94M and Section 501 of the WisDOT Standard Specifications.

D. Air-Entraining Admixture: ASTM C 260 and Section 501 of the WisDOT Standard Specifications.

E. Chemical Admixtures: Per Section 501 of the WisDOT Standard Specifications.

F. CURING MATERIALS
   1. In accordance with Section 415.3.12 of the WisDOT Standard Specifications.

G. SURFACE COLORING MATERIALS
   1. Pigmented mineral dry-shake hardener: Factory-packaged, dry combination of Portland cement, graded quartz aggregate, color pigments, and plasticizing admixture. Use color pigments that are finely ground, nonfading mineral oxides interground with cement. Color to be selected by Owner/Architect.
   2. Pigmented powder release agent: Factory-packaged, dry combination of surface-conditioning and dispersing agents interground with color pigments that facilitates release of stamp mats.

Use color pigments that are finely ground, nonfading mineral-oxides interground with cement. Color to be selected by Owner/Architect.

3. Liquid release agent: Manufacturer's standard, clear, evaporating formulation that facilitates release of stamp mats and texture rollers.

H. COLOR PIGMENT: ASTM C979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, nonfading, and resistant to lime and other alkalis; color to be selected by Owner/Architect.

I. STAMPING DEVICES
   1. Stamp Mats: Semirigid polyurethane mats with projecting textured and ridged underside capable of imprinting texture and joint patterns on plastic concrete; pattern to be selected by Owner/Architect.
   2. Stamp Tools: Open-grid, aluminum or rigid-plastic stamp tool capable of imprinting joint patterns on plastic concrete; pattern to be selected by Owner/Architect.
   3. Rollers: Manually controlled, water-filled aluminum rollers with projecting ridges on drum capable of imprinting texture and joint patterns on plastic concrete; pattern to be selected by Owner/Architect.
   4. Texture Rollers: Manually controlled, abrasion-resistant polyurethane rollers capable of imprinting texture on plastic concrete; texture to be selected by Owner/Architect.

J. RELATED MATERIALS
   1. Expansion Joint Material: Conform to Section 415.2.2 of the WisDOT Standard Specifications.

K. CONCRETE MIXTURES
   1. Grade A or Grade A2 conforming to Section 501.3.1 of the WisDOT Standard Specifications.

L. CONCRETE MIXING
   1. Measure, batch, and mix concrete materials and concrete in accordance with Section 501 of the WisDOT Standard Specifications.
   2. Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color.

PART 3 - EXECUTION

3.01 GENERAL

A. Conform to Section 415 of the WisDOT Standard Specifications for concrete pavements for on-site work

3.02 EXAMINATION AND PREPARATION

A. Proof-roll prepared subbase or base surface below concrete paving to identify soft pockets and areas of excess yielding.

B. Remove loose material from compacted subbase or base surface immediately before placing concrete.

3.03 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement 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 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edgings true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to cen-

terline, unless otherwise indicated. Conform to Section 415 of the WisDOT Standard Specifications for on-site work. Conform to City of Milwaukee Street Construction Specifications for work in the public right-of-way.

B. Construction Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than one-half hour unless pavement terminates at isolation joints.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.

D. 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 to match jointing of existing adjacent concrete pavement.

E. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.

3.05 CURBING

A. Comply with Section 601 of the WisDOT Standard Specifications.

3.06 SIDEWALKS

A. Comply with Section 602 of the WisDOT Standard Specifications.

3.07 CONCRETE PLACEMENT

A. Moisten subbase to provide a uniform dampened condition at time concrete is placed.

B. Comply with ACI 301 requirements and WisDOT Standard Specifications Section 501 requirements for measuring, mixing, transporting, and placing concrete.

3.08 FINISHING

A. On-site Work/Work in Bluemound Road
   1. Finish curbing in accordance with Section 601.3.5 of the WisDOT Standard Specifications.
   2. Finish sidewalk and plaza in accordance with Section 602.3.2.3 of the WisDOT Standard Specifications (light broom finish).
   3. Finish concrete vehicular pavements in accordance with Section 415.3.8 of the WisDOT Standard Specifications (artificial turf drag finish).

3.09 STAMPING

A. Mat stamping: After floating and while concrete is plastic, apply mat-stamped finish.
   1. Pigmented powder release agent: uniformly distribute onto concrete at a rate of 3-4 lbs. per 100 square feet.
   2. Liquid release agent: Apply liquid release agent to the concrete surface and the stamp mat. Uniformly mist surface of concrete at a rate of 5 gallons per 1,000 square feet.
   3. After application of release agent, accurately align and place stamp mats in sequence.
   4. Uniformly load mats and press into concrete to produce required imprint pattern and depth of imprint of concrete surface. Gently remove stamp mats. Hand stamp edges and surfaces unable to be imprinted by stamp mats.
   5. Remove residual release agent according to manufacturer's written instructions, but no fewer than 3 days after stamping concrete.

B. Tool stamping: After floating and while concrete is plastic, apply tool-stamped finish.
   1. Cover surface with polyethylene film, stretch taut to remove wrinkles, lap sides and ends 3 inches, and secure to edge forms. Lightly broom surface to remove air bubbles.

2. Accurately align and place stamp tools in sequence and tamp into concrete to produce required imprint pattern and depth of imprint on concrete surface. Gently remove stamp tools. Hand stamp edges and surfaces unable to be imprinted by stamp tools.
3. Carefully remove polyethylene film immediately after tool stamping.

C. Roller stamping: After floating and while concrete is plastic, apply roller-stamped finish.
1. Cover surface with polyethylene film, stretch taut to remove wrinkles, lap sides and ends 3 inches, and secure to edge forms. Lightly broom surface to remove air bubbles.
2. Accurately align roller and perform rolling operation to produce required imprint pattern and depth of imprint on concrete surface. Hand stamp surfaces inaccessible to roller.
3. Carefully remove polyethylene film immediately after tool stamping.

3.10 CONCRETE PROTECTION AND CURING

A. On-site Work/Work in Bluemound Road
1. Protect and cure sidewalk in accordance with Section 602.3.2.6 of the WisDOT Standard Specifications.
2. Protect and cure curbing in accordance with Section 601.3.7 of the WisDOT Standard Specifications.
3. Protect and cure vehicular concrete paving in accordance with Section 415.3.12 of the WisDOT Standard Specifications.

3.11 REPAIRS AND PROTECTION

A. Remove and replace concrete pavement that is broken, damaged, or defective or that does not comply with requirements in this Section.

B. Protect concrete from damage. Exclude traffic from pavement for at least 7 days after placement.

C. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION

SECTION 323113

CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Chain link fencing and accessories.

B. Fence framework, fabric, and accessories.

C. Excavation and foundation for post bases.

D. Chain link fence gates and related hardware.

1.02 DEFINITIONS

A. Corner Posts: Posts located at a change in horizontal alignment.

B. End Posts: Posts located at the beginning or end of a length of fence.

C. Gateposts: Posts supporting the weight of a gate: Gateposts may function also as terminal posts but generally are sized differently.

D. Line Posts: Posts between terminal posts.

E. Pull Posts: Posts located within a length of fence at certain distances, and at changes in vertical alignment, to facilitate stretching of fabric.

F. Terminal Posts: Posts set where fence fabric terminates, and between which the fabric is stretched; a term, which includes end, corner, and pull posts.

1.03 REFERENCE STANDARDS

A. ASTM A 90/A90M-01 - Standard Test Method for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.

B. ASTM A 121 - Standard Specification for Metallic-Coated Carbon Steel Barbed Wire; 2007.

C. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2002.

D. ASTM A 392 - Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric; 2007.

E. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2007.

F. ASTM C 94/C 94M - Standard Specification for Ready-Mixed Concrete; 2007.

G. ASTM F 567 - Standard Practice for Installation of Chain-Link Fence; 2007.

H. ASTM F 1083 - Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures; 2008.

I. CLFMI CLF 2445 - Product Manual; Chain Link Fence Manufacturers Institute; 1997.

1.04 SUBMITTALS

A. Product Data:
   1. Manufacturer's catalog cuts. Indicate post sizes and thicknesses, protective coatings, fabric characteristics, and accessories.

B. Shop Drawings:

1. Layout of fences and gates with dimensions, details, and finishes of components, accessories, and post foundations.
2. Show location and spacing of posts, fittings, and accessories.
3. Show anchorage details.
4. Provide details of gates.

1.05 CONTRACT CLOSEOUT SUBMITTALS

A. Gates:
   1. Complete and detailed operations and maintenance data for each component, including diagrams and part numbers for ordering spare or repair parts.

B. Project Record Documents: Accurately record actual locations of property perimeter posts relative to property lines and easements.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products described in this section, with not less than three years of documented experience.

PART 2 - PRODUCTS

2.01 CHAIN LINK FENCE

A. Fence Configuration:
   1. Height of fences shall be eight feet and constructed with:
      a. Top rails.
      b. Brace rails at each terminal post.
      c. Bottom tension wire.

B. Fence Fabric:
   1. Mesh and wire size: 2-inch mesh, 0.148 inch (9 gage).
   2. Galvanized steel finish: ASTM A 392, Class 2, with not less than 2.0 oz. zinc per sq. ft. of uncoated wire surface on wire coated before weaving or not less than 2.0 oz. per sq. ft. of uncoated wire surface on wire of fabric coated after weaving as determined from the average of two or more samples and not less than l.8 oz. zinc per sq. ft. of uncoated wire surface for any individual sample. Galvanize coating shall not be included in calculating required core wire diameter.

C. Fence Framework:
   1. Steel Pipe: Type 1, ASTM F 1083, standard weight, Schedule 40, minimum yield strength of 25,000 psi.
      a. Rail size: 1.660 inches outside diameter, 2.27 lb./ft.
      b. Corner, terminal and line post: 4 inches outside diameter at 9.10 lb./ft.
      c. Line Post: 1.9 inch diameter or as required for fence height.
      d. Gate Post: 3.5 inch diameter or as required for fence height.
      e. Gate Frame: 1.66 inch diameter for welded fabrication or as required for fence height.
   2. Zinc coating of steel pipe and steel shapes (ASTM A 90): Interior and exterior coating, l.8 oz. per sq. ft. of coated area.

2.02 CHAIN LINK FENCE FENCING AND ACCESSORIES

A. Caps:
   1. Formed steel, malleable or cast iron with ring to receive top rail.
   2. Snug-fitting, weathertight closure of posts.

B. Rail Ends: Formed steel, malleable or cast iron.

C. Wire Ties and Clips:
   1. Size: Not less than fabric wire gage.

2. Minimum zinc coating weight: 0.8 ounce per sq. ft.

D. Brace Bands and Tension Bands:
   1. 3/4-inch by 1/10-inch thick (nominal).

E. Tension Bars:
   1. Continuous length to match fabric width.
   2. Not required for roll-formed posts with integral fabric weaving loops.

F. Tension Wire: 7 gage, coil spring wire.

G. Truss Rods: 5/16-inch minimum diameter rod.

H. Hardware and lock for Double Swinging Gates: 180 degree hinges, 2 for gates up to 60 inches high, 3 for taller gates; drop bolt on inactive leaf engaging socket stop set in concrete, active leaf latched to inactive leaf preventing raising of drop bolt, padlock hasp; keepers to hold gate in fully open position.

I. Finish: To match fence framework.

2.03 CONCRETE

A. Grade A concrete in conformance with Section 501 of the Standard Specifications for Highway and Structure Construction in Wisconsin.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that line of fence has been properly identified.

B. Verify that proper grade has been established.

C. Verify location of underground utilities and structures.

D. Begin fence construction only after adequate clearance on both sides of fence is available.

3.02 INSTALLATION - POST

A. Layout:
   1. Space line posts at equal distance intervals not exceeding 10 feet on center measured parallel to grade.
   2. Locate terminal posts at the beginning and end of each continuous length of fence, at abrupt changes in line or grade, additionally at intervals not to exceed 500 feet, and as otherwise shown on the drawings.
   3. Install posts plumb and in proper alignment.

B. Anchorage of Posts in Soil:
   1. Set posts in concrete-filled holes, securely braced in proper position until concrete has cured at least 3 days above 60 degrees F.
   2. Hole shall be free of loose materials when placing concrete.
   3. Hole diameter shall be as recommended by fence manufacturer, but not less than 4 times largest cross section of post.
   4. Minimum hole depth for line and terminal posts:
      a. 36 inches for fence up to 8 feet high.
   5. Increase hole depth as necessary to provide at least 2 inches of cover under bottom of post. Do not allow post to contact soil.
   6. Remove and dispose of waste excavation material off site or spread in approved locations, as directed.
   7. Thoroughly consolidate concrete.
   8. Extend concrete 2 inches above grade, forming a crown to shed water.

3.03 INSTALLATION - CHAIN LINK FENCE

A. Install posts, braces, fabric, and other components in accordance with manufacturer's recommendations and approved shop drawings and to meet or exceed requirements of ASTM F 567.

B. Pull fabric taut and secure to tension wires at 1 foot on both sides of each post and at intervals of 24 inches, maximum, on center.

C. Secure fabric to line posts with tie wires or clips at intervals of 15 inches, maximum, on center.

D. Secure fabric to terminal posts for the full width of fabric by using stretcher bars and bands or by integrally weaving fabric to fastening loops on posts.

3.04 INSTALLATION - CHAIN LINK FENCE GATE

A. Install gates in accordance with manufacturer's instructions, plumb, level, and secure.

B. Gates shall operate freely without binding or dragging and shall be easily operable by hand.

3.05 CLEANING

A. Clean up debris and unused material, and remove from the site.

3.06 TOLERANCES

A. Maximum Variation From Plumb: 1/4 inch (6 mm).

B. Maximum Offset From True Position: 1 inch (25 mm).

C. Components shall not infringe adjacent property lines.

END OF SECTION

SECTION 323119

DECORATIVE METAL FENCES AND GATES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Industrial Aluminum Ornamental Picket Fencing, Gates, and Accessories.

1.02 SUBMITTALS:

A. Product Data: Manufacturer's data sheet for each product, including:
   1. Compliance with requirements.
   2. Preparation instructions and recommendations.
   3. Installation methods.

B. Shop Drawings:
   1. Show overall fence layout.
   2. Show location, height, and spacing of posts, fittings, and accessories.
   3. Show depth of posts and concrete for each type of post.
   4. Show anchorage details.
   5. Provide details of gates.

C. Samples: Submit two samples of manufacturer's full range of colors for finish.

1.03 SPECIAL WARRANTY

A. Provide manufacturer's standard limited lifetime warranty that its ornamental fence system is free from defects in material and workmanship including cracking, peeling, blistering and corroding for as long as the original purchaser owns the fence.

PART 2 - PRODUCTS

2.01 MANUFACTURER

A. Fence and pedestrian gate design based on Ameristar Echelon Plus. Vehicular gate design based on Ameristar Echelon II. Aluminum fencing is produced by Ameristar Fence Products, Inc., Tulsa, OK.

B. Products from other qualified manufacturers having a minimum of 5 years of experience manufacturing aluminum ornamental picket fencing may be considered acceptable by the Owner as equal if submitted for substitution in accordance with Section 016000 and they meet the design and quality established by the contract documents.

2.02 ORNAMENTAL PICKET FENCE TYPES

A. Fence Type: Ameristar Echelon Plus Classic, Height - 42”, 3-Rail.

B. Pedestrian Gate: Ameristar Echelon Plus Classic, 10’ double swing gate, to match fence.

C. Vehicular Gate: Ameristar Echelon II Classic, 40’ double swing gate, to match fence.

D. Verify extent of fence types and heights on Drawings.

2.03 MATERIAL

A. Aluminum material for fence framework shall conform to the requirements of ASTM B221. The aluminum extrusions for post and rails shall be Alloy and Temper Designation 6005-T5. The aluminum extrusions for pickets and rail inner slide channels shall be Alloy and Temper Designation 6063-T5.

B. The manufactured framework shall be finished with a thermal stratification coating process with an electrostatic spray application of a polyester finish. The topcoat shall be a “no-mar” TGIC polyester powder coat finish with a minimum thickness of 2 mils (0.0508mm).
   1. The color shall be: Black

C. Fence pickets shall be 3/4" square x .045" thick. Horizontal rails shall be 1-1/4" x 1-7/16" channel with .060" thick top & internal web wall, and .090" thick side walls and shall be punched to allow picket to pass through the top of the rail.

D. Material for the vehicular gate pickets shall be 1” square x 0.065” thick extruded tubing. The top wall of the outer channel of the rail shall be 0.100” thick. The inner slide channel of the rail shall be 0.080” thick. Pickets shall be spaced at 4.98”o.c. Post shall be a minimum of 2-1/2” square with a perimeter wall thickness of 0.800” and an interior reinforcing web thickness of 0.080”.

2.04 ACCESSORIES

A. All fasteners to be stainless steel. Bracket to rail attachments to be one-way tamperproof security bolts. Bracket to post connections to be self-drilling hex-head screws.

B. Rings, Finials and Post Caps: Aluminum casting. Provide weather-tight post cap for each post. Flat top cap either 2/12” or 4”.

2.05 SETTING MATERIAL

A. Grade A concrete in conformance with Section 501 of the Standard Specifications for Highway and Structure Construction in Wisconsin.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Field verify areas to receive fencing are completed to final grades and elevations.

B. Ensure property lines and legal boundaries of work are clearly established.

3.02 INSTALLATION

A. Install fence and gates in accordance with manufacturer's instructions.

B. Space fence posts uniformly at 8'-0” o.c. maximum face to face unless otherwise indicated.

C. Concrete Set Posts: Drill hole in firm, undisturbed or compacted soil. Holes shall have a minimum diameter of 4 times greater than nominal outside dimension of post, and depths approximately 6” deeper than post bottom. Excavate deeper as required for adequate support in soft and loose soils, and for posts with heavy lateral loads. Set post bottom 18” below surface when in firm, undisturbed soil. Place concrete around post in a continuous pour. Trowel finish around posts and slope to direct water away from posts.
   1. Gate Posts and Hardware: Set keepers, stops, sleeves and other accessories into concrete.

D. Check each post for vertical and top alignment, and maintain in position during placement and finishing operation.

E. Align fence panels between posts. Firmly attach rail brackets to posts with 1/4” (6 mm) bolt and lock nut, ensuring panels and posts remain plumb.

3.03 ACCESSORIES

A. Install post caps and other accessories to complete fence and gates.

3.04 CLEANING

A. Clean up debris and unused material, and remove from site.

B. Leave fence and gates in clean condition.

END OF SECTION

SECTION 323223

CONCRETE SEGMENTAL RETAINING WALL SYSTEM

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Concrete segmental retaining wall units

B. Geosynthetic reinforcement

C. Leveling pad base

D. Drainage aggregate

E. Reinforced Backfill

F. Drainage pipe

G. Pre-fabricated Drainage Composite

H. Geotextile Filter

I. Impervious Materials

J. Construction Adhesive

1.02 RELATED SECTIONS

A. Section 312000 – Earth Moving: For finish grading.

1.03 REFERENCES

A. American Association of State Highway Transportation Officials (AASHTO)
   1. AASHTO M288 Geotextile Specification for Highway Applications
   2. AASHTO Standard Specifications for Highway Bridges

B. American Society for Testing and Materials (ASTM)
   1. ASTM C140 Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units
   2. ASTM C1262 Standard Test Method for Evaluating the Freeze-Thaw Durability of Manufactured Concrete Masonry Units and Related Concrete Units
   3. ASTM C1372 Standard Specification for Segmental Retaining Wall Units
   4. ASTM D448 Standard Classification for Sizes of Aggregate for Road and Bridge Construction
   5. ASTM D698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/f^3)(600 kN-m/m^3)
   6. ASTM D1556 Standard Test Method for Density and Unit Weight of Soil In Place by the Sand Cone Method
   7. ASTM D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/f^3)(2700 kN-m/m^3)
   8. ASTM D2487 Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)
   9. ASTM D2922 Standard Test Methods for Density of Soil and Soil-Aggregate In Place by Nuclear Methods (Shallow Depth)
   10. ASTM D3034 Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer pipe and Fittings
   11. ASTM D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
   12. ASTM D4491 Standard Test Method for Water Permeability of Geotextiles by the Permittivity Method

13. ASTM D4595 Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method
14. ASTM D4873 Standard Guide for Identification, Storage and Handling of Geosynthetics
15. ASTM D5084 Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.
16. ASTM D5262 Standard Test Method for Evaluating the Unconfined Tension Creep Behavior of Geosynthetics
17. ASTM D5321 Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method
18. ASTM D5818 Standard Practice for Obtaining Samples of Geosynthetics from a Test Section for Assessment of Installation Damage
19. ASTM D6637 Standard Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-Rib Tensile Method
20. ASTM D6638 Standard Test Method for Determining Connection Strength Between Geosynthetic Reinforcement and Segmental Concrete Units
21. ASTM D6706 Standard Test Method for Measuring Geosynthetic Pullout Resistance in Soil
22. ASTM F405 Standard Specification for Corrugated Polyethylene (PE) Tubings and Fittings
23. ASTM G51 Standard Test Method for Measuring pH of Soil for Use in Corrosion Testing

C. Federal Highway Administration
   1. Elias, V., Christopher, B., and Berg, R., “Mechanically Stabilized Earth Walls and Reinforced Soil Slopes Design and Construction Guidelines”, Federal Highway Administration Report No. FHWA-NHI-00-043, March 2001.
   2. Elias, V., Christopher, B., and Berg, R., “Corrosion/Degradation of Soil Reinforcements for Mechanically Stabilized Earth Walls and Reinforced Soil Slopes”, Federal Highway Administration Report No. FHWA-NHI-00-044, March 2001.

D. National Concrete Masonry Association (NCMA)
   1. NCMA Design Manual For Segmental Retaining Walls, Second Edition, Second Printing (1997)

1.04 DEFINITIONS

A. Concrete Segmental Retaining Wall (SRW) Units: Dry-stacked masonry units used as the retaining wall fascia.

B. Reinforced Backfill: Soil which is used as fill behind the SRW unit, and within the reinforced soil mass (if applicable).

C. Drainage Aggregate: Material used (if applicable) within, between, and directly behind the concrete retaining wall units.

D. Geotextile Filter: Material used for separation and filtration of dissimilar soil types.

E. Foundation Soil: Soil mass supporting the leveling pad and reinforced soil zone of the retaining wall system.

F. Geosynthetic Reinforcement: Polymeric material designed specifically to reinforce the soil mass.

G. Pre-fabricated Drainage Composite: three-dimensional geosynthetic drainage medium encapsulated in a geotextile filter, used to transport water.

H. Impervious Materials: Clay soil or low permeability geosynthetic used to prevent water percolation into the drainage zone and reinforced backfill behind the wall.

I. Global Stability: The general mass movement of a soil reinforced segmental retaining wall structure and adjacent soil mass.

J. Project Geotechnical Engineer: A registered engineer who provides site observations, recommendations for foundation support, and verifies soil shear strength parameters.

1.05 SUBMITTALS

A. Submit the following at least thirty (30) days prior to construction for approval

1. Product Data
    a. Material description and installation instructions for each manufactured product specified including Segmental Retaining Wall Units (SRW) and Geosynthetic Reinforcement.
    b. Name and address of the production facility where the proposed SRW units will be manufactured. All units to be manufactured at the same facility.
    c. Notarized letter from the SRW manufacturer stating that the units supplied for this project are manufactured in complete compliance with Section 2.01 of this specification. The letter shall state that the SRW units shown in the attached test reports are representative samples of the plants normal mix design and regular production runs.
2. Samples:
    a. Furnish one unit demonstrating the color, face pattern, and texture of the SRW unit if specified by the project Architect or Owner.
    b. Furnish 12-inch square or larger piece of the geosynthetic reinforcement specified.
3. Test Reports:
    a. Independent laboratory reports indicating compressive strength, moisture absorption and freeze-thaw durability of the concrete retaining wall units from the proposed production facility. Only test performed within the past 12 months will be considered current and valid.
    b. Independent test reports verifying the long-term design strength properties (creep, installation damage, and durability) and soil interaction properties of the geosynthetic reinforcement.
    c. Independent test reports verifying the connection capacity between the geosynthetic reinforcement and the concrete retaining wall units.
4. Wall Design Engineer Qualifications:
    a. Current insurance policy verifying professional liability and errors and omissions insurance coverage for an aggregate and per claim limit of at least two million dollars ($2,000,000).
    b. Notarized letter certifying the proposed SRW Design Engineer is a licensed professional engineer in the state of wall installation and has a minimum of 4 years and 500,000 square feet of SRW system design experience.
5. Retaining Wall Installer Qualifications:
    a. Notarized statement showing that the retaining wall installer has installed a minimum of 100,000 square feet of segmental retaining walls.
    b. The Retaining Wall Installer shall furnish five (5) project references of similar size and scope to this project including the wall(s) height and square footage. References shall include the contact information of Owner or General Contractor.

B. Submit the following at least thirty (30) days prior to start of construction for approval

1. Retaining Wall Final Design Submittals
    a. Shop Drawings: Four (4) sets of the retaining wall system design, including wall elevation views, geosynthetic reinforcement layout, pertinent details, and drainage provisions. A registered professional engineer licensed in the state of wall installation shall sign and certify that the shop drawings are designed in accordance with the project civil plans and specifications.
    b. Design Calculations: Four (4) sets of engineering design calculations prepared in accordance with the NCMA Design Manual For Segmental Retaining Walls, Second Edition, Second Printing, 1997. Analysis shall include Internal, External, Global Stability, and Bearing Capacity Calculations.

1.06 DESIGN REQUIREMENTS

A. Designs for SRW's using extensible (geosynthetic) reinforcement shall be prepared according to design methodology presented in the NCMA "Design Manual for Segmental Retaining Walls, 1997, second edition, second printing" and conform to the minimum safety factors as specified in this specification section. Design submittals not meeting this design criteria or technical/ administrative criteria as specified will be rejected in their entirety until complete compliance is achieved. Owner reserves all rights in determining compliance for plan approval and may reject any submittals.

B. Design of the SRW shall be based on the following soil parameters as determined during the geotechnical investigation.

C. The Design Engineer of Record shall be responsible for selecting and specifying reinforced fill material. The General Contractor is responsible for ensuring and documenting the reinforced fill meets the specified parameters for both strength and compaction. Compacted retained soil shall meet the minimum requirements specified.

D. Design Criteria for Retaining Wall Systems: Unless otherwise indicated below, SRW design shall be in strict accordance with the procedures presented in the NCMA Design Manual for Segmental Retaining Walls.

1. Internal Stability
    a. Min. Factor of Safety on Tensile Overstress: 1.0
    b. Min. Factor of Safety on Geogrid Pullout (peak load criterion): 1.5
    c. Min. Factor of Safety on Facing Shear (peak load criterion): 1.5
    d. Min. Factor of Safety on Facing Shear (serviceability criterion) 2% of height of SRW units: 1.0
    e. Min. Factor of Safety Connections (peak load criterion): 1.5
    f. Minimum Factor of Safety for Uncertainties: 1.5
2. External Stability
    a. Min. Factor of Safety Against Base Sliding (static conditions): 1.5
    b. Min. Factor of Safety Against Overturning: 2.0
    c. Min. Factor of Safety for Global Stability: 1.3
    d. Min. Factor of Safety for Bearing Capacity: 2.0
3. Seismic factors of safety shall be 75% of static values

E. Design shall address hydrostatic loading, seismic loading, rapid drawdown, surcharge, and backslopes where appropriate. Minimum Design Live Load of 150 psf shall be used for all walls supporting parking areas. Minimum Design Live Load of 250 psf shall be used for walls supporting entrance drives, service drives and other areas subject to traffic.

F. Minimum reinforcement length shall be 60 percent of the wall height. Reinforcement coverage at each layer shall be 100 percent (no gaps).

G. The maximum vertical distance between layers of soil reinforcement shall be limited to a maximum of 25" (inches) for systems that derive their connection capacity from friction and 31" (inches) for systems using a mechanical connection to derive their connection capacity (per NHI 043 and AASHTO).

H. Drainage Aggregate shall be placed within, between, and a minimum of 12" (inches) behind the segmental concrete facing units.

1.07 DELIVERY, STORAGE AND HANDLING

A. Concrete Retaining Wall Units and Accessories: Deliver, store, and handle materials in accordance with manufacturer's recommendations, in such a manner as to prevent damage. Check the materials upon delivery to assure that proper material has been received. Store above ground on wood pallets or blocking. Remove damaged or otherwise unsuitable material, when so determined, from the site.

B. Exposed faces of concrete wall units shall be free of chips, cracks, stains, and other imperfections detracting from their appearance, when viewed from a distance of 10 feet.

C. Prevent mud, wet cement, adhesives and similar materials that may harm appearance of units, from coming in contact with system components.

D. Geosynthetics (including geosynthetic reinforcement, geotextile filter, pre-fabricated drainage composite) shall be delivered, stored, and handled in accordance with ASTM D4873.

1.08 EXTRA MATERIALS

A. Furnish Owner with 3 replacement units identical to those installed on the Project.

PART 2 PRODUCTS

2.01 MATERIALS

A. Segmental Retaining Wall units shall meet the following requirements:
   1. Physical Requirements:
      a. Compression and Absorption: Concrete retaining wall units shall be tested in accordance with ASTM C140, Sections 6, 8 and 9. Concrete retaining wall units shall meet requirements of ASTM C1372, except the compressive strength requirements will be increased to a minimum of 3,500 psi and the maximum water absorption shall be limited to 7 percent, and unit height dimensions shall not vary more than plus or minus 1/16 inch from that specified in the ASTM reference, not including textured face. Test shall be performed within the past 6 months to be considered current and valid.
      b. Freeze-Thaw Durability: Shall be tested in accordance with ASTM C1262 when required. Test shall be performed within the past 12 months to be considered current and valid.
   2. Per the Owner
      c. Color: Natural Grey
      d. Face Pattern Geometry: Straight
      e. Texture: Split Rock Face that exposes the natural aggregates.
      f. Batter: Include an integral batter control shear connector to provide a consistent setback for each wall course. Initial wall batter shall not exceed 7 degrees.

B. Approved Systems
   1. Anchor Wall Systems Diamond Pro – Contact: Nate Gish: 262-707-3974
   2. Versa-Lok
   3. Keystone

C. Geosynthetic Reinforcement shall be manufactured with high-tenacity polyester or HDPE in a grid or textile structure. The geosynthetic reinforcement must meet the long-term design strength, soil interaction, and connection capacity requirements as required by the design of the retaining wall.
   1. Long-term Design Strength: As determined in accordance with Method A of the NCMA Design Manual for Segmental Retaining Walls, Second Edition, Second Printing, 1997.
      a. Ultimate Tensile Strength: The ultimate tensile strength of the geosynthetic reinforcement shall be determined in accordance with ASTM D4595 or ASTM D6637.
      b. Creep: Creep testing of the geosynthetic shall be performed in accordance with ASTM D5262. The creep reduction factor shall be determined in accordance with FHWA-NHI-00-043.
      c. Installation Damage: The installation damage reduction factor shall be determined in accordance with ASTM D5818 and FHWA-NHI-00-043.
      d. Durability: The durability reduction factor shall be determined in accordance with FHWA-NHI-00-044.

2. Soil Interaction: The soil interaction properties include the coefficient of direct sliding and coefficient of interaction as determined through direct shear and pullout testing, respectively.
    a. Pullout: Shall be determined in accordance with ASTM D6706.
    b. Direct Sliding: Shall be tested in accordance with ASTM D5321.
3. Connection Capacity: As determined in accordance with ASTM D6638.

D. Leveling Pad Base

1. Aggregate Base: Crushed stone or granular fill meeting the following gradation as determined in accordance with ASTM D448:

Sieve Size	Percent Passing
1 inch	100
No. 4	35 to 70
No. 40	10 to 35
No. 200	3 to 10

2. Base Thickness: 6 inches (minimum compacted thickness).

E. Concrete Base: Nonreinforced lean concrete base.

1. Base Thickness: At least 2 inches

2. Minimum Compressive strength of 1,500 psi

F. Drainage Aggregate: Clean crushed stone or granular fill meeting the following gradation as determined in accordance with ASTM D448:

Sieve Size	Percent Passing
1 inch	100
3/4 inch	75 to 100
No. 4	0 to 60
No. 40	0 to 50
No. 200	0 to 5

G. Reinforced Backfill: Suitable reinforced backfill soils shall be free of organics and debris and consisting of GP, GW, SP, SW, or SM type, classified in accordance with ASTM D2487 and the USCS classification system. Soils classified as SC, ML and CL are considered suitable soils for segmental retaining walls with a total height of less than 10 feet.

1. The Plasticity Index (PI) of the reinforced backfill soils shall not be greater than 20 as measured in accordance with ASTM D4318.

2. Unsuitable soils are organic soils and those soils classified as CH, OH, MH, OL, or PT.

3. The pH of the reinforced backfill shall be between 3 and 10 and be tested in accordance with ASTM G51.

4. Maximum particle size less than or equal to 4 inches.

H. Drainage Pipe: Perforated or slotted PVC or corrugated HDPE pipe manufactured in accordance with D3034 and/or ASTM F405. The pipe may be covered with a geotextile filter to prevent fines migration into the pipe.

I. Pre-fabricated Drainage Composite: The pre-fabricated drainage composite shall be Miradrain 5000, manufactured by Mirafi, or equal.

J. Geotextile Filter: The geotextile filter shall be in accordance with AASHTO M288 guidelines.

K. Impervious Material: Clay soil and/or low permeability geosynthetic shall have a coefficient of permeability of less than 10^{-6} cm/s as tested in accordance with ASTM D5084 or ASTM D4491, as applicable.

L. Construction Adhesive: Exterior grade adhesive as recommended by the retaining wall unit manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION

A. The Project Geotechnical Engineer shall examine the areas and conditions under which the retaining wall system is to be erected, and notify the Owner and Contractor in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

B. Promptly notify the wall design engineer of site conditions that may affect wall performance, soil conditions observed other than those assumed, or other conditions that may require a reevaluation of the wall design.

C. Verify the location of existing structures and utilities prior to excavation.

3.02 PREPARATION

A. Ensure surrounding structures are protected from the effects of wall excavation.

B. Excavation support, if required, is the responsibility of the Contractor, including the stability of the excavation and it's influence on adjacent properties and structures.

3.03 EXCAVATION

A. Excavate to the lines and grades shown on the Drawings. The General Contactor shall replace any unsuitable soils discovered during excavation. Use care in excavating to prevent disturbance of the base beyond the lines shown.

3.04 FOUNDATION PREPARATION

A. Excavate foundation soil as required for footing or base dimension shown on the Drawings, or as directed by the Project geotechnical engineer.

B. The Project geotechnical engineer will examine foundation soil to ensure that the actual foundation soil strength meets or exceeds that indicated on the Drawings. Remove soil not meeting the required strength. Oversize resulting space sufficiently from the front of the block to the back of the reinforcement, and backfill with suitable compacted backfill soils.

C. The Project geotechnical engineer will determine if the foundation soils will require special treatment or correction to control total and differential settlement.

D. Fill over-excavated areas with suitable compacted backfill, as recommended by the Project geotechnical engineer.

3.05 BASE COURSE PREPARATION

A. Place base materials to the depths and widths shown on the Drawings, upon undisturbed soils, or foundation soils prepared in accordance with Article 3.04.

   1. Extend the leveling pad laterally at least 6 inches in front and behind the lowermost concrete retaining wall unit.

   2. Provide aggregate base compacted to 6 inches thick (minimum).

   3. The Contractor may at their option, provide a concrete leveling pad as specified in Subparagraph 2.01.C.2, in lieu of the aggregate base.

   4. Where a reinforced footing is required by local code official, place footing below frost depth.

B. Compact aggregate base material to provide a level, hard surface on which to place the first course of units. A thin, less than 1 inch, can be used to assist in leveling the base units

C. Prepare base materials to ensure complete contact with retaining wall units.

3.06 ERECTION

A. General: Erect units in accordance with manufacturer's instructions and recommendations, and as specified herein.

B. Place first course of concrete wall units on the prepared base material. Check units for level and alignment. Maintain the same elevation at the top of each unit within each section of the base course.

C. Ensure that foundation units are in full contact with natural or compacted soil base or lean concrete leveling pad.

D. Place concrete wall units side-by-side for full length of wall alignment. Alignment may be accomplished by using a string line measuring from the back of the block.

E. Place 12 inches (minimum) of drainage aggregate directly behind the concrete wall units. Fill voids in and between retaining wall units with drainage aggregate. Provide a drainage zone behind the wall units to within 12 inches of the final grade. Cap the backfill and drainage aggregate zone with 12 inches of impervious material.

F. Install drainage pipe at the lowest elevation possible, to maintain gravity flow of water to outside of the reinforced zone. Slope the main collection drainage pipe, located just behind the concrete retaining wall units, 2 percent (minimum) to provide gravity flow to the daylighted areas. Daylight the main collection drainage pipe to an appropriate location away from the wall system at each low point and at 50-foot (maximum) intervals along the wall.

G. Remove excess fill from top of units and install next course. Ensure drainage aggregate and backfill are compacted before installation of next course.

H. Check each course for level and alignment. Adjust units as necessary to maintain level and alignment prior to proceeding with each additional course. Install alignment devices (pins, clips, bars etc.) if required.

I. Install each succeeding course. Backfill as each course is completed. Pull the units forward until the locating surface of the unit contacts the locating surface/device of the units in the preceding course. Interlock wall segments that meet at corners by overlapping successive courses. Attach concrete retaining wall units at exterior corners with adhesive specified.

J. Install geosynthetic reinforcement in accordance with geosynthetic manufacturer's recommendations and the shop drawings.

   1. Orient geosynthetic reinforcement with the highest strength axis perpendicular to the wall face.

   2. Prior to geosynthetic reinforcement placement, place the backfill and compact to the elevation of the top of the wall units at the elevation of the geosynthetic reinforcement.

   3. Place geosynthetic reinforcement at the elevations and to the lengths shown on the Drawings.

   4. Lay geosynthetic reinforcement horizontally on top of the concrete retaining wall units and the compacted backfill soils. Ensure that the geosynthetic reinforcement extends to within one inch of the face of the concrete retaining wall units. Place the next course of concrete retaining wall units on top of the geosynthetic reinforcement.

   5. The geosynthetic reinforcement shall be laid horizontally, pulled taught and be free from wrinkles prior to placement of the backfill soils. The geosynthetic reinforcement may be secured in place with staples, stakes, soil fill or by hand tensioning until the geosynthetic reinforcement is covered by 6 inches of loose fill.

   6. The geosynthetic reinforcements shall be continuous throughout its embedment length. Splices in the geosynthetic reinforcement strength direction are not allowed.

7. Do not operate tracked construction equipment directly on the geosynthetic reinforcement. At least 6 inches of compacted backfill soil is required prior to operation of tracked vehicles over the geosynthetic reinforcement. Keep turning of tracked construction equipment to a minimum.

8. Rubber-tired equipment may pass over the geosynthetic reinforcement at speeds of less than 5 miles per hour. Turning of rubber-tired equipment is not allowed on the geosynthetic reinforcement.

3.07 BACKFILL PLACEMENT

A. Place reinforced backfill, spread and compact in a manner that will minimize slack in the reinforcement.

B. Place fill within the reinforced zone and compact in lifts not exceeding 6 to 8 inches (loose thickness) where hand-operated compaction equipment is used, and not exceeding 12 inches (loose thickness) where heavy, self-propelled compaction equipment is used.

1. Only lightweight hand-operated compaction equipment is allowed within 4 feet of the back of the retaining wall units. If the specified compaction cannot be achieved within 4 feet of the back of the retaining wall units, replace the reinforced soil in this zone with drainage aggregate material.

C. Compaction testing shall be done in accordance with ASTM D1556 or ASTM D2922.

D. Minimum Compaction Requirements for Fill Placed in the Reinforced Zone

1. The minimum compaction requirement shall be determined by the project geotechnical engineer testing the compaction. At no time shall the soil compaction requirements be less than 95 percent of the soil's standard Proctor maximum dry density (ASTM D698) [modified Proctor maximum dry density (ASTM D1557)] for the entire wall height

2. Utility Trench Backfill: Compact utility trench backfill in or below the reinforced soil zone to 98 percent of the soil's standard Proctor maximum dry density (ASTM D698) [modified Proctor maximum dry density (ASTM D1557)], or as recommended by the Project geotechnical engineer. If the height from the utility to finish grade is higher than 30 feet, increase compaction to 100 percent of the standard Proctor density [modified Proctor density].
    a. Utilities must be properly designed (by others) to withstand all forces from the retaining wall units, reinforced soil mass, and surcharge loads, if any.

3. Moisture Content: Within 2 percentage points of the optimum moisture content for all wall heights.

4. These specifications may be changed based on recommendations by the Project geotechnical engineer.
    a. If changes are required, the Contract Sum will be adjusted by written Change Order.

E. At the end of each day's operation, the wall installer shall slope the last level of compacted backfill away from the interior (concealed) face of the wall to direct surface water runoff away from the wall face.

1. The General Contractor is responsible for ensuring that the finished site drainage is directed away from the retaining wall system.

2. In addition, the General Contractor is responsible for ensuring that surface water runoff from adjacent construction areas is not allowed to enter the retaining wall area of the construction site.

F. Refer to Article 3.10 for compaction testing.

3.08 CAP UNIT INSTALLATION

A. Apply adhesive to the top surface of the unit below and place the cap unit into desired position.

B. Cut cap units as necessary to obtain the proper fit.

C. Backfill and compact to top of cap unit.

3.09 SITE CONSTRUCTION TOLERANCES

A. Site Construction Tolerances

1. Vertical Alignment: Plus or minus 1-1/2 inches over any 10-foot distance, with a maximum differential of 3 inches over the length of the wall.

2. Horizontal Location Control From Grading Plan
   a. Straight Lines: Plus or minus 1-1/2 inches over any 10-foot distance.
   b. Corner and Radius Locations: Plus or minus 12 inches.
   c. Curves and Serpentine Radii: Plus or minus 2 feet.

3. Immediate Post Construction Wall Batter: Within 2 degrees of the design batter of the concrete retaining wall units.

4. Bulging: Plus or minus 1-1/4 inches over any 10-foot distance.

3.10 FIELD QUALITY CONTROL

A. Installer is responsible for quality control of installation of system components.

B. The Owner, at their expense, shall retain a qualified independent testing agency to perform quality assurance checks, evaluation of foundation soils, and compaction testing of the installer's work.

C. Installer shall correct work that does not meet these specifications or the requirements shown on the Drawings at the installer's expense.

D. An independent testing agency shall be contracted by the Owner to perform compaction testing of the reinforced backfill placed and compacted in the reinforced backfill zone.

1. Testing Frequency
   a. One test for every 2 feet (vertical) of fill placed and compacted, for every 50 lineal feet of retaining wall.
   b. Vary compaction test locations to cover the entire area of the reinforced soil zone, including the area compacted by the hand-operated compaction equipment.

3.11 ADJUSTING AND CLEANING

A. Replace damaged units with new units as the work progresses.

B. Remove debris caused by wall construction and leave adjacent paved areas broom clean.

3.12 MEASUREMENT AND PAYMENT

A. Measurement of segmental retaining wall shall be on an installed square foot basis computed on the total face area of wall installed. Wall face area includes from the bottom of the embedded base wall unit to the top of the wall, including cap unit, and the entire length of the wall.

B. Payment for the wall will be made on a square foot basis at the agreed upon Contract Unit Price.

1. Payment should be considered full compensation for labor, materials, and equipment required to install the wall in accordance with these specifications and the Drawings.

2. Quantities may vary from that shown on the Drawings depending on existing topography. Change to the total quantity of wall face area will be paid or withheld at the agreed upon Contract Unit Price.

END OF SECTION

SECTION 334100

STORM DRAINAGE

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes gravity-flow, nonpressure storm drainage outside the building, with the following components:
   1. Storm Sewer Piping
   2. Precast concrete catch basins.
   3. Precast storm manholes

B. Related Sections:
   1. Section 312000 Earthwork

1.02 REFERENCES

A. Standard Specifications for Sewer and Water Construction in Wisconsin, Latest Edition

B. Wisconsin Department of Safety and Professional Services Plumbing Code SPS 381 to 384.

1.03 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For catch basins. Include plans, elevations, sections, details, and catch basin frames and grates.

PART 2 - PRODUCTS

2.01 PIPING MATERIALS

A. PVC Sewer Pipe and Fittings: ASTM D 3034, SDR 35, with bell-and-spigot ends with rubber gasketed joints in accordance with Chapter 8.10.0 of the Standard Specifications for Sewer and Water Construction in Wisconsin, Latest Edition. Joints shall conform to ASTM D-3212.

B. Reinforced Concrete Pipe: ASTM C76 with bell and spigot ends and gasketed joints with ASTM C443 rubber gaskets in accordance with Chapter 8.6.0 of the Standard Specifications for Sewer and Water Construction in Wisconsin, Latest Edition.

C. HDPE Pipe: As approved on the Department of Safety and Professional Services Plumbing Product Register.

2.02 NONPRESSURE-TYPE PIPE COUPLINGS

A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:
   1. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
   2. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
   3. For Concrete Pipes: ASTM C443, rubber

C. Unshielded Flexible Couplings: Elastomeric sleeve with stainless-steel shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

D. Shielded Flexible Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism

on each end. Coordinate subparagraph and list below with Part 2 "Manufacturers" Article. Retain "Available" for nonproprietary and delete for semiproprietary specifications.

E. Ring-Type Flexible Couplings: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

2.03 CLEANOUTS

A. Cleanouts shall be in accordance with Department of Commerce Code Chapter 82.35.

2.04 CATCH BASINS

A. Standard Precast Concrete Catch Basins: Conforming to Chapter 3.6.0 of the Standard Specifications for Sewer and Water Construction in Wisconsin, Latest Edition, of depth indicated.
   1. Base Section: 12-inch minimum thickness for floor slab and 5-inch minimum thickness for walls and base riser section.
   2. Top Section: Eccentric-cone type.

B. Frames and Grates: As indicated on plans.

2.05 MANHOLES

A. Standard Precast Reinforced Concrete Manholes: Conform to ASTM C478 and Section 8.39.0 and File No. 12 of the Standard Specifications for Sewer and Water Construction in Wisconsin, Latest Edition.

B. Manhole steps: Conform to Section 8.40.0 and File No. 15 of the Standard Specifications for Sewer and Water Construction in Wisconsin, Latest Edition.

C. Frames and Covers: As indicated on plans.

PART 3 - EXECUTION

3.01 PIPING APPLICATIONS

A. Pipe couplings and fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.
   1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping, unless otherwise indicated.
      a. Unshielded flexible couplings for same or minor difference OD pipes.
      b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
      c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

3.02 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. 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 in accordance with Chapter 3.2.0 of the Standard Specifications for Sewer and Water Construction in Wisconsin, Latest Edition.

C. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

D. Use Class B Compacted Trench Section in accordance with the Standard Specification for Sewer and Water Construction in Wisconsin.

E. Clear interior of piping and manholes of dirt and superfluous material as work progresses.

F. Install tracer wire over non-metallic piping in accordance with SPS Ch. 382.30(11)(h) and 382.36(7)(d).

3.03 PIPE JOINT CONSTRUCTION

A. Where specific joint construction is not indicated, follow piping manufacturer's written instructions.

B. Join gravity-flow, nonpressure drainage piping according to the following:
   1. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-gasket joints.
   2. Join reinforced concrete piping according to ACPS's Concrete Pipe Installation Manual for rubber-gasketed joints
   3. Join HDPE pipe in accordance with manufacturer's guidelines.
   4. Join dissimilar pipe materials with nonpressure-type flexible couplings.

3.04 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Install piping so cleanouts open in direction of flow in sewer pipe.
   1. Use light-duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.
   2. Use medium-duty, top-loading classification cleanouts in paved foot-traffic areas.
   3. Use heavy-duty, top-loading classification cleanouts in vehicle-traffic service] areas.

B. Set cleanout frames and covers in pavement with tops flush with pavement surface.

3.05 CATCH BASIN INSTALLATION

A. Set frames and grates to elevations indicated.

B. Install in accordance with Chapter 3.6.1 of the Standard Specifications for Sewer and Water Construction in Wisconsin, Latest Edition.

C. Catch Basin excavation and preparation of subgrade shall be in accordance with Section 3.5.4(a) and (b) of the Standard Specifications for Sewer and Water Construction in Wisconsin, Latest Edition.

3.06 MANHOLE INSTALLATION

A. Set manhole rims to elevations indicated.

B. Install in accordance with Section 3.5.0 of the Standard Specifications for Sewer and Water Construction in Wisconsin, Latest Edition.

3.07 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred.

B. Conduct deflection testing of installed pipe in accordance with Section 3.2.6(i)4 of the Standard Specifications for Sewer and Water Construction in Wisconsin, Latest Edition.
   1. Replace any pipe section not passing the deflection test using new materials.
   2. Reinspect and repeat procedure until results are satisfactory.

END OF SECTION