Lee County

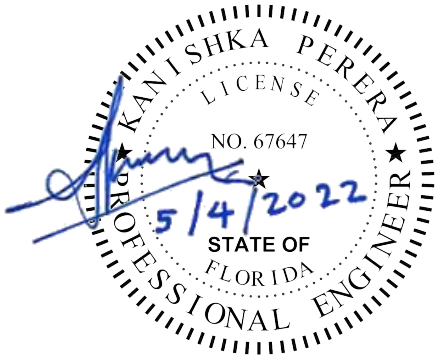
Lee-Hendry Landfill Cells 11A - 11B and 12 Construction

Construction Documents
Project Manual

Issued for Bid

May 2022

HDR Project No. 10236229



Kanishka Perera, P.E.
Florida P.E. No. 67647

This page intentionally left blank.

TABLE OF CONTENTS

This page intentionally left blank.

SECTION 01010
GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Scope of work.

B. Drawings and specifications to be followed.

C. Design intent of Drawings and Specifications.

D. References to other specifications.

E. Enumeration of Drawings.

F. Permits and agency approvals.

G. Contractor use of site and premises.

H. Construction quality assurance (CQA) requirements.

I. References.

J. Completion dates and substantial completion.

K. Guarantee.

L. Patents.

1.2 SCOPE OF WORK

A. Work to be performed is identified in the Contract Documents (i.e., Drawings, these Specifications, and other parts of the Project Manual). CONTRACTOR shall furnish machinery, tools, equipment, material, and labor necessary for the performance of the Work and shall furnish and do everything necessary to make the Work satisfactory, complete, neat, and finished.

B. All incidental, minor and miscellaneous items, Work, and materials not specified or shown, which are necessary to complete the indicated Work and to maintain and repair the Work, or which may be reasonably implied as included, shall be done and furnished by CONTRACTOR without extra charge to OWNER.

1.3 DRAWINGS AND SPECIFICATIONS TO BE FOLLOWED

A. Drawings to be followed under this Contract shall be approved drawings on file in the office of OWNER for the Lee/Hendry County Landfill Cells 11A, 11B and 12 Construction. Drawings show the location, details, and dimensions of the Work contemplated. The Work shall be performed in strict accordance with the Drawings and Specifications. There shall be no deviation from the Drawings and Specifications on account of the exigencies of the construction, unless approved and authorized in writing by ENGINEER and OWNER.

1.4 DESIGN INTENT OF DRAWINGS AND SPECIFICATIONS

A. The design intent, as determined by ENGINEER, shall govern in the case of discrepancy in or between the Drawings and Specifications. The Specifications are

intended to supplement and clarify the Drawings. CONTRACTOR shall comply with both Drawings and Specifications in order to fulfill the Contract requirements. Any work called for by either is as binding as though it were called for by both. CONTRACTOR shall take no advantage of any error or omission in the Drawings or of any discrepancy between the Drawings and/or Specifications. In all cases of doubt as to the meaning of the Drawings and Specifications, the decision of ENGINEER will be final and conclusive. CONTRACTOR shall notify ENGINEER upon discovery of any actual or perceived discrepancy in or between the Drawings and Specifications.

1.5 REFERENCES TO OTHER SPECIFICATIONS

A. Wherever references are made to other specifications, standards, or requirements, it shall be understood that the latest specifications, standards or requirements are intended and shall apply, except as otherwise specified or to the extent that said specifications, standards or requirements may be in conflict with applicable laws, ordinances, rules and regulations.

1.6 ENUMERATION OF DRAWINGS

A. Following is a list of the Construction Drawings that form a part of the Contract Documents. The Drawings furnished by OWNER and referred to in these Specifications are as follows:

B. DRAWING NO. TITLE
   1. GENERAL
      a. 00G-01 COVER SHEET
      b. 00G-02 GENERAL NOTES AND ABBREVIATIONS
   2. CIVIL
      a. 00C-01 FACILITY SITE PLAN
      b. 00C-02 CLASS I LANDFILL EXISTING CONDITIONS
      c. 00C-03 TOP OF SUBGRADE GRADING PLAN
      d. 00C-04 TOP OF SUGRADE CONSTRUCTION POINT TABLE (1 OF 4)
      e. 00C-05 TOP OF SUGRADE CONSTRUCTION POINT TABLE (2 OF 4)
      f. 00C-06 TOP OF SUGRADE CONSTRUCTION POINT TABLE (3 OF 4)
      g. 00C-07 TOP OF SUGRADE CONSTRUCTION POINT TABLE (4 OF 4)
      h. 00C-08 LEACHATE DETECTION PLAN
      i. 00C-09 TOP OF PROTECTIVE COVER GRADING PLAN
      j. 00C-10 TOP OF PROTECTIVE COVER CONSTRUCTION POINT TABLE (1 OF 2)
      k. 00C-11 TOP OF PROTECTIVE COVER CONSTRUCTION POINT TABLE (2 OF 2)
      l. 00C-12 LEACHATE COLLECTION, PROPOSED TOE DRAIN AND SITE FINISHING PLAN
      m. 00C-13 PROPOSED POND EXPANSION GRADING PLAN
      n. 00C-14 POND EXPANSION CONSTRUCTION POINT TABLE (1 OF 3)
      o. 00C-15 POND EXPANSION CONSTRUCTION POINT TABLE (2 OF 3)
      p. 00C-16 POND EXPANSION CONSTRUCTION POINT TABLE (3 OF 3)
      q. 00X-01 CELL CROSS SECTIONS
      r. 00X-02 POND CROSS SECTIONS
      s. 00D-01 LINER DETAILS
      t. 00D-02 LEACHATE COLLECTION SYSTEM DETAILS (1 OF 4)
      u. 00D-03 LEACHATE COLLECTION SYSTEM DETAILS (2 OF 4)
      v. 00D-04 LEACHATE COLLECTION SYSTEM DETAILS (3 OF 4)

w. 00D-05 LEACHATE COLLECTION SYSTEM DETAILS (4 OF 4)
x. 00D-06 MASTER PUMP STATION MODIFICATIONS AND ADDITIONS
y. 00D-07 MISCELLANEOUS DETAILS (1 OF 2)
z. 00D-08 MISCELLANEOUS DETAILS (2 OF 2)
aa. 01C-01 EROSION AND SEDIMENT CONTROL PLAN (1 OF 2)
bb. 01C-02 EROSION AND SEDIMENT CONTROL PLAN (2 OF 2)
cc. 01D-01 EROSION AND SEDIMENT CONTROL DETAILS

3. ELECTRICAL
   a. 00E-01 ELECTRICAL LEGEND AND NOTES
   b. 00E-02 ELECTRICAL SITE PLAN
   c. 00E-03 TYPICAL LEACHATE MONITORING STATION ELECTRICAL PLAN
   d. 00E-04 MASTER PUMP STATION (MPS) 2 ELECTRICAL PLAN
   e. 01E-01 ELECTRICAL RISER DIAGRAM
   f. 01E-02 PUMP CONTROL DETAILS
   g. 01E-03 PUMP STATION ELECTRICAL DIAGRAM
   h. 01E-04 ELECTRICAL DETAILS

1.7 PERMITS AND AGENCY APPROVALS

A. CONTRACTOR's attention is drawn to the fact that certain permits and governmental agency approvals are required for various portions of the Work. The Owner has obtained an Environmental Resource Permit (ERP) from the FDEP and a solid waste construction permit for the landfill expansion. Copies of these permits are included in the Appendices. It shall be expressly understood that nothing in these Specifications shall relax or modify any permit stipulation or condition of approval, and that it is CONTRACTOR's responsibility to comply with all regulatory requirements affecting the Work, including any and all environmental requirements.

B. CONTRACTOR shall be responsible for obtaining and complying with any and all permits necessary to perform the Work. This shall include, but not be limited to: (i) erosion and sediment control permits and approved plans for off-site borrow pits or spoil areas; (ii) traffic and highway permits; and (iii) temporary building and/or electrical permits. The CONTRACTOR shall pay all costs and fees associated with obtaining the permits for which the CONTRACTOR is responsible.

1.8 CONTRACTOR'S USE OF SITE AND PREMISES

A. CONTRACTOR's access to OWNER's property is limited to the project Work area as identified in the Contract Documents to include:
   1. limits of disturbance of the landfill construction areas;
   2. staging and storage area; and
   3. access roads.

1.9 CONSTRUCTION QUALITY ASSURANCE REQUIREMENTS

A. All material incorporated into the Work shall be new and of the highest grade. All materials shall be handled in accordance with manufacturer's recommendations.

B. All Work will be monitored and tested by a Construction Quality Assurance (CQA) Consultant in accordance with the requirements of the CQA Plan.

C. CONTRACTOR shall be aware of all testing activities outlined in the CQA Plan and shall account for these activities in the construction schedule.

D. CONTRACTOR shall be responsible for cooperating with the ENGINEER during all earthwork-related testing activities. CONTRACTOR shall provide equipment and labor to assist the ENGINEER in sampling, if requested, and shall also provide access to all areas requiring testing. CONTRACTOR shall repair any damage to finished Work caused by the ENGINEER's sampling or testing activities.

E. CONTRACTOR shall be responsible for surveying and geometric control of the Work.

F. CONTRACTOR (and its subcontractors, suppliers, manufacturers, etc.) shall abide by all qualification requirements identified in the CQA Plan.

1.10 REFERENCES

A. Construction Quality Assurance Plan.

B. Latest version available at the time of contract execution of American Society for Testing Materials (ASTM) Standards.

C. Latest version available at the time of contract execution of the Florida Department of Transportation (FDOT) Standard Specifications for Road and Bridge Construction.

D. Latest version available at the time of contract execution of the FDEP's Florida Stormwater Erosion and Sediment Control Inspector's Manual.

E. Latest version available at the time of contract execution of the American Association of State Highway Transportation Officials (AASHTO) Standards.

F. Latest version available at the time of contract execution of the Geosynthetic Research Institute (GRI) Test Methods.

G. Latest version available at the time of contract execution of the Federal Test Methods.

H. Latest version available at the time of contract execution of the Plastic Pipe Institute (PPI) Rating.

I. Latest version available at the time of contract execution of the American National Standards Institute (ANSI) Standards.

J. Latest version available at the time of contract execution of the American Concrete Institute (ACI) Standards.

1.11 COMPLETION DATES AND SUBSTANTIAL COMPLETION

A. The Work of the Project will be considered substantially completed when the following conditions are met:
   1. All the components of the Work have been completed and are operational to the satisfaction of OWNER and ENGINEER. Components include, but are not limited to: dewatering, clearing and grubbing, excavation and removal of unsuitable material, subgrade installation, GCL, secondary liner, leak detection geocomposite, primary liner, leachate collection geocomposite, protective cover layer, stormwater structures, modifications to stormwater ponds, piping and appurtenances, perimeter channel, pumps, control panel, leachate monitoring station, waste limit markers, erosion and sediment control, sodding, electrical systems and restoration of disturbed areas.
   2. All required final as-built documentation for the project has been submitted (including operation and maintenance manuals), and the ENGINEER has confirmed that the as-built documentation submitted is acceptable and complies with the Contract Documents.

3. All construction quality control and quality assurance testing for soils, geosynthetics, pipes, pumps and controls required for the Project have been completed and acceptable results have been obtained.
4. The applicable conditions of all permits and approvals governing the work conducted by CONTRACTOR are completed to the satisfaction of the applicable regulatory authority.

1.12 GUARANTEE

A. CONTRACTOR shall guarantee all of the Work included in this Contract for a period specified in the front-end contract documents:

B. Against all faulty or imperfect materials and against all imperfect, careless, or unskilled workmanship on the part of CONTRACTOR, its subcontractors, suppliers, or component manufacturers.

C. The entire Work and each and every part thereof shall operate, with normal care and attention, in a satisfactory and efficient manner, and in accordance with the requirements of the Specifications.

D. CONTRACTOR agrees to replace with proper workmanship and materials, and to re-execute, correct, or repair without cost to OWNER, Work that may be found to be improper or imperfect or that does not operate in satisfactory manner or fails to perform as specified.

E. The guarantee obligations assumed by CONTRACTOR under the Specifications shall not be held or taken to be in any way impaired because of the Specifications, indication or approval by or on behalf of OWNER of any articles, materials, means, combinations or things used or to be used in the construction, performance, and completion of the Work or any part thereof.

F. No use or acceptance by OWNER of the Work specified herein, or any part thereof, nor any repairs, adjustments, replacements, or corrections made by OWNER due to CONTRACTOR's failure to comply with any of its obligations under the Specifications shall impair in any way the guarantee obligations assumed by CONTRACTOR under the Contract Documents.

G. If these contract documents include warranty periods for products, installation and other Work that exceed the guarantee period, these items' warranty periods shall not be superseded by the warranty period.

1.13 PATENTS

A. CONTRACTOR shall pay all applicable royalties and license fees. It shall defend all suits or claims for infringement of any patent rights and save OWNER harmless from loss on account thereof, except that OWNER shall be responsible for any such loss when a particular process, design, or the product of a particular manufacturer or manufacturers is specified. However, if CONTRACTOR has reason to believe that the design, process, or product specified is an infringement of a patent, it shall be responsible for such loss unless it promptly gives such information to ENGINEER.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. CONTRACTOR shall execute all Work in accordance with the requirements of the Drawings, Specifications, and CQA Plan.

3.2 FAMILIARIZATION

A. Prior to implementing any Work described in these Specifications, CONTRACTOR shall become thoroughly familiar with the site, the existing site conditions, and all portions of the Work falling within the appropriate section of the Specifications. Also, the CONTRACTOR shall assess weather conditions, based on the historical weather data that can potentially delay any of the work.

B. Inspection
   1. Prior to implementing any of the Work, CONTRACTOR shall carefully inspect the previously installed Work to verify that the previous Work is complete to the point where the installation of succeeding Work may properly commence without adverse impact.
   2. If CONTRACTOR has any concerns regarding the previously installed Work, it should immediately notify OWNER verbally and in writing (within 48 hours of the site visit). Failure to notify OWNER or continuance with Work will be construed as CONTRACTOR's acceptance of the previous Work.

3.3 USE OF EXPLOSIVES

A. No explosives shall be used on OWNER's property.

3.4 WATER SUPPLY

A. The CONTRACTOR shall provide potable drinking water for personnel. If public water supply is used CONTRACTOR shall be responsible for setting up the service and paying all fees with the local utility. Non-portable water shall be obtained from on-site stormwater management ponds depending on the availability. CONTRACTOR is responsible for pumping out non-portable water and delivering to the site.

3.5 HOURS OF OPERATION

A. In addition to any applicable local ordinances or state laws affecting hours of operation, the following requirements shall be adhered to:

B. Approved hours for construction activities are 7 am to 4 pm Monday through Friday, including all fueling, warm-up, clean-up, and all other construction-related activities. Work that requires CQA Observation shall be performed within those hours (a total time of 45 hours per calendar week) unless approved by OWNER, and ENGINEER.

C. If CONTRACTOR intends to install geomembrane between one hour before sunset and one hour after sunrise, CONTRACTOR shall notify ENGINEER and CQA Consultant in writing prior to the start of the Work. CONTRACTOR shall indicate additional precautions that shall be taken during these installation hours. CONTRACTOR's plan for installing geomembrane during these installation hours must be approved by ENGINEER before the start of the Work.

D. No geomembrane repair, liner system construction, or earthwork construction, will be allowed between one hour before sunset and one hour after sunrise, unless approved by ENGINEER.

E. No surveying will be allowed between one hour before sunset and one hour after sunrise, unless approved by ENGINEER and CQA Consultant.

3.6 RELOCATION AND PROTECTION OF EXISTING UTILITIES

A. CONTRACTOR shall protect and/or support all existing utilities that are endangered by its operations and the cost for these activities will be taken to be included in the total contract price except as specified herein.

B. CONTRACTOR shall submit to OWNER for acceptance, complete details for each and every operation involving interruption of service of any existing utility, item of equipment, piping, building, structure, or similar existing items, a minimum of 14 days before said operation commences. Details shall include the proposed methods of construction, construction schedule, estimated times that items will be out of service, details of temporary bypass piping, bypass pumping equipment and controls, and other similar items deemed pertinent in the opinion of OWNER. CONTRACTOR will not be permitted to commence said operations until acceptance is obtained from OWNER.

3.7 PROTECTION OF WORK

A. CONTRACTOR shall use all means necessary to protect all prior Work, including all materials and completed Work of other Sections.

B. In the event of damage to Work performed by CONTRACTOR prior to OWNER's acceptance of the Work, CONTRACTOR shall immediately make all repairs and replacements necessary, to the approval of the CQA Consultant and at no additional cost to OWNER.

3.8 USE OF ELECTRONIC DATA

A. The delivery of AutoCAD drawings in electronic format is for the benefit of the CONTRACTOR. Nothing in this transfer should be construed to provide any right of the CONTRACTOR to rely on the information provided or that the use of this electronic information implies the review and approval by the ENGINEER or OWNER of any drawing based on the information.

B. The electronic files are provided solely as a convenience and shall NOT be considered "Contract Documents", "Construction Documents" or any type of certified document. All documents considered "Contract Documents", "Construction Documents" or any type of a certified document shall be hard copy and shall be accompanied by a professional's stamp and signature. The hardcopy shall be referred to and shall govern in the event of any inconsistency between the hardcopy and the electronic files. The information contained in the electronic files may not be used in lieu of obtaining information by other means required by other agreements, including those with ENGINEER or OWNER, such as by survey or other procedures or sources, and any conclusions or information obtained or derived from such electronic files will be at user's sole risk. By providing information in this format, the OWNER or ENGINEER makes no representations, whether express or implied, whether user's means, methods, techniques, sequences, or procedures are adequate, appropriate, or approved, and whether the use of the information contained in the electronic files is appropriate.

C. CONTRACTOR is advised to check all electronic media for computer viruses before loading the files. Contractor is fully responsible for intercepting and disabling viruses, if any, that may be inadvertently transmitted with the electronic files and hereby agrees to indemnify and hold CONTRACTOR or ENGINEER harmless from and against all claims of any type or nature asserted by CONTRACTOR or any third party as a result of viruses inadvertently transmitted with the electronic media.

D. Files distributed electronically are subject to data erosion, erasure and/or alteration, and computer systems and software become obsolete in time. By accepting these electronic files, CONTRACTOR acknowledges these risks and agrees to waive all claims against ENGINEER or OWNER should data erosion, erasure and/or alteration of these electronic files occur.

E. If CONTRACTOR, employees, or agents choose to use or alter in any way, in whole or in part, the electronic files provided for the Project or any future project(s), or the electronic files are inadvertently altered in any way, CONTRACTOR agrees to indemnify OWNER or ENGINEER and hold OWNER or ENGINEER harmless from all claims, injuries, losses, damages, costs and expenses (including without limitation, attorneys' fees) arising out of such alteration or use.

END OF SECTION

SECTION 01050
FIELD ENGINEERING (SURVEYS)

PART 1 - GENERAL

1.1 SUMMARY

A. OWNER shall provide surveys to establish control points that, in OWNER'S judgment, are necessary to enable CONTRACTOR to proceed with the Work. The CONTRACTOR shall establish the location of all the Work from control points that are shown on the Drawings, or as modified by the ENGINEER.

B. The CONTRACTOR shall provide record drawings, sealed and signed by a Florida Registered Land Surveyor, who shall verify that all portions of the work are located vertically and horizontally as shown on the design drawings, and that protective cover is installed to the required minimum thicknesses.

C. The CONTRACTOR shall have the responsibility to carefully preserve the benchmarks, reference points and stakes and, in the case of destruction thereof, CONTRACTOR shall replace at his own cost all such damaged markers.

D. Existing or new control points, property markers and monuments that are destroyed during the normal course of construction shall be reestablished by the CONTRACTOR at his expense, and all reference ties shall be recorded and submitted to the OWNER. All computations necessary to establish the exact position of the work shall be made and preserved by the CONTRACTOR.

E. The OWNER may check all or any portion of the work, and the CONTRACTOR shall afford all necessary assistance to the OWNER in carrying out such checks. Any necessary corrections to the work shall be immediately made by the CONTRACTOR. Such checking by the OWNER shall not relieve the CONTRACTOR of any responsibilities for the accuracy or completeness of his work.

F. All surveying and associated work performed by the CONTRACTOR shall be performed in accordance with this Specification.

1.2 RELATED WORK

A. The General and Supplementary Conditions of these specifications are a part of this section as if incorporated herein.

B. Other related specification sections contained herein are as listed below.
   1. Section 02300 – Earthwork
   2. Section 02775 – HDPE Liner
   3. Section 02776 – Geosynthetic Clay Liner

1.3 SUBMITTALS

A. See Part 1, Paragraph 1.01 B Surveyor name, address, telephone number, and Florida State Registration Number.

B. See Part 3, Paragraph 3.01 C: preconstruction survey.

C. See Part 3, Paragraph 3.01 for a complete listing.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 LAYOUT AND LEVELS

A. The CONTRACTOR shall layout the features and structures as shown on the Drawings, and shall be responsible for any damage caused the OWNER due to incorrect laying out of the work.

B. The Surveyor shall locate and clearly mark in the field all property boundaries within 100 feet of the work area. The Surveyor shall submit to OWNER a description of the evidence and procedures used to locate the property boundary or boundaries. The Surveyor shall immediately notify OWNER of any discrepancy between the boundary location shown on the Drawings and the location indicated by the evidence and procedures used by the Surveyor.

C. The CONTRACTOR shall, prior to start of construction, perform a preconstruction survey in order to verify all grades, lines, levels and dimensions as shown on the drawings, and shall report any errors or inconsistencies in them to the OWNER in writing within seven (7) days before commencing of the Work. Failure to notify OWNER prior to commencing of Work will be construed as CONTRACTOR's acceptance of the survey data presented in the Construction Drawings.

D. The CONTRACTOR shall employ a Florida Registered Land Surveyor to layout the Work, establish benchmarks and control points.

E. The Surveyor shall maintain lines and levels, layout, and locate the work utilizing recognized engineering survey practices. A complete and accurate log of control and survey work must be maintained. The Surveyor shall establish a 50 foot by 50 foot survey grid or grade breaks whichever is closer for construction and record documentation. All survey control points shown on the Drawings shall be included in the Surveyor's documentation. Within seven (7) days after completion of each of the following construction items, the CONTRACTOR shall prepare and deliver to the OWNER three (3) copies to review that all dimensions, elevation grades, slopes and contours at one foot (1') contour interval or closer were constructed in accordance with the Contract Documents:
   1. A preconstruction survey of the area within the proposed development including storm water control system (pond, swales and structures), future MSW landfill cells, and at least 100 feet in all directions beyond the limits of disturbance prior to commencing site construction.
   2. All items that CONTRACTOR requires to complete its work and establish pay quantities.
   3. All reasonable items requested by OWNER to verify that CONTRACTOR's work meets the requirements of the Drawings and Specifications to include as a minimum the items described below.
      a. The location of the anchor trenches and dimensions;
      b. Tie-in to existing liner system;
      c. Top of prepared subgrade.
      d. The surface and limits of primary and secondary base liner geomembrane, geomembrane, including locations of seam samples, repairs, and edge of liner;

e. Top of protective cover including leachate collection piping of the base liner and top of vegetative subsoil on final cover;
f. Waste limit markers;
g. Location of electrical system components including control panel and buried conduits;
h. Locations and invert elevations related to gravity leachate conveyance pipes, downdrain pipes and connections, manholes, pump stations, leachate storage tanks, forcemains, structures, including sumps and cleanouts. Note that invert elevations shall be obtained at tie-in locations, intersections and end points and every 50 feet between the intersections and end points;
i. Locations and invert elevations related to drainage channels, underground culverts, inlets, grates and manholes;
j. As-built survey of the pond expansion limits; and
k. Top and toe of all berms, roads and channels.

4. Topographic surveys shall extend a minimum of 100 ft in all directions beyond the limits of construction.
5. These drawings shall include the horizontal and vertical location and record data of pipes, inverts, slopes, penetrations, and other pertinent features as shown on the Drawings. CONTRACTOR submitted drawings shall also include the location of the electrical line and outlets, access roads, channels and stockpiles and any revisions made to any of the “details” included in the Contract Drawings.

F. The survey instruments used shall be capable of reading to a precision of 0.01 ft and with a setting accuracy of 10 seconds.

G. Topographic surveys shall be referenced to the site grid system and shall show a minimum of three grid points.

H. The OWNER will review the record documentation within 48 hours of receipt from the Certifying Surveyor. The OWNER will notify CONTRACTOR within this 48 hour period as to whether the record documentation for the subject component demonstrates construction to the specified grades, elevations, etc. CONTRACTOR shall not proceed with construction of subsequent components until it has received notification from the OWNER. Any work on subsequent components performed prior to this notification may be subject to removal and replacement, at no additional cost to OWNER.

I. A minimum of three sets, or otherwise requested by OWNER, of final certified copies of the record documentation shall be prepared within 14 days after final review and approval by the OWNER. CONTRACTOR shall also submit electronic files of all record documents to the Owner along with the hard copies.

3.2 TOLERANCES

A. Construction tolerances shall be as given in the various sections of the Specifications and Drawings, and as given below.

B. Subbase construction survey tolerance shall be 0.10 feet.

C. Protective cover layer minimum thickness shall be 24 inches with a construction survey tolerance of plus 0.10 feet. Vegetative subsoil on final cover thickness shall be 18 inches with a construction survey tolerance of plus 0.10 feet.

D. On piping for leachate collection/detection lines, stormwater conveyance pipes/culverts and inlet structures the maximum tolerance shall be 0.02 feet. This tolerance must be set to the record elevation of the surface below it and not the design elevation.

E. For cleanout risers, the tolerance shall be 0.10 foot. This tolerance must be set to the record elevation of the surface below it and not the design elevation.

F. No surveying will be allowed between one hour before sunset and one hour after sunrise, unless approved by OWNER.

G. CONTRACTOR shall be aware of the surveying activities and shall account for them in the construction schedule.

H. The Surveyor shall cooperate fully with OWNER at all times.

I. Proposed modifications to stormwater management system shall meet the invert elevations and minimum slopes defined on the Contract Drawings.

J. CONTRACTOR shall meet the minimum slopes for the leachate collection/detection pipe trench, stormwater conveyance pipes, top of subbase and top of protective layer shown in the Contract Drawings and Specifications. The CONTRACTOR's compliance with these slopes shall be calculated using elevation points that are measured by the Surveyor to the 0.01 feet between every 50 feet. If the surveyed elevations are not in-line with the flow path, interpolated elevations shall be used.

K. Unless otherwise specified on the Drawings, completed slopes shall be no steeper than 33%.

END OF SECTION

SECTION 01200
DESCRIPTION OF SCHEDULE OF VALUES

PART 1 - GENERAL

1.1 DESCRIPTION

A. A completed, quality project, as intended by the general nature of the drawings and specifications, shall be produced whether or not any particular wording or direction is inadvertently omitted. Pay items listed on the Bid Form are for comparison of bids and may be used as a method of determining the value of work performed for partial payment requests.

1.2 LUMP SUM QUANTITIES

A. CONTRACTOR shall be solely responsible for determining the quantities of each lump sum pay item necessary to complete the work as required by the Contract Documents. When lump sum items are broken into components, the sum of the components shall be the total Contract Price for the work. The lump sum schedule of values stated on the Bid Form shall constitute full compensation for each pay item completed in accordance with the Drawings and specifications. No other payments will be made to the CONTRACTOR except as specifically authorized by change order.

1.3 SCHEDULE OF VALUES

A. The lump sum descriptions provided in the following paragraphs are to be used by the Bidder in preparation of his bid proposal. They generally indicate how the major workscope items and their respective costs are to be separated into the line items listed in the Schedule of Values. These descriptions are neither fully representative nor all inclusive of the work required for completing the project in accordance with the Contract Documents. It is the Bidder's responsibility to include costs within the most appropriate line item(s) of the Lump Sum Pay Items. The following descriptions are ordered in the same numeric sequence of the Schedule of Values.

B. The estimated quantities for specific unit price pay items are approximate only and are included solely for the purpose of comparison of bids. OWNER does not expressly, or by implication, agree that the nature of the materials encountered below the ground surface or the actual quantities of material encountered will correspond with the estimated quantities.

C. <u>Item 1 – Mobilization, Demobilization and General Conditions</u>

1. This lump sum item shall include and cover the costs for performance of construction preparatory and overhead operations, including, but not limited to, movement of personnel and equipment to and from the site, temporary facilities, sanitary facilities, project administration and management, dust control, insurance, bonds, OWNER and ENGINEER indemnification, site health and safety, environmental protection, permits related to construction and all other similar activities and facilities necessary for execution of this project. This item shall not exceed 7% of the total contract amount. Contractor will be paid up to 75% of this item upon completion of mobilization and general conditions with the remainder paid upon demobilization.

D. Item 2 – Erosion and Sediment Control
   1. This lump sum item shall consist of furnishing all equipment, materials, labor, and appurtenances required for sedimentation and erosion control at the site as required by the Contract Documents, applicable laws and regulations, and standards of practice. This work includes but is not limited to furnishing, installing, and maintaining silt fence; temporary or intermediate sodding and mulching; temporary stormwater channels and diversion berms; sediment traps; turbidity barrier; final sodding of completed berms, side slopes and channels; temporary check dams; temporary construction entrances; temporary gravel access road and maintenance of the stormwater swales during construction. The lump sum price proposed shall be full compensation for performing sedimentation and erosion control work required. Payment for this bid item will be on a lump sum basis based on the value of materials furnished or services and work completed using estimates provided by CONTRACTOR and approved by OWNER's representative.

E. Item 3 – Surveying
   1. This lump sum item shall include furnishing of all labor, materials, tools, supervision, transportation, and equipment necessary to perform project surveying work as specified in the CQA Plan, Section 01050 of these Specifications and Contract Drawings including establishing survey control points, providing survey control during construction, preconstruction survey, partial and final as-built Drawings, and obtaining all survey information required to compile Record (As-Built) Drawings as required by the Contract Documents. Unless ENGINEER has directed in writing that surveying shall vary from that indicated on the Construction Drawings and these Specifications, the payment quantity shall not exceed the price in the Bid Schedule. The lump sum price proposed shall be full compensation for performing the surveying work required. Payment for this item shall be made on a lump sum basis, wherein no measurement will be made. Payments for this lump sum item will be made based on the CONTRACTOR submitted schedule and approved by ENGINEER for sub-survey items. Full payment for each milestone will be made upon full completion of the item. Surveys shall only be submitted by CONTRACTOR after previous surveys have been approved by OWNER's representative.

F. Item 4 – Groundwater Monitoring Well Installation
   1. The lump sum price shall include all materials, equipment, labor, transportation, and all else required to construct the groundwater monitoring wells to the depths shown on the Drawings including: obtaining well installation permits, drilling; backfilling; clearing any obstructions; supply monitoring probes; supply fittings; install well casing/well screen; well development; locks; concrete pads; reporting and paint above ground well casing. No additional payment will be made for losses due to settlement, well collapse, over-drilling, replacement of rejected material, dewatering, installation of bollards or protection. The lump sum price proposed shall be full compensation for performing all relevant requirements to achieve successful installation of monitoring wells as shown in the Drawings.

G. Item 5 – Groundwater Monitoring Well Abandonment
   1. The lump sum price shall include all materials, equipment, labor, transportation, health and safety needs, and all else required to abandon specified groundwater monitoring wells as shown on the Drawings including: inform required authorities as specified; positive well identification; clear any obstructions; remove below ground

and above-ground well casings and dispose as directed by OWNER; backfilling and compacting; and preparation and submittal of well abandonment forms.

H. Item 6 – Leachate Forcemain
   1. This lump sum item shall consist of furnishing all equipment, materials, labor, and appurtenances required for installation of leachate forcemain, associated cleanouts, future access points and valves as required by the Contract Documents to applicable standards of practice. This work includes but is not limited to connecting forcemains to existing and proposed master pump stations, trench excavation and backfilling and compaction with onsite/offsite material. The lump sum price proposed shall be full compensation for performing all relevant requirements to achieve successful installation of forcemain including cleanouts and air release valves as shown in the Drawings.

I. Item 7 – Subsurface Dewatering within Project Limits
   1. This Work shall consist of furnishing all equipment, materials, labor, and appurtenances required for subsurface dewatering within the project limits to facilitate construction activities as required by the Contract Documents, applicable laws and regulations, and standards of practice. This Work includes but is not limited to preparation of proposed dewatering plan and furnishing, installing, maintaining and monitoring dewatering equipment and conveyance system during the construction period. This Work also includes installation of piezometers as shown in the plans for monitoring groundwater levels. The lump sum price proposed shall be full compensation for performing all relevant requirements to achieve successful dewatering to proceed with excavation/backfilling to proposed grades and compaction. Payment for this bid item will be on a lump sum basis based on the value of materials furnished or services and work completed using estimates provided by CONTRACTOR and approved by OWNER's representative.

J. Item 8 – Preparation of Subgrade
   1. The lump sum price shall include furnishing all necessary materials, equipment, transportation, labor, and appurtenances necessary to prepare subgrade to the lines and grades shown on the plans including the perimeter berms, channel and road. The work includes, but is not limited to, removal of vegetation, excavation of soil to achieve subgrade elevation, backfilling using on-site soil, compaction, grading to achieve design elevations, testing and verification of subgrade competency. The lump sum price proposed shall be the full compensation for performing all relevant requirements to achieve construction of subgrade to the lines and grades as shown in the Drawings.

K. Item 9 - Anchor Trenches and Liner Tie-in
   1. This lump sum item shall include furnishing all necessary materials, equipment, transportation, labor, and appurtenances necessary to excavate anchor trenches, backfilling and compaction with onsite low permeability soil, construction of anchor trench corridor with onsite soil and exposing and tie-in to existing liner components. No additional payment for relocation of waste if encountered, covering of exposed waste surfaces by hauling onsite soil, establishing vegetation or repairing damaged liner during liner exposure. The lump sum price proposed shall be full compensation for performing all relevant requirements to anchor the liner system and/or tie-in to existing liner as shown in the Drawings.

L. Item 10 – GCL Material
   1. Measurement for payment will be made on a square foot basis of GCL installed, calculated based on surveys of the material accepted, performed in accordance with Section 01050 of these Specifications, or such other means of measurement that may be agreed between OWNER and CONTRACTOR.
   2. This unit price shall include all materials necessary to install the GCL where shown on the Drawings and in accordance with the technical specifications and CQA Plan. This Work will include but not be limited to all material including required bentonite, delivery, stockpiling, protection, wastage, necessary overlaps and anchor trenches.
   3. Unless ENGINEER has directed in writing that amount of GCL shall vary from the quantities shown on the Drawings, the payment quantity will not exceed the estimate in the Schedule of Values..

M. Item 11 – GCL Installation
   1. This lump item shall include all equipment, labor, and appurtenance necessary to install the GCL material where shown on the Drawings and in accordance with the technical specifications and CQA Plan. This Work will include but not be limited to placement, connections, tie-in to existing liner, anchor trenches, necessary overlaps and testing involving GCL. No payment will be made for GCL placed outside of the anchor trench, replacing hydrated GCL or where testing has indicated that the installed material does not meet the specified requirements. The lump sum price proposed shall be full compensation for performing all relevant requirements to achieve successful installation of GCL to the limits shown in the Drawings.

N. Item 12 – Secondary HDPE Geomembrane Material
   1. Measurement for payment will be made on a square foot basis of HDPE Geomembrane installed, calculated based on surveys of the material accepted, performed in accordance with Section 01050 of these Specifications, or such other means of measurement that may be agreed between OWNER and CONTRACTOR.
   2. This unit price item shall include all materials necessary to install the secondary HDPE geomembrane where shown on the Drawings and in accordance with the technical specifications and CQA Plan. This Work will include but not be limited to all material delivery, stockpiling, protection, wastage, necessary overlaps and anchor trenches. .
   3. Unless ENGINEER has directed in writing that amount of HDPE Geomembrane shall vary from the quantities shown on the Drawings, the payment quantity will not exceed the estimate in the Schedule of Values.

O. Item 13 – Secondary HDPE Geomembrane Installation
   1. This lump sum item shall include all equipment, labor, and appurtenance necessary to install the secondary HDPE geomembrane where shown on the Drawings and in accordance with the technical specifications and CQA Plan. This Work will include but not be limited to placement, connections, cleaning, securing, existing liner tie-in, necessary overlaps, anchor trenches, pipe boots and testing involving HDPE secondary geomembrane. No payment will be made for HDPE geomembrane placed outside of the anchor trench or where testing has indicated that the installed material does not meet the specified requirements. The lump sum price proposed shall be full compensation for performing all relevant requirements to achieve successful installation of geomembrane to the limits shown in the Drawings.

P. Item 14 – Leak Detection Geocomposite Material
   1. Measurement for payment will be made on a square foot basis of leak detection geocomposite installed, calculated based on surveys of the material accepted, performed in accordance with Section 01050 of these Specifications, or such other means of measurement that may be agreed between OWNER and CONTRACTOR.
   2. This unit price item shall include all materials necessary to install the leak detection geocomposite where shown on the Drawings and in accordance with the technical specifications and CQA Plan. This Work will include but not be limited to all material delivery, stockpiling, protection, necessary overlaps and anchor trenches.
   3. Unless ENGINEER has directed in writing that amount of leak detection geocomposite shall vary from the quantities shown on the Drawings, the payment quantity will not exceed the estimate in the Schedule of Values.

Q. Item 15 – Leak Detection Geocomposite Installation
   1. This lump item shall include all equipment, labor and appurtenance necessary to install the leak detection geocomposite material where shown on the Drawings and in accordance with the technical specifications and CQA Plan. This Work will include but not be limited to placement, connections, cleaning, securing, protecting, existing liner tie-in, anchor trenches, and testing involving leak detection geocomposite. No payment will be made for geocomposite placed outside of the anchor trench or where testing has indicated that the installed material does not meet the specified requirements. The lump sum price proposed shall be full compensation for performing all relevant requirements to achieve successful installation of geocomposite to the limits shown in the Drawings.

R. Item 16 – Primary HDPE Geomembrane Material
   1. Measurement for payment will be made on a square foot basis of primary HDPE geomembrane installed, calculated based on surveys of the material accepted, performed in accordance with Section 01050 of these Specifications, or such other means of measurement that may be agreed between OWNER and CONTRACTOR.
   2. This unit price item shall include all materials necessary to install the primary HDPE geomembrane where shown on the Drawings and in accordance with the technical specifications and CQA Plan. This Work will include but not be limited to all material delivery, stockpiling protection, wastage, necessary overlaps and anchor trenches. The unit price proposed shall be full compensation for purchase, deliver and stockpiling of geomembrane material required to the limits shown in the Drawings.
   3. Unless ENGINEER has directed in writing that amount of primary HDPE geomembrane shall vary from the quantities shown on the Drawings, the payment quantity will not exceed the estimate in the Schedule of Values.

S. Item 17 – Primary HDPE Geomembrane Installation
   1. This lump sum item shall include all equipment, labor and appurtenance necessary to install the primary HDPE geomembrane where shown on the Drawings and in accordance with the technical specifications and CQA Plan. This Work will include but not be limited to placement, connections, cleaning, securing, existing liner tie-in, necessary overlaps, anchor trenches and testing involving HDPE primary geomembrane. No payment will be made for HDPE geomembrane placed outside of the anchor trench or where testing has indicated that the installed material does not meet the specified requirements. The lump sum price proposed shall be full

compensation for performing all relevant requirements to achieve successful installation of geomembrane to the limits shown in the Drawings.

T. Item 18 – Leachate Collection Geocomposite Material
   1. Measurement for payment will be made on a square foot basis of leachate collection geocomposite installed, calculated based on surveys of the material accepted, performed in accordance with Section 01050 of these Specifications, or such other means of measurement that may be agreed between OWNER and CONTRACTOR.
   2. This unit price item shall include all materials necessary to install the leachate collection geocomposite where shown on the Drawings and in accordance with the technical specifications and CQA Plan. This Work will include but not be limited to all material delivery, stockpiling, protection, necessary overlaps and anchor trenches. The unit price proposed shall be full compensation for purchase, deliver and stockpiling of geocomposite material to the limits shown in the Drawings.
   3. Unless ENGINEER has directed in writing that amount of leachate collection geocomposite shall vary from the quantities shown on the Drawings, the payment quantity will not exceed the estimate in the Schedule of Values.

U. Item 19 – Leachate Collection Geocomposite Installation
   1. This lump item shall include all equipment, labor and appurtenance necessary to install the leachate collection geocomposite material where shown on the Drawings and in accordance with the technical specifications and CQA Plan. This Work will include but not be limited to placement, connections, cleaning, securing, protecting, existing liner tie-in, anchor trenches, and testing involving leachate collection geocomposite. No payment will be made for geocomposite placed outside of the anchor trench or where testing has indicated that the installed material does not meet the specified requirements. The lump sum price proposed shall be full compensation for performing all relevant requirements to achieve successful installation of geocomposite to the limits shown in the Drawings.

V. Item 20 –Protective Cover Layer
   1. This lump sum item is to include, but not be limited to, all necessary materials, equipment, transportation, and labor necessary to prepare and install protective cover layer above the leachate collection geocomposite. The Work will include but not be limited to all material identification and testing of off-site sources, hauling to the site, furnishing and installing the protective cover layer where shown on the Drawings and in accordance with the Specifications and CQA Plan. The CONTRACTOR shall locate the source of the material in this line item off the landfill property and the unit price shall include all transportation costs, borrow area permitting fees, and other incidentals related to this item. No payment will be made for protective drainage layer placed outside of the limits shown on the Drawings or where testing has indicated that the installed material does not meet the specified requirements or required depth. Costs for QC testing shall be included in this item. Prequalification testing shall be performed by the CONTRACTOR. Conformance testing will be performed by the CQA firm. The lump sum price proposed shall be full compensation for performing all relevant requirements to achieve successful installation of protective cover to the lines and grades as shown in the Drawings.

W. Item 21 –Leachate Collection/Detection/Chemical Injection Pipe Trench
   1. The lump sum price shall include, but not be limited to, all costs associated with supply and installation of the leachate collection/leak detection swales to the required minimum slopes including perforated/solid wall HDPE piping, chemical

injection pipes, blind flanges, pipe fittings, pipe welding, geonet, gravel, geotextile, cleanouts with concrete saddle, connecting to injection lines to leachate collection pipes and surveying. The lump sum price proposed shall be full compensation for performing all relevant requirements to achieve successful installation of leachate collection/detection/chemical injection pipe trench to the lines and grades and details shown in the Drawings.

X. Item 22 –Installation of Toe Drain_
   1. The lump sum price shall include, but not be limited to, all costs associated with supply and installation of the toe drain to the required minimum slopes including perforated/solid wall HDPE piping, blind flanges, pipe fittings, pipe welding, connecting to leachate collection pipes, gravel, geotextile, toe drain tie-in poles and surveying. The lump sum price proposed shall be full compensation for performing all relevant requirements to achieve successful installation of toe drain to the lines and grades and details shown in the Drawings.

Y. Item 23 –Leachate Collection and Leak Detection Sump
   1. The lump sum price for this item includes all costs required for supply and installation of the leachate collection and detection sumps. The work shall include, but not limited to, perforated and solid HDPE sideslope risers, blind flanges, piping and connections to leachate forcemain, aggregate, and HDPE boot to the leak detection sideslope riser pipes. Costs for QC testing shall be included in this item. This work shall include but is not limited to supply and installation of pumps, control panel, pipes, pipe supports, valves, grading, reinforced concrete slab, meters, pressure gauges, trenching, access points, bollards, mounting of control panel and appurtenances. The lump sum price proposed shall be full compensation for performing all relevant requirements to achieve successful installation of leachate collection/detection sump to the lines, grades and details as shown in the Drawings.

Z. Item 24 Installation of MPS-2
   1. This lump sum item shall consist of furnishing all equipment, materials, labor, appurtenances and installations required for proposed MPS-2 as required by the Contract Documents. This Work includes but is not limited to dewatering and excavation, gravel bedding, fabricate and installation of HDPE wetwell, anti-floating concrete, submersible pumps and floats, concrete pads, control panels, testing and installation of other appurtenances shown in the drawings. The lump sum price proposed shall be full compensation for performing all relevant requirements associated with installation of MPS-2 including excavation per Trench Safety Act. The lump sum price proposed shall be full compensation for performing all relevant requirements to achieve successful installation of MPS-2 as shown in the Drawings.

AA. Item 25 – Installation of Stormwater Conveyance System
   1. This lump sum item shall consist of furnishing all equipment, materials, labor, appurtenances and installations required for proposed stormwater conveyance system as required by the Contract Documents. This work includes but is not limited to fine grading to the lines and grades shown in the drawings and installation of topsoil followed by sod. The lump sum price proposed shall be full compensation for performing all relevant requirements to achieve successful installation of stormwater conveyance system to the lines, grades and details as shown in the Drawings.

BB. Item 26 – Cell Access Drive

1. The lump sum item shall include equipment, labor, transportation, and all else required to install the cell access drive as shown in the Drawings including RCP culverts and mitered end sections. No additional payment will be made for construction of access drive using onsite soil borrow sources, lime rock pavement from offsite, geotextile, equipment breakdown or protection of the work. The lump sum price proposed shall be full compensation for performing all relevant requirements to achieve successful installation of cell access drive to the lines and grades as shown in the Drawings.

CC. Item 27 – Monitoring Station Access Ramps

1. The lump sum item shall include equipment, labor, transportation, and all else required to install the monitoring station access ramps as shown in the Drawings including RCP culverts and mitered end sections. No additional payment will be made for construction of access ramps using onsite soil borrow sources, lime rock pavement from offsite, geotextile, equipment breakdown or protection of the work. The lump sum price proposed shall be full compensation for performing all relevant requirements to achieve successful installation of monitoring station access ramps to the lines and grades as shown in the Drawings.

DD. Item 28 – Expansion of Stormwater Pond

1. The lump sum item shall consist of furnishing all equipment, materials, labor, appurtenances and installations required for temporary coffer dams, dewatering, excavation and stockpiling of soil and surveying. This Work includes but is not limited to preparation of proposed pond dewatering plan, installation of observation piezometers, and construction and operation of dewatering system. The lump sum price proposed shall be full compensation for performing all relevant requirements to modify components associated with expansion of stormwater pond to the lines and grades shown in the drawings.

EE. Item 29 – Asphalt Pavement

1. The lump sum item shall include equipment, labor, materials, transportation, and all else required to construct asphalt pavement to the lines, grades and geometry shown on the Drawings. No additional payment will be made for fine grading and compaction of subgrade, geotextile, stone base, binder course or wearing course. The lump sum price proposed shall be full compensation for performing all relevant requirements to achieve successful installation of asphalt pavement to the lines, grades and details shown in the Drawings.

FF. Item 30 – Electrical Systems

1. The lump sum price for this item includes all work required to fully operate the pumps, control panels, lighting and electrical system. The work shall include, but not be limited to pump controls, pump connections, flow meter connections, running above ground and below ground electrical conduits, pull box installation, handhole installation, site lighting, generator connection, coordination with the power company and signal/communication lines. All necessary certifications, demonstrations, QC and production of record documents shall be included with this item. The lump sum price proposed shall be full compensation for performing all relevant requirements to achieve successful installation and operation of entire electrical system as indicated in the construction Drawings and Specifications.

END OF SECTION

SECTION 1200A
SCHEDULE OF VALUES - BID SCHEDULE

No.	Item	Quantity	Unit	Unit Cost	Total Cost
1	Mobilization, Demobilization and General Conditions	1	LS		$ -
2	Erosion and Sediment Control	1	LS		$ -
3	Surveying	1	LS		$ -
4	Groundwater Monitoring Well Installation	1	LS		$ -
5	Groundwater Monitoring Well Abandonment	1	LS		$ -
6	Leachate Forcemain	1	LS		$ -
7	Subsurface Dewatering within Project Limits	1	LS		$ -
8	Preparation of Subgrade	1	LS		$ -
9	Anchor Trenches and Liner Tie-in	1	LS		$ -
10	GCL Material	660,000	SF		$ -
11	GCL Installation	1	LS		$ -
12	Secondary HDPE Geomembrane Material	660,000	SF		$ -
13	Secondary HDPE Geomembrane Installation	1	LS		$ -
14	Leak Detection Geocomposite Material	660,000	SF		$ -
15	Leak Detection Geocomposite Installation	1	LS		$ -
16	Primary HDPE Geomembrane Material	660,000	SF		$ -
17	Primary HDPE Geomembrane Installation	1	LS		$ -
18	Leachate Collection Geocomposite Material	660,000	SF		$ -
19	Leachate Collection Geocomposite Installation	1	LS		$ -
20	Protective Cover Layer	1	LS		$ -
21	Leachate Collection/Detection/Chemical Injection Pipe Trench	1	LS		$ -
22	Installation of Toe Drain	1	LS		$ -
23	Leachate Collection and Leak Detection Sump	1	LS		$ -
24	Installation of MPS-2	1	LS		$ -
25	Installation of Stormwater Conveyance System	1	LS		$ -
26	Cell Access Drive	1	LS		$ -
27	Monitoring Station Access Ramps	1	LS		$ -
28	Expansion of Stormwater Pond	1	LS		$ -
29	Asphalt Pavement	1	LS		$ -
30	Electrical Systems	1	LS		$ -
				TOTAL BASE BID	$ -
				PERFORMANCE & PAYMENT BONDS	$ -
				TOTAL BID (BASE BID + PERFORMANCE AND PAYMENT BONDS)	$ -

This page intentionally left blank.

SECTION 01330
PROJECT MEETINGS AND ADMINISTRATION

PART 1 - GENERAL

1.1 PRECONSTRUCTION MEETING

A. OWNER will schedule a preconstruction meeting at the Project Site or other convenient location prior to commencement of construction activities. The meeting will be conducted to review responsibilities and personnel assignments.

B. Attendees: OWNER, ENGINEER, CQA Consultant, and CONTRACTOR and its superintendent, major subcontractors, manufacturers, suppliers and other concerned parties shall each be represented at the conference by persons familiar with, and authorized to, conclude matters relating to the Work.

C. Agenda: The agenda for the meeting will be developed by OWNER/ENGINEER and should include items of significance that could affect progress including such topics as:
   1. Tentative construction schedule.
   2. Critical work sequencing.
   3. Designation of responsible personnel.
   4. Construction quality control requirements.
   5. Construction quality assurance (CQA) procedures and protocols.
   6. Procedures for processing field decisions and Change Orders.
   7. Procedures for processing Applications for Payment.
   8. Distribution of Contract Documents.
   9. Submittal of shop drawings, product data, and samples.
   10. Preparation of record documents.
   11. Use of the premises including traffic controls.
   12. Office, work and storage areas.
   13. Equipment deliveries and priorities.
   14. Safety procedures.
   15. First aid.
   16. Security.
   17. Housekeeping.
   18. Working hours.
   19. Erosion and Sediment Control Requirements.
   20. Stop work orders and related regulatory compliance matters.

1.2 PROGRESS MEETINGS

A. Progress meetings will be conducted by CQA Consultant at the Project Site every week in the County offices. CQA Consultant will notify the OWNER and CONTRACTOR of scheduled meeting dates.

B. In addition to CQA Consultant, the OWNER, and CONTRACTOR, each subcontractor, supplier or other entity concerned with current progress or involved in planning, coordination or performance of future activities shall be represented at these meetings by persons familiar with the project and authorized to conclude matters relating to progress.

C. The CQA Consultant will distribute copies of minutes of the meeting to each party present and to other parties who should have been present. The minutes will include a brief summary, in narrative or bulleted form, of progress since the previous meeting.

1.3 PROBLEM OR WORK DEFICIENCY MEETING

A. A special meeting shall be held when and if a problem or deficiency is present or likely to occur. At a minimum, the meeting shall be attended by OWNER, ENGINEER, CQA Consultant, CONTRACTOR, and any affected subcontractors. The purpose of the meeting shall be to define and resolve the problem or work deficiency.

B. The meeting shall be documented by CQA Consultant and minutes shall be transmitted by CQA Consultant to the meeting attendees and others as appropriate.

1.4 CORRESPONDENCE

A. All correspondence to ENGINEER, plus copy to OWNER, shall be submitted in original plus two copies, unless otherwise specified.

1.5 PROGRESS SCHEDULES

A. Throughout the project, CONTRACTOR shall furnish in duplicate, graphic type construction progress schedules, listing trade divisions and all parts of work, and showing the planned starting date and completion time for each part of the work. The scheduled completion date shall conform to the contract completion time. The schedule format and starting and completion dates shall be as approved by OWNER and ENGINEER. A proposed construction schedule shall be provided at the preconstruction conference, and shall be updated and distributed to the Owner and CQA Engineer every two weeks throughout the duration of the Contract. An acceptable construction schedule must be submitted and approved before the Notice to Proceed will be given. All requests for Change Orders shall be accompanied by a discussion of the impact on schedule; requests for Change Order will not be reviewed without schedule impact discussion.

1.6 ADMINISTRATION OF CONTRACT

A. CONTRACTOR shall follow the Drawings strictly and execute all Work in accordance therewith, and with the kind and quality of materials set forth in the Specifications, using the figured dimensions marked on the Drawings and not scaled measurements.

B. The Specifications and Drawings shall be coordinated, so that any work shown on the Drawings and not mentioned in the Specifications, and vice-versa, shall be executed in the same manner as though mentioned in the Specifications and shown on the Drawings.

C. CONTRACTOR shall furnish and install such work and material as may be proper and suitable preparation, basis, support, or finish for the Work which is shown or specified, whether or not the same is specifically mentioned in the Specifications or shown on the Drawings. CONTRACTOR shall be required to make plural and complete work that is shown single or partially indicated to avoid needless repetition, for the sake of brevity, and for reasons of clarity. In all cases, the intent and meaning of the Drawings and Specifications, as defined herein, shall be followed. CONTRACTOR shall not avail himself of any errors or omissions therein, should any exist, which may be in conflict therewith.

1.7 PROJECT RECORD DOCUMENTS

A. Documents: CONTRACTOR shall maintain at the Project Site one copy of all Drawings, Specifications, CQA Plan, Addenda, approved Shop Drawings, Change Orders, Field Orders, other Contract Modifications, product data and samples, record documentation, and other approved documents submitted by CONTRACTOR in compliance with various sections of these Specifications.

B. Identification and Maintenance: The Project Record Documents maintained at the Project Site by CONTRACTOR shall be clearly marked “Project Record Copy”, maintained in good condition, available at all times for inspection by OWNER, ENGINEER, and CQA Consultant, and not used for construction purposes.

C. Records:
   1. CONTRACTOR shall mark up and maintain a copy of the most recent Contract Documents (Drawings, CQA Plan and Specifications) to show:
      a. Significant changes made during the construction process; and
      b. Details not shown in the original Contract Documents.
   2. The information given on the mark-up documents shall include, but shall not be limited to:
      a. The location of underground utilities and appurtenances, referenced to permanent surface improvements;
      b. The location of internal utilities and appurtenances, referenced to permanent surface improvements;
      c. Any relocation of concealed structural components; and
      d. Other changes as directed by OWNER, ENGINEER, or CQA Consultant.
   3. CONTRACTOR shall keep Project Record Documents current. CQA Consultant will review the drawings biweekly on a schedule agreed to by CONTRACTOR and CQA Consultant.
   4. The Project Record Documents shall be kept on the Project Site, amended as changes occur, and returned to OWNER with claim for final Application for Payment.

END OF SECTION

This page intentionally left blank.

SECTION 01350
SUBMITTALS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section includes requirements for Shop Drawings, Working Drawings, Record Drawings, certificates of compliance, manufacturer's certifications, manufacturer's instructions, and other items required to be submitted by CONTRACTOR for acceptance by OWNER and ENGINEER. Approval of the submittals by ENGINEER does not relieve the CONTRACTOR from compliance with Contract Documents.

1.2 SUBMITTAL LIST AND SCHEDULE

A. Within 10 days of the Notice of Agreement, CONTRACTOR shall submit a Submittal Schedule to ENGINEER of all submittals that will be made and the dates that they will be submitted, subject to approval of ENGINEER. The approved list will be used by ENGINEER and CONTRACTOR throughout the project to communicate submittal requirements and responsibilities.

1.3 SUBSTITUTIONS

A. Whenever an item of material or equipment is specified or described in the Contract Documents by using the name of a proprietary item or the name of a particular Supplier, the specification or description is intended to establish the type, function, appearance, and quality required. Unless the specification or description contains or is followed by words reading that no like, equivalent, or "equal" item or no substitution is permitted, other items of material or equipment of other Suppliers may be submitted to ENGINEER for review under the circumstances described below.

B. "Or-Equal" Items: If in ENGINEER and OWNER's discretion an item of material or equipment proposed by CONTRACTOR is functionally equal to that named and sufficiently similar so that no change in related Work will be required, it may be considered by ENGINEER and OWNER as an "or-equal" item, in which case review and approval of the proposed item may, in ENGINEER and OWNER's discretion, be accomplished without compliance with some or all of the requirements for approval of proposed substitute items. For the purposes of this paragraph, a proposed item of material or equipment will be considered functionally equal to an item so named if:
   1. In the exercise of reasonable judgment ENGINEER and OWNER determines that: (i) it is at least equal in quality, durability, appearance, strength, and design characteristics; (ii) it will reliably perform at least equally well the function imposed by the design concept of the completed Project as a functioning whole, and;
   2. CONTRACTOR certifies that: (i) there is no increase in cost to the OWNER; and (ii) it will conform substantially, even with deviations, to the detailed requirements of the item named in the Contract Documents.

C. Substitute Items
   1. If in ENGINEER and OWNER's discretion an item of material or equipment proposed by CONTRACTOR does not qualify as an "or-equal" item under paragraph 1.03.A.1, it will be considered a proposed substitute item.

2. CONTRACTOR shall submit sufficient information as provided below to allow ENGINEER and OWNER to determine that the item of material or equipment proposed is essentially equivalent to that named and an acceptable substitute therefore. Requests for review of proposed substitute items of material or equipment will not be accepted by ENGINEER and OWNER from anyone other than CONTRACTOR.
3. The procedure for review by ENGINEER and OWNER will be as set forth in paragraph 1.03.B.4, as supplemented in the General Requirements and as ENGINEER and OWNER may decide is appropriate under the circumstances.
4. CONTRACTOR shall first make written application to ENGINEER and OWNER for review of a proposed substitute item of material or equipment that CONTRACTOR seeks to furnish or use. The application shall certify that proposed substitute item will perform adequately the function and achieve the results called for by the general design, be similar in substance to that specified, and be suited to the same use as that specified. The application will state the extent, if any, to which the use of the proposed substitute item will prejudice CONTRACTOR's achievement of Substantial Completion on time, whether or not use of the proposed substitute item in the Work will require a change in any of the Contract Documents (or in the provisions of any other direct contract with ENGINEER and OWNER for work on the Project) to adapt the design to the proposed substitute item and whether or not incorporation or use of the proposed substitute item in connection with Work is subjected to payment of any license fee or royalty. All variation of proposed substitute item from that specified will be identified in the application, and available engineering, sales, maintenance, repair, and replacement services will be indicated. The application will also contain an itemized estimate of all costs or credits that will result directly or indirectly from use of such substitute item, including costs of redesign and claims of other contractors affected by any resulting change, all of which will be considered by ENGINEER and OWNER in evaluating the proposed substitute item. ENGINEER and OWNER may require CONTRACTOR to furnish additional data about the proposed substitute item.

D. Substitute Methods or Procedures: If a specific means, method, technique, sequence, or procedure of construction is shown or indicated in and expressly required by the Contract Documents, CONTRACTOR may furnish or utilize a substitute means, method, technique, sequence, or procedure of construction approved by ENGINEER and OWNER. CONTRACTOR shall submit sufficient information to allow ENGINEER and OWNER, in ENGINEER and OWNER's sole discretion, to determine that substitute proposed is equivalent to that expressly called for by the Contract Documents. The procedure for review by ENGINEER and OWNER will be similar to that provided in subparagraph 1.03A.

E. Engineer and Owner's Evaluation: ENGINEER and OWNER will be allowed a reasonable time within which to evaluate each proposal or submittal made pursuant to paragraphs 1.03A and 1.03B. ENGINEER and OWNER will be sole judge of acceptability. No "or-equal" or substitute will be ordered, installed or utilized until ENGINEER and OWNER's review is complete, which will be evidenced by either a Change Order for a substitute or an approved Shop Drawing for an "or equal." ENGINEER or OWNER will advise CONTRACTOR in writing of any negative determination.

F. Special Guarantee: OWNER may require CONTRACTOR to furnish at CONTRACTOR's expense a special performance guarantee or other surety with respect to any substitute.

G. ENGINEER's Cost Reimbursement: ENGINEER will record time required by ENGINEER and ENGINEER's Consultants in evaluating substitute proposed or submitted by CONTRACTOR pursuant to this Section and in making changes in the Contract Documents (or in the provision of any other direct contract with OWNER for work on the Project) occasioned thereby. Whether or not ENGINEER approves a substitute item so proposed or submitted by CONTRACTOR, CONTRACTOR shall reimburse OWNER for the charges of ENGINEER and ENGINEER's Consultants for evaluating each such proposed substitute.

H. CONTRACTOR's Expense: CONTRACTOR shall provide all data in support of any proposed substitute or "or-equal" at CONTRACTOR's expense.

I. An offer of a substitute article or material by CONTRACTOR, not specified herein, will raise the presumption that it is for the purpose of saving money. If, in such case, the article or material is accepted, OWNER shall be given credit as follows: the difference in the net cost to CONTRACTOR of the article or material submitted and the price at which it could have obtained the lowest priced article or material specified. For convenience in checking the credit, CONTRACTOR shall submit these figures with each substitute submittal, and no article or materials will be considered without such figures.

J. If, subsequent to award of the Contract, it becomes necessary because of the inability of CONTRACTOR to obtain any items or material as specified or the equal thereof, within a reasonable time frame, and could possibly cause future delays in the project, ENGINEER, at his discretion, may authorize use of substitute items or materials of the same, greater, or less cost than those specified. The review procedures shall be the same as in Part 1.03.B.4. The procedure for review by ENGINEER will be as set forth in paragraph 1.03.B.4, as supplemented in the General Requirements and as ENGINEER may decide is appropriate under the circumstances.

K. In such cases as described in Paragraphs 1.03A and B above, CONTRACTOR shall submit, in writing, his request before 30 days of proposed use for permission to make a substitution and shall furnish full information as to costs of the item or material specified and the item or material to be substituted therefore. Such information shall be in such form and detail as to permit OWNER to check, to its satisfaction, the costs involved. Upon acceptance of the substitution, when the cost thereof is greater or less, ENGINEER will authorize, in writing, the proper credits to be allowed OWNER, or the proper additional payments to be made to CONTRACTOR. Payment adjustments shall represent the difference between the net cost to CONTRACTOR of the accepted substituted item or material and the price at which he could have obtained the lowest priced items or material specified.

L. The decisions of ENGINEER, from time to time as to the proper credits to be allowed to OWNER, or proper payments to be made to CONTRACTOR, or substitutions to be allowed, shall be final.

1.4 IDENTIFICATION

A. The Shop and Working Drawings shall have the following identification data contained thereon or permanently attached thereto.

B. Project Name, Contract Number, and description of item.

C. Submittal Number. Shop Drawings and Working drawings shall be numbered sequentially in order of original submission. Re-submittals shall include the original submittal number and shall be lettered sequentially (i.e., A, B, ...). CONTRACTOR shall maintain the submittal log in current and correct condition.

1.5 SHOP DRAWINGS

A. CONTRACTOR shall submit for ENGINEER's acceptance the requisite number of complete detailed Shop Drawings of all materials, equipment, accessories, and appurtenances specified herein or shown on the Drawings prior to the fabrication, installation, or incorporation of the specified materials, equipment, accessories, and appurtenances in the Work.

B. Shop Drawings are generally defined as all drawings, diagrams, illustrations, brochures, schedules, and other data that are prepared by CONTRACTOR, a subcontractor, manufacturer, fabricator, supplier, or distributor, which illustrate how specific portions of the Work shall be fabricated or installed.

C. All Shop Drawings shall conform to the Contract Documents. All Shop Drawings shall be to scale, shall be accurate and distinct, and shall give all dimensions required for the fabrication, installation, and incorporation of the specified items in the Work. Wherever the location of any of the materials, equipment, accessories, and appurtenances is not shown on the Drawings, CONTRACTOR shall furnish prints of Shop Drawings for the purpose of giving the exact location in plan and in elevation of the said materials, equipment, accessories, and appurtenances.

D. Transmittals may be made electronically.
1. Use email.
2. Use Contractor's Submittal Certification Form included with this Section.
3. Protocols and processes will be determined at the Pre-Construction Conference.
4. Shop Drawings for a particular component shall be submitted complete at least 14 days prior to the anticipated date of furnishing or installation of the particular component, unless an alternative schedule is given elsewhere in the Specifications. Shop Drawings will be reviewed and returned to CONTRACTOR within 7 days unless otherwise indicated.

1.6 WORKING DRAWINGS FOR CHANGES, SUBSTITUTIONS, AND CONTRACTOR DESIGN ITEMS

A. Working Drawings shall be submitted 30 days before changes to the Work and substitutions requested by CONTRACTOR, and for CONTRACTOR design items.

B. Working Drawings and calculations shall be certified by a registered Professional Engineer licensed in the State of Florida and shall be accompanied by calculations or other sufficient information to explain in complete detail the proposed method of construction. The information should be submitted to the ENGINEER before 30 days of proposed use.

C. Submission and review by the CQA Consultant for Working drawings shall be as stipulated herein.

D. The acceptance of Working Drawings is not to be taken or construed to mean that they have been examined in detail and shall not relieve CONTRACTOR in any way from its responsibility regarding fulfillment of the terms of the Contract. OWNER will not be

responsible for errors on the Working Drawings furnished by CONTRACTOR, even though the Working Drawings containing such errors are inadvertently accepted. Working drawings shall, upon acceptance by the CQA consultant, become a part of the Contract Documents.

1.7 ON-SITE RECORDS

A. CONTRACTOR shall keep one record copy of all Contract Documents and Shop Drawings at the site in good order and annotated to show all changes made during the manufacturing, supply and delivery process. Such annotations shall be kept current. These items shall be available to ENGINEER, CQA Consultant, and OWNER at all times.

1.8 CERTIFICATES OF COMPLIANCE

A. CONTRACTOR's attention is directed to the fact that it shall be required to furnish to the CQA Consultant notarized certification for various items specified elsewhere herein. The material or equipment manufacturer shall certify in writing that the material supplied is in compliance with the requirements stipulated in the Contract Documents.

1.9 MANUFACTURER'S CERTIFICATION

A. CONTRACTOR's attention is directed to the fact that it will be required to furnish to the CQA Consultant notarized manufacturers' certifications for major equipment and materials specified elsewhere herein. For items of equipment so stipulated, a qualified and authorized manufacturer's representative shall inspect the equipment or machinery both at rest and in operation, and shall certify to CONTRACTOR, in writing, that the equipment has been installed, serviced, adjusted and calibrated properly and is ready for continuous operation under the specified conditions of service. The CQA Consultant will reject such manufacturer certification when, in his judgment, equipment and machinery have been improperly installed, serviced, adjusted or calibrated, or given evidence of unsatisfactory operation.

1.10 MANUFACTURER'S WARRANTY

A. CONTRACTOR's attention is directed to the fact that it will be required to furnish to the CQA Consultant notarized manufacturers' warranties for major equipment items specified elsewhere herein. The form for this manufacturer's warranty for equipment is included on the following page. In requesting pricing from equipment suppliers, the bidder shall inform them that equipment manufacturers will be required to execute the written manufacturer's warranty. This warranty shall be executed personally by an officer of the company manufacturing the equipment, with the authority to bind the manufacturer. The executed warranty shall be submitted in duplicate with the Shop Drawing for the equipment within 30 days of proposed use. This warranty shall be in addition to any other warranties or certifications required by the Contract Documents.

MANUFACTURER'S WARRANTY AGREEMENT

This Warranty furnished by _____ of_____ (hereafter Manufacturer) on this day of _____to the Lee County Board of County Commissioners (hereafter, OWNER) is furnished with full knowledge that OWNER has relied on CONTRACTOR's understanding of the requirement for this Warranty in awarding the contract, that the bid price to CONTRACTOR shall include any amount necessary to cover potential risks to Manufacturer from this Warranty, and that this Warranty is in addition to any other warranties or certifications required by the Contract Documents, any other documents, laws, or regulations offered by the Manufacturer or CONTRACTOR to the purchaser or user of this material.

Manufacturer hereby warrants that it has reviewed all of the Contract Drawings and Specifications for this project and that the material bid on and listed below is fit for the particular purpose for which it is to be used in this project as set forth in the Contract Drawings and Specifications. CONTRACTOR hereby warrants that if the product fails in the first year of service or if, within the first year, evidence that the product will ultimately fail as a result of unsuitability for the application, CONTRACTOR shall repair or replace the product at no cost to OWNER. The venue for any dispute will be in Lee County, FL.

Project: Cells 11A, 11B and 12 Construction, Lee/Hendry County Landfill, Florida

Name of Equipment:

Model Number:

Serial Number(s):

NOTE: NO EXCEPTIONS OR LIMITATIONS WILL BE ALLOWED ON THIS WARRANTY UNLESS FULLY DISCLOSED AND ALLOWED BY THE OWNER BEFORE BIDS ARE OPENED. ANY UNALLOWED EXCEPTION OR LIMITATION ON THIS WARRANTY MAY CAUSE THE BID TO BE DISQUALIFIED.

_____	_____
MANUFACTURER	CONTRACTOR
_____ (Seal)	_____
(Seal) Signature	Signature
_____	_____
Name and Title (print or type)	Name and Title (print or type)

Witness:
by:_____ (Seal)

SUBSTITUTION REQUEST FORM

Project: Cells 11A, 11B and 12 Construction
Lee/Hendry County Landfill

Substitution Request No: _____
From: _____
Date: _____

To: HDR Engineering, Inc.
76 S. Laura Street, Ste. 1600
Jacksonville, FL 32202

RE: _____

Specification Title: _____ Description: _____
Section: _____ Page: _____ Article/Paragraph: _____

Proposed Substitution: _____
Manufacturer: _____Address: _____Phone: _____
Trade Name: _____ Model No.: _____

Attached data includes product description, specifications, drawings, photographs, and performance and test data adequate for evaluation of the request: applicable portion of the data are clearly identified.

Attached data also includes a description of changes to the Contract Documents that the proposed substitution will require for its proper installation.

If a request is submitted with inadequate documentation, it will be rejected.

The undersigned certifies:

- Proposed substitution has been fully investigated and determined to be equal or superior in all respects to specified product.
- Same warranty will be furnished for proposed substitution as for specified product.
- Same maintenance service and source of replacement parts, as applicable, is available.
- Proposed substitution will have no adverse effect on other trades and will not affect or delay progress schedule.
- Proposed substitution does not affect dimensions and functional clearances.
- Payment will be made by the undersigned for changes to building design, including A/E design, detailing, and construction caused by substitution.

Submitted by: _____
Signed by: _____
Bidders Name: _____
Address: _____
Telephone: _____

Engineer Review and Action

_____ Substitution Approved
_____ Substitution Approved as Noted
_____ Substitution Rejected
_____ Substitution Request Received after Expiration Date

Signed By: _____ Date: _____

Supporting Data Attached:

_____ Drawings _____ Product Data _____ Samples _____ Tests _____Report

Contractor's Submittal Certification

Shop Drawing Transmittal No.: _____

Contract/Project Name: **Lee/Hendry County Landfill, Cells 11A, 11B and 12 Construction**

Company Name: _____

has

1. reviewed and coordinated this Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the Work and the Contract Documents;

2. determined and verified all field measurements, quantities, dimensions, specified performance and design criteria, installation requirements, materials, catalog numbers, and similar information with respect thereto;

3. determined and verified the suitability of all materials offered with respect to the indicated application, fabrication, shipping, handling, storage, assembly, and installation pertaining to the performance of the Work; and

4. determined and verified all information relative to Contractor's responsibilities for means, methods, techniques, sequences, and procedures of construction, and safety precautions and programs incident thereto.

☐ This Submittal **does not** contain any variations from the requirements of the Contract Documents.

☐ This Submittal **does** contain variations from the requirements of the Contract Documents. A separate description of said variations and a justification for them is provided in an attachment hereto identified as:

"Shop Drawing Transmittal No. _____Variation and Justification Documentation"

Insert picture file or electronic signature of Authorized Representative

_____ _____

Authorized Representative Date

Revision Log

END OF SECTION

SECTION 01550
TEMPORARY FACILITIES AND TEMPORARY CONTROLS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This section includes descriptions of temporary facilities and controls necessary for the Work.

1.2 STANDARDS

A. In addition to compliance with all governing regulations and standards, and/or rules and recommendations of franchised utility companies, comply with specific requirements indicated and with applicable local industry standards for construction work. Whenever OWNER's facility standards are more stringent, the OWNER's facility standards shall apply. Obtain inspections and permits as required.

1.3 JOB CONDITIONS

A. Establish and initiate use of each temporary facility at time first reasonably required for proper performance of the Work. Terminate use and remove facilities at earliest reasonable time, when no longer needed or when permanent facilities have, with authorized use, replaced the need.

B. Install, operate, maintain and protect temporary facilities in a manner and at locations that will be safe, non-hazardous, sanitary and protective for persons and property, and free of deleterious effects.

1.4 JOB CONDITIONS

A. Ten (10) days prior to the installation of temporary facilities, CONTRACTOR shall submit copies of any permits required for temporary facilities. All permits shall be posted as required by applicable regulations for such facilities.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 TEMPORARY UTILITY SERVICES

A. Where possible and reasonable, connect to existing utilities for required services. Locate and relocate services (as necessary) to minimize interference with construction operations.

B. CONTRACTOR shall be responsible for maintaining utility connections and for payment of all fees resulting from usage of all temporary facilities, including those facilities used by the OWNER and ENGINEER at the site during the execution of the work under this Contract.

3.2 TEMPORARY CONSTRUCTION FACILITIES

A. The types of temporary construction facilities required may include, but not be limited to, dewatering equipment, toilet facilities, electrical power distribution, lighting, telephone facilities and roads. Provide facilities reasonably required to perform construction operations properly and adequately. Provide either new or used materials and equipment that are in good condition.
   1. Enclosure
      a. Provide temporary enclosures for the work, where reasonably required to ensure adequate workmanship and protection from weather and unsatisfactory ambient conditions, including enclosures where temporary heat is used.
   2. Electrical Power
      a. Provide weatherproof, grounded, power distribution system sufficient to accommodate construction operations requiring power, field offices, use of power tools, electrical heating, lighting and start-up testing of permanent electric powered equipment prior to its permanent connection to electrical systems. Provide overload protection. The installation shall comply with all applicable electrical and safety codes.
      b. Supply power for electric welding, if any, from either temporary power distribution system or by engine-driven power generator sets, at CONTRACTOR's option.
      c. CONTRACTOR shall provide all necessary temporary power for execution of the Work. NO TEMPORARY ELECTRICAL POWER IS AVAILABLE FROM OWNER. The CONTRACTOR shall comply and make all necessary arrangements with the local power utility for the temporary service at CONTRACTOR's own cost.
   3. Lighting
      a. Provide sufficient temporary lighting to ensure proper workmanship everywhere by combined use of daylight, general lighting and portable plug-in task lighting.
   4. Temporary Heat
      a. The CONTRACTOR shall provide temporary heat when required to maintain temperatures within limits recommended by a MANUFACTURER for the installation of his products or as specified.
   5. Access Provisions
      a. Provide ramps, ladders and similar temporary access elements as reasonably required to perform the work and facilitate its inspection during execution. Comply with reasonable requests of governing authorities performing inspections.
   6. Temporary Water
      a. The CONTRACTOR shall furnish all water required during his operations to complete the work under this Contract.
      b. The CONTRACTOR, at the commencement of the work, shall make the necessary arrangements to provide a temporary water supply at the site during construction operations. This water supply shall be for the use of all trades employed on the work and shall be obtainable at various locations.
      c. The CONTRACTOR shall furnish and install as required: all pipe, bases, tanks, receptacles, meters, backflow preventions valves, equipment and accessories necessary for the conveyance and application of water to the construction work.
      d. All water for drinking purposes shall be potable and shall be conveyed in sanitary tanks or receptacles.

e. Water for construction purposes shall be free from oil, acid, alkali, salt, vegetable matter, organic matter or other deleterious substances.
f. Non-potable water shall be obtained from on-site stormwater management ponds depending on the availability. CONTRACTOR is responsible for pumping out non-potable water and delivering to the site.

3.3 TEMPORARY SUPPORT FACILITIES AND EQUIPMENT

A. The types of temporary support facilities required include, but not by way of limitation, field offices, storage sheds, fabrication sheds, sanitary facilities, drinking and service water, first aid facilities, waste disposal service, and similar miscellaneous general services, all as may be reasonably required for proficient performance of the Work. Locate temporary support facilities for convenience of users, and for minimum interference with OWNER operations.
   1. CONTRACTOR's Field Office (Optional)
      a. The CONTRACTOR may provide and maintain a separate field office and telephone for use of his job representative throughout the course of the job.
      b. The CONTRACTOR shall provide, furnish, maintain and pay all janitor service, telephone and electricity charges for CONTRACTOR's Field Offices.
      c. The CONTRACTOR's Field Office shall be in a single location on the property as approved by the OWNER. CONTRACTOR shall be responsible for any and all damages, direct or indirect of whatever nature, occurring to the property that is kept in the Field Office. Such damages would include any loss caused by, but not limited to, fire, theft, vandalism or malicious mischief.
      d. The CONTRACTOR'S Field Office is not compulsory. In the event the CONTRACTOR does not bring a field office, the CONTRACTOR will not be allowed to share any facilities with the OWNER.
   2. CONTRACTOR's Sanitary Facilities (Required)
      a. CONTRACTOR shall provide self-contained toilet units of type acceptable to governing authorities, adequate (at all stages of construction) for use of CONTRACTOR and CQA Consultant personnel at project site. Provide separate facilities for male and female personnel when both sexes are working, in any capacity, at project site.
   3. CONTRACTOR and designated subcontractors shall not utilize the OWNER's present facilities and are restricted to the areas in which they have authorized work assignments.
   4. CQA Consultant shall designate to CONTRACTOR an on-site location for storage of large equipment and material laydown areas. The CQA Consultant shall also designate the locations of all trailers. These locations are provided on the Construction drawings.
   5. CONTRACTOR shall not post signs other than those required by the Contract during the performance of his work.

3.4 SECURITY/PROTECTION PROVISIONS

A. General
   1. The types of temporary security and protection provisions required may include, but are not limited to, fire protection, barricades, warning signs/lights, building enclosure/lockup, personnel security program (theft prevention), environmental protection, and similar provisions intended to minimize property losses, personal injuries and claims for damages at project site.

B. Fire Extinguishers
   1. Provide types, sizes, numbers and locations as would be reasonably effective in extinguishing fires during early stages, by personnel at project site. Provide Type A extinguishers at locations of low-potential for either electrical or grease/oil/flammable liquids fires, provide Type ABC dry chemical extinguishers at other locations; comply with recommendations of NFPA No. 10. Post warning and quick response instructions at each extinguisher location, and instruct all personnel at project sites at time of their first arrival, on proper use of extinguishers and other available facilities at project site. Post local fire department call number on each telephone instrument at project site.

3.5 NOISE CONTROL

A. CONTRACTOR's vehicles and equipment shall be configured in a manner that minimizes noise to the greatest degree practicable. Noise levels shall conform to the latest OSHA minimum standards (i.e., lowest decibel level allowable) and in no case will noise levels be permitted which interfere with the Work of OWNER or others.

3.6 DUST CONTROL

A. CONTRACTOR shall be responsible for controlling dust caused from his operation of vehicles and equipment, from clearing or grubbing, grading, fill placement, travel, or any other activities within the Work area. CONTRACTOR shall apply water or use other methods to keep dust in the air to a minimum, subject to the approval of OWNER.

3.7 FIRE PREVENTION CONTROL

A. CONTRACTOR shall take all precautions necessary to prevent fires and explosions. CONTRACTOR is hereby advised that flammable and explosive gases are naturally generated at the existing landfill.

B. Fuel for cutting and heating torches shall be contained in containers approved by the Underwriter's Laboratory.

C. CONTRACTOR shall furnish and maintain a 20-pound maximum capacity dry chemical type fire extinguisher in the immediate vicinity of the Work when welding tools or torches of any type are in use.

D. No smoking or open flame is permitted on landfill property.

3.8 POLLUTION CONTROL

A. CONTRACTOR shall provide methods, means and facilities required to prevent contamination of soil, water, or atmosphere by discharges from construction operations.

B. CONTRACTOR's equipment used during construction shall conform to current federal, state, and local laws and regulations regarding pollution control.

3.9 ROADS, ACCESS AND TRAFFIC REGULATION

A. Use of existing site access roads will be permitted to CONTRACTOR's personnel who lawfully frequent the site.

B. Existing roads shall be kept open by CONTRACTOR for the passage of vehicular traffic and pedestrians during the construction period unless otherwise approved by OWNER.

C. Control and maintain traffic within the project area. Supply traffic control personnel if directed by ENGINEER. Provide signs, signals, barricades, lights and personnel to regulate all traffic and to warn vehicles and personnel of hazards. Such Work shall conform to the requirements of authorities having jurisdiction and as required by OWNER.

D. Construct and maintain temporary roads required for excavation operations, fill hauling operations, and disposal of excavated material.

E. Provide and maintain traffic control and maintenance devices, including, but not limited to, flag-persons, advance warning sign barricades, traffic cones. Use of such control and maintenance devices shall be in accordance with the current edition of the “Manual on Uniform Traffic Control Devices for Streets and Highways” as prepared by the National Joint Committee on Uniform Traffic Control Devices, and other applicable codes and standards.

F. Landfill equipment and public vehicles shall have continuous access to disposal areas and facilities during this project.

G. Provide for access by emergency traffic, such as police, fire, and disaster units at all times. CONTRACTOR shall be liable for damages resulting from failure to provide such access.

3.10 ACCESS ROUTES AND PARKING AREAS

A. Routes of ingress and egress to the location of the Work shall be clearly marked by CONTRACTOR and approved by OWNER before use by CONTRACTOR.

B. CONTRACTOR shall store materials and perform the Work so that pedestrian and vehicular traffic is not impeded at access routes and parking areas.

C. CONTRACTOR shall maintain storage and Work areas free of debris and obstructions.

D. CONTRACTOR is responsible for providing security at any construction entrances to the facility.

3.11 PROTECTION OF PERSONNEL, WORK, AND PROPERTY

A. CONTRACTOR shall protect all streets and sidewalks and shall make all necessary repairs at its own expense to same, where he is required to disturb the existing walks or streets, or where existing streets or walks become damaged from activities associated with the new construction Work.

B. CONTRACTOR shall construct and maintain all necessary temporary drainage and do all pumping necessary to keep the affronted excavations and all other Work free of water, no matter what the source. CONTRACTOR IS FULLY AND SOLELY RESPONSIBLE FOR PROTECTION OF THE WORK FROM STORM WATER RUN ON, RUN OFF, SEDIMENTATION, EROSION, AND ALL OTHER POTENTIAL WEATHER-RELATED IMPACTS TO THE WORK AND THE PROJECT.

C. CONTRACTOR shall provide all shoring, bracing, and sheeting for safety and for the proper execution of the Work and have same removed when Work is completed.

D. CONTRACTOR shall provide and maintain guard lights at all barricades, railing obstructions in streets, roads, or sidewalks and at all trenches or pits adjacent to public walks or roads or otherwise accessible to the public.

E. Any Work damaged by failure to provide the protection required above shall be removed and replaced with new Work at CONTRACTOR's expense.

F. Install stop signs when temporary road intersect the Facility's main haul road so that the Facility customers and Facility employees always have right-of-way.

3.12 TEMPORARY SIGNS

A. No sign or advertisement, except the project identification sign, shall be allowed to be displayed without OWNER's approval. Should directional signs be required, such signs shall be of size, color and lettering to meet with OWNER's and ENGINEER's approval.

3.13 CONSTRUCTION EQUIPMENT

A. CONTRACTOR shall provide construction equipment and operating personnel necessary to perform its Work.

B. CONTRACTOR shall provide equipment with proper guys, bracing, and other safety devices as required by local or State codes.

C. CONTRACTOR shall provide all scaffolding, staging, platforms, temporary flooring, railing, stairs, etc., as required by local and State laws and codes for the protection of Workmen and the public.

3.14 PROTECTION

A. CONTRACTOR shall replace and put in good condition every public and private way, catch basin, pipe, trees, fence or things injured in carrying out the contract, unless the same shall be permanently done away with by order of ENGINEER as being unnecessary for the proper execution of the Contract.

B. CONTRACTOR shall take all proper precautions to protect persons from injury and unnecessary interference or inconvenience. CONTRACTOR shall leave an unobstructed way along paths and private places for pedestrians and vehicles and for access to hydrants.

C. The location of any construction fencing, and areas for on-site storage of equipment and other facilities required by CONTRACTOR shall be subject to approval by ENGINEER.

3.15 PUMPING

A. CONTRACTOR shall provide and maintain pumps of the number and size necessary to control stormwater and groundwater within, running on, and running off of the Work area. Pump discharge location(s) shall be approved by OWNER prior to pumping. CONTRACTOR shall assume full and complete responsibility for controlling stormwater within, running on, and running off the Work area, and shall be liable for uncontrolled releases of stormwater.

3.16 TRUCKING

A. All trucks bringing to or removing from the site, earth, loose materials or debris shall be loaded in a manner to prevent dropping of materials on streets.

B. At all points, where trucks leave the project site and enter adjacent paved streets, CONTRACTOR shall maintain a crew to prevent any mud from being carried onto such adjacent paved streets.

C. Earth, loose materials or debris deposited on the streets due to contract trucking activities shall be removed daily.

D. All trucks entering or leaving the project shall be covered by a tarp.

3.17 ODOR AND FUGITIVE EMISSION CONTROL

A. CONTRACTOR shall control to the greatest degree practical, as determined by OWNER, the emission of odors and other fugitive emissions from the Work including, but not limited to, gas, dust, and litter.

3.18 RELOCATION AND REMOVALS

A. Should a change in location of a temporary facility be necessary in order to promote progress of the Work, CONTRACTOR shall remove and relocate such items as directed without additional cost to OWNER.

B. CONTRACTOR shall remove temporary facilities when they are no longer required. Restore permanent facilities used for or connected to temporary facilities to their original or better condition.

3.19 CONTRACTOR'S USE OF PREMISES

A. The limits of the area allocated for use by CONTRACTOR for storage and Work operations is indicated on the Drawings. If additional space is available and OWNER's approval for use of such space is given, CONTRACTOR may have use of other areas of the site.

B. CONTRACTOR shall:
   1. not unreasonably encumber the site with materials or equipment;
   2. not load or surcharge existing site structures or other facilities with equipment or supplies having a weight that will endanger the integrity of the structures;
   3. assume full responsibility for protection and safekeeping of CONTRACTOR-supplied or owned products stored on premises;
   4. move any stored products which interfere with the operations of OWNER or other CONTRACTORS;
   5. coordinate and cooperate with other CONTRACTORS and utilities on the site;
   6. restore to original condition any structures, equipment or roadways damaged during storage of equipment or materials;
   7. not restrict access to the site by others; and
   8. stockpile materials removed from excavations within the Work area as directed by OWNER.

3.20 CLEAN-UP DURING CONSTRUCTION

A. Clean-up shall be performed as required with once daily serving as the minimum to prevent accidents to personnel, protect all Work in place, and to effect completion of the project in an orderly manner.

B. Construction clean-up shall consist of the removal of all mud, oil, grease, sand, gravel, dirt, trash, scrap, debris, accidental fuel spills and excess materials, from any floor space or walking surface, that may cause the tripping or sliding of Workmen, ladders, or equipment. Particular attention shall be given to the removal of water from floor

areas where electrical power tools are to be used and to the prevention of stains on concrete which will be exposed in the finish Work.

C. Burning of waste material will not be permitted.

END OF SECTION

SECTION 01700
PROJECT CLOSEOUT

PART 1 - GENERAL

1.1 CLOSEOUT PROCEDURES

A. CONTRACTOR shall submit written certification before final payment that Contract Documents have been reviewed, work has been inspected, and that work is complete, in accordance with Contract Documents, and ready for ENGINEER's and OWNER's final inspection.

B. CONTRACTOR shall provide "as-built" documentation, all submittals of Section 01050 and 01350 of these Specifications, and any other submittals required by governing or other authorities to ENGINEER and OWNER.

C. CONTRACTOR shall submit final Application for Payment identifying total adjusted Contract Sum (adjusted, if appropriate), previous payments, and sum remaining due.

1.2 FINAL CLEANING

A. Upon completion of work, and prior to final inspection, CONTRACTOR shall remove all of its equipment, signs, facilities, construction materials, and trash, and shall perform any other reasonable cleanup activities requested by OWNER. All disturbed areas shall be revegetated, restored, or otherwise put into a condition satisfactory to OWNER. Revegetation shall be carried out in accordance with the Specifications.

1.3 PROJECT RECORD DOCUMENTS

A. CONTRACTOR shall maintain on site, one set of the following Project Record Documents:
   1. Red-line drawings.
   2. Specifications.
   3. CQA Plan.
   4. Addenda.
   5. Change Orders, Field Orders, and other modifications to the Contract.
   6. Approved Shop Drawings.
   7. Product data and samples.
   8. As-built documentation and record drawings.
   9. Other approved documents submitted by CONTRACTOR in compliance with these Specifications.

B. CONTRACTOR shall store Project Record Documents separate from documents used for construction in fireproof files.

C. CONTRACTOR shall record information concurrent with construction progress.

D. CONTRACTOR shall legibly mark each project record document and shop drawing item to record actual construction, including:
   1. Field changes of dimension and detail; and
   2. Details not on original Drawings.

E. CONTRACTOR shall submit a complete copy of the Project Record Documents identified in Paragraph 1.03A above to OWNER with claim for final Application for Payment.

PART 2 - PART 2 PRODUCTS (NOT USED)

PART 3 - PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 02170
MONITORING WELLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Construction and development of groundwater monitoring wells.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
      b. C94/C94M, Standard Specification for Ready-Mixed Concrete.
      c. C150, Standard Specification for Portland Cement.
      d. D1586, Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils.
      e. D1587, Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes.
      f. D1785, Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
      g. F480, Standard Specification for Thermoplastic Well Casing Pipe and Couplings Made in Standard Dimension Ratio (SDR), Schedules 40 and 80.

B. Qualifications:
   1. INSTALLER shall have completed at least five successful monitoring wells of similar type and depth within the last five years.
   2. All groundwater monitoring wells shall be installed by a drilling company certified in the State of Florida.

1.3 DEFINITIONS

A. INSTALLER or Applicator:
   1. INSTALLER or applicator is the person actually installing or applying the product in the field at the Project site.
   2. INSTALLER and applicator are synonymous.

1.4 SUBMITTALS

A. Shop Drawings:
   1. Certification of well INSTALLER's geologist/geological engineer and surveyor's registration number.

B. Project Record Documents:

C. Samples:
   1. Filter pack material sample.
   2. Developed well water sample.

D. Informational Submittals:
   1. Padlock keys.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers of PVC casing, screen, protective casing and accessories are acceptable:
   1. Johnson Filtration Systems, Inc.
   2. TriLoc Casing and Screen, Brainard-Kilman.
   3. Bonding Agent, SICA Corporation.

2.2 MATERIALS

A. Well Casing:
   1. 2 IN nominal.
   2. ASTM D1785 Schedule 40 PVC.
   3. ASTM F480.

B. Well Screen:
   1. Same material and dimensions as casing.
   2. 0.010 IN slots.
   3. 5 FT lengths.

C. Jointing:
   1. Threaded, flush joint coupling, watertight.
   2. No solvents, cements, or adhesive tapes are allowed.

D. Filter Pack:
   1. Clean washed sand/gravel.
   2. See Drawings for gradations.

E. Bentonite Seal:
   1. Pellet form of sodium bentonite.

F. Cement/Bentonite Grout:
   1. ASTM C150 cement.
   2. Clean potable water.
   3. Bentonite powder.

G. Top and Bottom Cap:
   1. Same material as well casing.
   2. Flush threaded.

H. Protective Casing:
   1. Aluminum.
   2. 1/8 IN thickness.
   3. 4 IN by 4 IN.

I. Concrete Pad:
   1. ASTM C94/C94M concrete.

J. Guard Post:
   1. SDR 11 HDPE pipe filled with concrete.
   2. 6 IN DIA.
   3. 7 FT length.

2.3 ACCESSORIES

A. Padlock:
   1. Capable of locking the protective casing.

2. All locks keyed alike.
3. Weatherproof construction.

2.4 MIXES

A. Cement/Bentonite Grout:
   1. 94 LB of Portland cement.
   2. Not more than 7.5 GAL of water.
   3. 4 LB of bentonite powder.
   4. Add bentonite following mixing of cement.

PART 3 - EXECUTION

3.1 PREPARATION

A. Existing well logs may be available at OWNER's office for replacement/abandonment upon request.

B. Steam clean all casings, screens, and other materials used in monitoring well construction and wrap in plastic prior to installation in the borehole.

3.2 INSTALLATION

A. Well Hole Construction:
   1. Drill monitoring wells using a 4-1/4 IN ID and nominal 6-1/2 IN OD hollow stem auger. Other drilling methods must be given approval by the ENGINEER.

B. Well Installation:
   1. Measure depth of boring in order to place filter pack by tremie pipe in the bottom of the boring.
   2. Connect the well screen and a sufficient length of well casing including bottom plug.
   3. Lower the well screen and casing to the sand-gravel filter pack in the bottom of the boring.
      a. The well screen will be situated such that it intersects the estimated elevation of the water table.
   4. Continue tremie pipe placement of filter pack into the annulus between the well screen and the borehole wall until the filter pack is approximately 2 FT above the top of the well screen.
   5. Take periodic depth soundings to monitor the level of the filter pack and detect any bridging.
      a. Clean, fresh, nonchlorinated potable water will be added as required to avoid sand bridging.
   6. Place cement/bentonite grout mixture with tremie pipe from top of bentonite seal upward to the frostline.
   7. Fill remaining annulus with concrete.
   8. Prior to concrete set, center protective casing on well casing and adjust to height.

C. Well Screen and Casing:
   1. Lower screen into the well with the casing.
      a. In no instance, drive or force into position.
   2. Suspend from the ground surface until the filter pack has been placed.
   3. Join screen sections for a single interval by threaded, flush joint couplings.
   4. Assure joint(s) are straight, sand-tight and retain 100% of the screen strength.
   5. Casing and screen will be set plumb and true to line.
   6. Extend casing to 3 FT above ground surface.

D. Filter Pack:
   1. Install filter pack from the bottom of the boring to 2 FT above the top of the well screen.
   2. Protect filter pack from contamination during delivery and storage.
   3. Do not install any filter pack contaminated with foreign substances.
   4. Place filter pack by slowly scooping washed sand/gravel into the annulus or place filter pack with a tremie pipe lowered to bottom of borehole.
   5. Place in 1 FT lifts saturating each lift with potable water and allow 30 minutes for hydration prior to placing next lift.
   6. Measure top of filter pack using a weighted measuring tape after an adequate settling period.
   7. Control placement of filter pack to protect against segregation of filter pack material.

E. Bentonite Seal:
   1. Place a seal of not less than 1 FT and a maximum of 2 FT thickness in the annular space above the filter pack.
   2. Protect bentonite from moisture and contamination during delivery and storage.
   3. Slowly scoop or tremie bentonite pellets.
   4. Using a weighted tape, measure depth of bentonite seal after allowing adequate time for settling.
   5. Hydrate bentonite pellets for 2 HRS after placement.

F. Cement/Bentonite Grout:
   1. Assure that annular space is free from obstructions before placing grout.
   2. Place grout by means of a tremie pipe beginning at a depth of not more than 1 FT above the bentonite seal.
   3. Pump grout at a rate so as to displace any groundwater but not puncture the bentonite seal.
   4. Place grout into the annular space above the bentonite seal to proposed bottom of concrete surface pad.

G. Concrete Surface Pad and Protective Casing:
   1. Insert protective casing over the well casing with 3.5 FT extending above ground surface.
   2. Position protective casing to allow for easy removal of the well's top cap and secure closure.
   3. Construct a surface pad at least 2 FT SQ and 4 IN thick above ground centered around the protective casing.
   4. Construct pad to slope away from the protective casing.
   5. Drill 1/4 IN drainhole in protective casing 4 IN above top of concrete pad.

H. Well Development:
   1. Furnish necessary pumps, compressors, plungers, surge block, bailers, or other equipment needed to develop the wells.
   2. Begin no sooner than 48 HRS no longer than seven calendar days following the placement of the cement or bentonite grout and develop each well for a minimum of 2 HRS or longer until visible turbidity is eliminated as determined by the ENGINEER.
   3. Development procedures may include use of a surge block, bailing, or surging of the well by pumping compressed nitrogen into the screen.

4. Remove at least five well annulus volumes of water during the development process.
5. Water sample:
   a. Collect one sample per well within 15 minutes of finishing development in a 1 L glass or plastic container.
   b. Label container with well number.
6. Dispose of development water in on-site drainageways or at other locations approved by the ENGINEER.

I. Sampling Requirements:
1. Collect soil samples for geotechnical analysis from each monitoring well boring.
   a. Collect soil samples continuously from the first well.
   b. Sampling frequency from subsequent wells shall be continuously through the first 10 FT, sample every 5 FT thereafter, and again continuously below the first encountered water.
   c. Collect the sample using a split-spoon sampler (ASTM D1586) or thin wall tube sampler (ASTM D1587) and standard sampling techniques.
      1) Other methods cannot be used without prior approval from the ENGINEER.
   d. Collect samples in plastic or glass jars.
   e. Visually classify samples by the Unified Soil Classification System, and appropriately describe on the boring log.
2. Collect soil samples for chemical analysis from each monitoring well boring.
   a. Collect a sample from approximately the 5 FT depths.

J. Decontamination:
1. Provide all labor, material, equipment and perform all work and services necessary for decontamination.
2. Wash the drilling rig and ancillary equipment with a high pressure, hot water detergent wash and hot water rinse upon site entry and exit and between each borehole.
3. Wash all sampling equipment between sampling events.

K. Well Survey:
1. Locate to +1.0 FT to center of casing and relate to Project grid system.
2. Vertically locate to +0.1 FT the ground surface, top of protective casing and top of well casing.

L. Well Abandonment:
1. Remove well casing and screen.
2. Fill borehole with cement/bentonite grout to 3 FT below the ground surface.
   a. Cap the well with a 4 IN concrete slat and backfill the remainder of the hole with native topsoil mounded for settlement.
3. Clean up and return the drilling location as close to its original condition as possible.

M. Photography:
1. Photographs:
   a. Disposal of fluids and debris.
   b. Decontamination procedures.
   c. Location after drilling, development, and well abandonment.

END OF SECTION

This page intentionally left blank.

SECTION 02225
TRENCHING

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. CONTRACTOR shall furnish all labor, materials, tools, supervision, transportation, and installation equipment to perform all trenching work as specified herein and as shown on the Drawings.

B. CONTRACTOR shall be prepared to construct all trenches in conjunction with other aspects of the Work.

C. Work of this section includes, but is not necessarily limited to, trenching for stormwater pipe/culvert installation, leachate forcemain/transmission pipe installation, anchor trenches and installation of backfill material.

1.2 RELATED SECTIONS

A. Section 01200 – Description of Schedule of Values

B. Section 01050 – Field Engineering (Surveys)

C. Section 02300 – Earthwork

D. Section 02310 – Dewatering

1.3 SUBMITTALS

A. CONTRACTOR shall notify OWNER in writing a minimum of 7 days prior to starting trenching activities. The notice shall state the material to be used, shoring, the equipment to be used, the date and time that placement operations will start, methods taken to avoid interruptions to daily landfill traffic and the name of the person in the field who will be in charge of the trenching activities.

B. CONTRACTOR shall submit to OWNER the proposed layout for each trench 7 days prior to the start of trenching.

C. If work is interrupted for reasons other than inclement weather, CONTRACTOR shall notify OWNER a minimum of 24 hours prior to the resumption of work.

1.4 CONSTRUCTION QUALITY ASSURANCE

A. CONTRACTOR shall be aware of the activities outlined in the CQA Plan and shall account for these activities in the construction schedule.

B. Trenching activities will be visually monitored by the CQA Consultant.

1.5 CONSTRUCTION LAYOUT

A. CONTRACTOR shall be responsible for all construction layouts.

PART 2 - PRODUCTS

2.1 EQUIPMENT

A. CONTRACTOR shall furnish, operate, and maintain equipment as is necessary to produce uniform trenches.

B. Dewatering equipment is required when excavating below groundwater table and/or subsurface liquid interaction.

PART 3 - EXECUTION

3.1 FAMILIARIZATION

A. Contours of existing ground elevations shown on the Drawings are believed to be reasonably correct for the date that the topographic survey was obtained. The CONTRACTOR is advised that grades depicted on the Drawings may vary from field conditions at the time of construction and that such variations will not be a justification for additional costs to OWNER.

B. CONTRACTOR shall maintain, abandon, relocate and/or protect existing utilities that may pass through the work area without interrupting daily landfill operations.

C. CONTRACTOR shall protect benchmarks and existing structures from excavation equipment and vehicular traffic.

D. CONTRACTOR shall protect above and below grade utilities that are to remain.

E. CONTRACTOR shall allow uninterrupted traffic on the landfill roads when excavating leachate transmission pipe trenches and assure road stability during excavation activities.

3.2 TRENCHING

A. CONTRACTOR shall take all necessary safety precautions during construction activities and shall conform to all applicable OSHA regulations, OWNER’s safety requirements, and CONTRACTOR’s health and safety plan.

B. Prior to starting trenching operations, CONTRACTOR shall remove topsoil found suitable by OWNER for reuse. Such material shall be removed in a manner to separate it clearly from underlying material and shall be stored on site where directed by OWNER. Topsoil shall remain the property of OWNER.

C. Trenches shall be constructed to the dimensions and alignments shown in approved trench layout plan. Alignments shall be adjusted by CONTRACTOR, if necessary and based on CQA Consultant’s approval, to achieve the specified slope and spacing requirements.

D. Any excavated soil not suitable for reuse shall be hauled and stockpiled at OWNER designated location for OWNER's use.

E. The minimum anchor trench dimensions shall always be maintained. Anchor trenches shall be compacted with 2 passes using a walk-behind vibrating plate compactor (refer to Section 02300).

F. CONTRACTOR shall minimize open overnight trenches.

G. When performing trench excavation in excess of 5 FT in depth, comply with the Occupational Safety and Health Administration's (OSHA) trench safety standards, 29 CFR 1926, Subpart P, and all subsequent revisions or updates adopted by the Department of Labor and Employment Security. Ensure that trench boxes are wide enough to accommodate compaction and density testing.

3.3 LIQUIDS AND WATER

A. Groundwater will be encountered during trenching operations. CONTRACTOR shall meet Section 02310 requirements before commencing trench excavations.

B. CONTRACTOR shall take every precaution to prevent water from entering an open trench. Should water enter the trench, the water shall be removed so as to return the trench bottom to a firm, dry condition.

3.4 FIELD QUALITY ASSURANCE

A. The CQA Consultant will visually observe trenching operations, dimensions, dewatering and monitor compaction.

3.5 TOLERANCE

A. Anchor trenches shall be constructed to within the tolerances in Section 01050.

3.6 SAFETY PROVISIONS

A. Trenching shall be performed in strict accordance with OSHA and all other applicable laws and regulations, as well as CONTRACTOR's health and safety plan for this project. Job site safety is the sole responsibility of CONTRACTOR.

END OF SECTION

This page intentionally left blank.

SECTION 02270
EROSION AND SEDIMENT CONTROL

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. CONTRACTOR shall furnish all labor, materials, tools, supervision, transportation, installation equipment, and incidentals required to install temporary construction entrances, silt fencing, stormwater diversion berms and temporary and permanent vegetation for erosion control as specified herein and as shown on the Drawings.

B. CONTRACTOR shall furnish all labor, materials, tools, supervision, transportation, installation equipment, and incidentals required to maintain all erosion and sediment control measures and structures throughout the duration of the Project and removal of temporary measures and structures, where necessary.

1.2 RELATED SECTIONS

A. Section 01200 – Description of Schedule of Values

B. Section 01050 – Field Engineering (Surveys)

C. Section 02300 – Earthwork

D. Section 02485 – Sodding

1.3 REFERENCES AND STANDARDS

A. Florida Erosion and Sediment Control Planning Handbook, or current edition.

B. Florida Department of Transportation Standard Specifications for Roads and Structures Construction, Latest edition.

1.4 SUBMITTALS

A. At least 14 days prior to starting the work of this section, CONTRACTOR shall submit the following to ENGINEER:
   1. Samples of proposed materials.
   2. Manufacturer's product data and recommended methods of installation.
   3. CONTRACTOR's proposed erosion and sedimentation control plan, based on CONTRACTOR's proposed Work staging and sequencing plan. Such plan shall include all temporary measures proposed to ensure sufficient measures to control stormwater run on, runoff, erosion, and sedimentation to protect the Work and the property. CONTRACTOR's proposed erosion and sedimentation control plan shall include, at a minimum, all erosion and sedimentation control measures described and illustrated in the Contract Documents, plus such additional measures to control erosion and sedimentation based on the CONTRACTOR's means, methods, staging and sequencing of construction.

1.5 CONSTRUCTION QUALITY ASSURANCE

A. CONTRACTOR shall be aware of the activities outlined in the Construction Quality Assurance (CQA) Plan and shall account for these CQA activities.

B. At the discretion of the OWNER, the work of this section may be subjected to CQA monitoring.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Silt fence shall meet the requirements given in the Construction Drawings.

PART 3 - EXECUTION

3.1 FAMILIARIZATION

A. Prior to implementing any of the work described in this section, CONTRACTOR shall become thoroughly familiar with all portions of the work falling within this section.

B. Inspection:
   1. Prior to implementing any of the work in this section, CONTRACTOR shall carefully inspect the installed work of all other sections and verify that all work is complete to the point where the installation of this section may properly commence without adverse impact.
   2. If CONTRACTOR has any concerns regarding the installed work of other sections, it shall notify ENGINEER in writing within 48 hours of its site inspection. Failure to inform ENGINEER in writing or installation of the work of this section will be construed as CONTRACTOR's acceptance of the related work of all other sections.

3.2 INSTALLATION

A. CONTRACTOR shall install silt fence on a level grade downslope of all disturbed areas as shown on the Drawings and at locations where stockpiles and temporary measures not shown on Drawings need silt fence to prevent sedimentation. Both ends of the silt fence section must extend at least 8 FT upslope at 45 DegF to the main fence alignment. Sediment accumulated against the silt fence shall be removed when it reaches one half of the above-ground height of the fence and stockpiled as directed by the Owner.

B. CONTRACTOR shall re-vegetate all disturbed areas within 14 days of termination of earthwork activities per the contract specifications.

C. CONTRACTOR shall construct all stone check dams, erosion control mats, riprap and silt fence as shown on the Drawings.

3.3 PRODUCT PROTECTION

A. CONTRACTOR shall use all means necessary to protect all prior Work and materials and completed work of other sections.

B. In the event of damage, CONTRACTOR shall immediately make all repairs and replacements necessary, to the approval of OWNER and at no additional cost to OWNER.

END OF SECTION

SECTION 02300
EARTHWORK

PART 1 - GENERAL

1.1 SUMMARY

A. This section covers the work necessary to perform earthwork associated with construction of the landfill liner system and site work. The work includes, but is not limited to, earthwork, excavating and removal of unsatisfactory soils and replacement with backfill material, clearing and grubbing, trench excavation, providing satisfactory material for fill and backfill as required, and soil placement and compaction.

1.2 RELATED WORK

A. The General and Supplementary Conditions of these specifications are a part of this section as if incorporated herein.

B. Other related specification sections contained herein are as listed below:
   1. Section 01050 – Field Engineering (Surveys)
   2. Section 02775 – HDPE Geomembrane
   3. Section 02776 – Geosynthetic Clay Liner (GCL)
   4. Section 02777 – Drainage Composite
   5. Construction Quality Assurance Plan.

1.3 DEFINITIONS

A. "Relative compaction" is defined as the ratio, in percent, of the as-compacted field dry soil density to the laboratory maximum dry density as determined by the Standard Proctor Method, ASTM D 698. Corrections for oversize material may be applied to either the as-compacted field dry density or the maximum dry density, as determined by the ENGINEER.

B. "Optimum moisture content" is defined as the moisture content corresponding to the maximum dry density obtained by the Standard Proctor test, ASTM D 698. Field moisture content shall be determined on the basis of the fraction passing the No. 4 sieve.

C. "Completed course" is defined as a course or layer that is complete and ready for testing and/or the next layer or phase of construction.

D. "Clearing" shall consist of the felling, trimming, and cutting of trees into sections and the satisfactory disposal of the trees and other vegetation designated for removal, including down timber, snags, brush, and rubbish occurring in the areas to be cleared.

E. "Grubbing" shall consist of the removal and disposal of stumps, roots, and matted roots from the designated grubbing areas.

1.4 REFERENCE STANDARDS

A. Reference standards and recommended practices referred to herein shall be the latest revision of any such document.

B. Standards referenced herein are as listed below:
   1. ASTM C 535, Standard Test Method for Resistance to Degradation of Large-Size Course Aggregate by Abrasion and Impact in the Los Angeles Machine
   2. ASTM D 422, Particle Size - Analysis of Soils

3. ASTM D 698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3))
4. ASTM D 2216, Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil Aggregate Mixtures
5. ASTM D 2434, Standard Test method for Permeability of Granular Soils (Constant Head)
6. ASTM D 2487, Classification of Soils for Engineering Purposes (Unified Soil Classification System)
7. ASTM D 2974, Standard Test Methods for determining the Water (Moisture) Content, Ash Content, and Organic Material of Peat and Other Organic Soils
8. ASTM D 3042, standard Test method for Insoluble Residue in Carbonate Aggregates
9. ASTM D 4318, Liquid Limit, Plastic Limit, and Plasticity Index of Soils
10. ASTM D 4972, Standard Test Methods for pH of Soils

C. Florida Department of Transportation (FDOT) Standard Specifications for Road and Bridge Construction 2022 (Standard Specifications).

1.5 QUALITY ASSURANCE, ACCEPTANCE, AND TOLERANCES

A. Prior to commencing any excavation or grading, the CONTRACTOR shall satisfy himself as to the accuracy of all survey data as indicated on the drawings and in the specifications and/or as provided by the OWNER. Should the CONTRACTOR discover any inaccuracies, errors, or omissions in the survey data, he shall immediately notify the OWNER that proper adjustments can be anticipated or ordered. Commencement by the CONTRACTOR of any excavation or grading shall be held as an acceptance of the survey data by him after which time the CONTRACTOR has no claim against the OWNER resulting from alleged errors, omissions, or inaccuracies of the survey data.

B. All grading shall be performed to strictly maintain slopes and drainage as shown on the drawings. Allowable tolerances are provided in Section 01050.

1.6 SUBMITTALS

A. Submittals shall be in sufficient detail to show full compliance with the specifications.
   1. MANUFACTURER's catalog data sheets for equipment scheduled for use in proof-rolling the subgrade and for operating over geosynthetic layers shall be submitted.
   2. Certificates of compliance for proposed materials shall be submitted at least 10 days before the material is required for use. Certificates of Compliance for all sources of soil materials shall clearly reference the source.

B. SAMPLING AND TESTING
   1. Tests required for location of an acceptable material source shall be done by an independent soils testing agency which shall be approved by the OWNER and retained by the CONTRACTOR as illustrated in Table 02300-1. Certification for all materials indicating that the material conforms to the specification requirements along with copies of the test results from a qualified independent testing laboratory, approved by the OWNER and retained by the CONTRACTOR, shall be submitted to the OWNER for approval at least 10 days before the material is required for use. The CONTRACTOR shall coordinate material location and delivery with the testing agency and the OWNER. No materials shall be delivered to the site or used in construction until the proposed source and materials tests have been tentatively

accepted in writing by the OWNER. The CONTRACTOR shall notify the OWNER, in writing, a minimum of 24 hours prior to the time materials approval is required.

2. Tests required for in-place final acceptance shall be performed by an independent Soils CQA Laboratory as retained by the Soils CQA Consultant. The number and location of the tests shall be as specified in the CQA plan and as directed by the Soils CQA Consultant throughout the project time period. The CONTRACTOR shall coordinate activity with the Soils CQA Consultant and the testing agency to permit testing as directed in the presence of the Soils CQA Consultant. The cost of any and all retests due to failure to achieve specified requirements are not included in the cost indicated in the Contract Documents, shall be invoiced to the CONTRACTOR separately, and shall be borne by the CONTRACTOR. All testing agency activities shall be performed under the direction and supervision of a Professional Engineer, licensed in the state of Florida.
3. Test results shall be sealed and signed by the testing agency representative who shall be a Professional Engineer, licensed in the state of Florida. Copies of test results shall be transmitted to the Soils CQA Consultant for review and approval. The reports shall include, as a minimum, project title; project location; location of sample, time, and date of testing or sampling; and test results.
4. The CONTRACTOR shall provide certification that proposed material is clean and meets gradation and other parameters herein specified. The certification tests shall be performed at a minimum frequency of one per borrow source and/or change in material, except as noted per Table 02300-1.

Table 02300-1 Prequalification Testing

ITEM	TEST	ASTM NO.
Structural Fill (Liner Subgrade)	Soil Classification (USCS Classification System)	D2487
	Sieve and Hydrometer Analysis	D 422
	Atterberg Limits	D 4318
	Natural Moisture Content	D 2216
	Standard Proctor	D698
Low Permeability Soil (Anchor Trench and Corridor	Soil Classification (USCS Classification System)	D2487
	Sieve and Hydrometer Analysis	D 422
	Atterberg Limits	D 4318
	Natural Moisture Content	D 2216
	Standard Proctor	D698
Protective Cover Layer (Sand Drainage Layer)	Soil Classification (USCS Classification System)	D2487
	Sieve and Hydrometer Analysis	D 422
	Atterberg Limits	D 4318
	Natural Moisture Content	D 2216
	Standard Proctor	D 698
	Permeability of Granular Soils	D2434
	Calcium Carbonate	D3042
Leachate Collection Gravel	Soil Classification (USCS Classification System)	D 448
	Permeability of Granular Soils	D2434
	Resistance to Degradation (LA Abrasion)	C535
	Calcium Carbonate	D3042

ITEM	TEST	ASTM NO.
Topsoil	Soil Classification	D 2487
	Organic Content	D 2974
	pH	D 4972

5. The Soils CQA Consultant shall provide conformance tests during construction as specified in the CQA Plan.
6. Classification tests on all materials as specified herein shall be made on samples of each material at its place of production prior to shipment. Classification tests in excess of those listed above may be required on the finished product if variation in gradation is apparent or if the material appears to depart from the specifications. Additional testing shall be as directed by the OWNER.
7. The soil material source will only be considered suitable if the hydraulic conductivity of the materials, as documented on laboratory test specimens, can be shown to meet the requirements of the project specifications at the 98% confidence level where applicable.
8. In-place density and moisture content shall be performed by the Soils CQA Laboratory using the methods specified herein, or other methods selected by the Soils CQA Consultant. The CONTRACTOR shall cooperate with this testing work by leveling small test areas designated by the Soils CQA Consultant.
9. Final acceptance will be based on tests made on samples of material taken from the completed and compacted course. Acceptance will be made only on completed courses.
10. The OWNER and the Soils CQA Consultant reserve the right to perform additional tests at the OWNER's expense of any material at any time, location, or elevation.
11. Any areas which do not meet compaction requirements shall be reworked, as necessary, to achieve the specified compaction and retested, at the CONTRACTOR’s, to confirm that compaction requirements have been met.

PART 2 - PRODUCTS

2.1 PROTECTIVE COVER SOIL (SAND DRAINAGE LAYER)

A. Protective cover shall be obtained from off-site sources approved by the ENGINEER and shall be clean, excavated, natural sand, free from roots, sharp objects, or organic material, with a maximum size of 1/4 IN and 5% maximum by weight passing the No. 200 Sieve when tested in accordance with ASM D2487. The sand drainage layer shall have a laboratory permeability not less than 1×10^{-3} cm/sec (ASTM D2434) at 90% relative compaction (ASTM D 698). The sand shall be less than 10 percent loss of weight when tested in accordance with ASTM D3042 (Calcium Carbonate).

2.2 LEACHATE COLLECTION GRAVEL

A. Leachate collection gravel shall be imported from off-site sources, washed AASHTO #3 coarse aggregate as approved by OWNER, free from roots, organic material, and other deleterious material. Leachate collection gravel will have a hydraulic conductivity of 1×10^{-1} cm/s (1×10^{-3} m/s) or greater. Material shall not be limerock or other material that would react and/or break down when in contact with solid waste leachate. The material shall not be calcareous or of any other material that would interact with leachate. The aggregate shall be less than 10 percent loss of weight when tested in accordance with ASTM D3042 (Calcium Carbonate).

B. Aggregate shall be of sound, hard and durable quality. Aggregate shall have less than 15 percent loss when tested in accordance with ASTM C535. It shall not contain any soapstone, shale, or other material that easily disintegrates.

2.3 STRUCTURAL FILL AND SUBGRADE

A. Structural fill will be used for the subgrade, perimeter berms and channels, anchor trench corridor and inter-cell berms as shown on the Drawings. The structural fill will consist of on-site relatively homogenous natural soils that are free of debris, foreign objects, organics and other deleterious materials. Structural fill shall be classified according to ASTM D 2487 as SP, GW, GM, GC, SW, SM, SC, ML, or CL and their combinations and will have no particles or soil clods larger than 4 IN (100 mm) except for the top 6 IN of the subgrade. The maximum particle size within top 6 IN of subgrade shall not exceed 0.5 IN (12 mm). Fill material shall be free from alkali, salt, petroleum products, roots, stones, rocks, and building debris. The structural fill shall be placed and compacted in lifts to the lines and grades shown on the Drawings. The compacted thickness of each lift will be 6 IN maximum (150 mm). Each lift will be compacted to at least 95 percent of the standard Proctor maximum dry density (ASTM D 698) within ±3% of optimum moisture content.

2.4 LOW-PERMEABILITY SOIL

A. The low-permeability soil shall consist of relatively homogeneous, natural soils that are free of debris, foreign objects, excess silt, and organics imported from on-site sources. No particles larger than 1 IN shall be allowed. The soil shall be classified according to the Unified Soil Classification System (USCS, ASTM D 2487) as MH, ML, CL, or CH material. Regardless of the classification requirements, the material shall meet all of the requirements of this section. The selected soil shall not be gap-graded or susceptible to piping. Substandard materials shall be segregated at the source and will not be permitted at the work area. Any material that is found by the OWNER to be substandard shall be removed from the work area by the CONTRACTOR at no extra cost to the OWNER.

2.5 TOPSOIL

A. The topsoil shall be obtained from on-site sources or material recovered during initial site preparation activities that are capable of promoting the growth of vegetation. The topsoil will be relatively homogenous natural soils that are free of debris, foreign objects, excess silt, clay lumps, brush, roots, weeds, or other deleterious materials. The topsoil will have at least 75 percent by weight passing the U.S. Standard No. 4 (4.75 mm) sieve, and at least 60 percent by weight passing the U.S. Standard No. 10 (2 mm) sieve. For the portion passing the U.S. Standard No. 10 (2 mm) sieve, the material will be classified as sandy loam, loam, or silt loam in accordance with the USDA classification system. In addition, the topsoil will have a pH in the range of 5.8 to 7; a minimum of 7 percent by weight of organic matter; and a maximum of 4 milliohms per centimeter of soluble salts. The material shall comply with the requirements of FDOT's Standard Specifications for Road and Bridge Construction (2022), Section 987 for Topsoil. If necessary, nutrients (including agricultural lime and fertilizer) shall be added to the topsoil to enhance its ability to promote vegetation growth. The OWNER shall be consulted prior to use of nutrients.

2.6 WATER AND MOISTURE CONTROL EQUIPMENT

A. The CONTRACTOR shall provide water for compaction as necessary to achieve proper moisture conditions.

B. Equipment for applying water shall be of a type and quality adequate for the work, shall not leak excessively, and shall be equipped with a distributor bar or other approved device to assure uniform application. Equipment for mixing and drying out material shall include blades, discs, or other approved equipment.

PART 3 - EXECUTION

3.1 EXCAVATION SAFETY AND LEGISLATION

A. Protect benchmarks and existing structures, roads, sidewalks, monitoring wells, piezometers, paving, and curbs against damage from equipment, vehicular or foot traffic, settlement, lateral movement, undermining, and washout.

B. Install and maintain shoring, sheeting, bracing, and sloping necessary to support the sides of the excavation, to keep and to prevent any movement which may damage adjacent pavements, utilities, or structures; damage or delay the work; or endanger life and health. Install and maintain shoring, sheeting, bracing, and sloping as required by the Occupational Safety and Health Administration (OSHA) and other applicable governmental regulations and agencies.

C. The CONTRACTOR shall be solely responsible for making all excavations in a safe manner. Excavations shall be barricaded and posted with warning signs for the safety of persons. Warning lights shall be provided during hours of darkness.

D. Excavated materials suitable for backfill shall be piled in an orderly manner sufficiently distant from excavations to prevent overloading, slides, cave-ins, and obstruction of access ways and roadways.

E. Underpin adjacent structure(s) which may be damaged by excavation work, including service lines.

F. Notify OWNER of unexpected subsurface conditions and discontinue work in area until ENGINEER provides notification to resume work.

G. Excavations shall be performed in ways that will prevent surface and subsurface water from flowing into excavations and will also prevent flooding of the site and surrounding area.

H. The CONTRACTOR shall familiarize themselves with, and comply with, all applicable codes, ordinances, and statutes, and bear sole responsibility for the penalties imposed for noncompliance.

I. When performing trench excavation in excess of 5 feet in depth, comply with the Occupational Safety and Health Administration’s (OSHA) trench safety standards, 29 CFR 1926, Subpart P, and all subsequent revisions or updates adopted by the Department of Labor and Employment Security. Ensure that trench boxes are wide enough to accommodate compaction and density testing.

3.2 TEMPORARY EROSION CONTROL

A. It is the CONTRACTOR's responsibility to provide temporary erosion control procedures to protect slopes and other areas from erosion. Measures such as straw bales, temporary slope flumes, sediment traps or other methods shall be used to protect completed work from damage due to erosion. Damage to facilities under construction shall be repaired at the CONTRACTOR's sole expense.

3.3 REMOVAL OF WATER/STORMWATER

A. At all times during construction, CONTRACTOR shall provide and maintain proper equipment and facilities to remove all water entering the construction area so as to obtain satisfactory working conditions.

B. Avoid settlement or damage to adjacent property. When dewatering open excavations, dewater from outside the structural limits and from a point below the bottom of the excavation when possible.

C. Design dewatering system to prevent removal of fines from existing ground. CONTRACTOR shall comply with the facility FDEP Permit requirements for all discharges of groundwater to the stormwater conveyance system.

D. The CONTRACTOR shall be responsible for the control and maintenance of stormwater and dewatering of groundwater within project limits through all phases of construction. Under no circumstances shall stormwater be allowed to run into the excavation or pond therein. The CONTRACTOR shall prevent stormwater runoff from the existing/active landfill cell area entering the proposed work area at all times during the construction and for the duration of the contract. The CONTRACTOR shall provide temporary stormwater control methods including berms, swales, ponds, and employ other such methods and devices to prevent stormwater runoff from entering and ponding in the proposed cell limits. Any work in the proposed cell limits shall be coordinated with the OWNER 24 hours in advance of when needed. Ponded stormwater of any kind shall be pumped out of the cell and into the stormwater conveyance system within 24 hours of being identified.

3.4 SUBGRADE PREPARATION

A. Heavy growths of grass and other vegetation, roots, debris, stones, objects larger than 2 IN in any dimension, and other materials undesirable to the subsurface construction shall be removed by mowing, grubbing, raking, or other methods from the surface of areas to be stripped.

B. Topsoil Stripping
   1. Topsoil shall be stripped from the surface of those areas to receive fills/excavation or embankments.
   2. Excavated topsoil shall be transported to, and stockpiled in, designated topsoil storage areas on site. Stripped topsoil may be used as topsoil for the Project if approved by the OWNER.

C. Clearing Operations
   1. Clearing shall consist of the felling, trimming, and cutting of trees into sections and the satisfactory disposal of the trees and other vegetation designated for removal, including downed timber, snags, brush, and rubbish occurring within the areas to be cleared. Trees, stumps, roots, brush, and other vegetation in areas to be cleared shall be completely removed except such trees and vegetation as may be indicated or directed to be left standing. Vegetation to be left standing shall be protected from damage incident to clearing, grubbing, and construction operations by the erection of barriers or by such other means as the circumstances require. Clearing shall also include removal and disposal of structures that obtrude, encroach upon, or otherwise obstruct the work.

D. Grubbing Operations

1. The CONTRACTOR shall completely remove material to be grubbed, including logs, metallic and concrete debris, boulders, stumps, roots, and organic or other debris protruding through the ground surface.

E. Filling Depressions
   1. Depressions resulting from grubbing operations shall be completely filled with structural fill material, unless further excavation or earthwork is required.
   2. Prior to filling, subgrade surfaces of depressions shall be free of standing water. Unsatisfactory soil materials shall be removed.

F. The CONTRACTOR shall excavate/fill the subgrade as required to achieve the subgrade elevations indicated on the drawings. Fill shall be placed not to exceed 6 IN compacted lifts and shall be compacted to at least 95% of the Standard Proctor (ASTM D 698) maximum dry density, within ±3% of optimum moisture content. The subgrade shall be proof-rolled with a vibratory drum roller. The CONTRACTOR shall provide the equipment and techniques necessary to produce a well-mixed, homogenous layer of the specified thickness, density, and moisture content. The subgrade lifts shall not pump, rut, or crack under equipment loadings. Any subgrade areas that show evidence of “pumping” shall be remediated by waiting for it to dry, ripping, or discing the soil before re-compacting and testing. Upon completion of proof rolling the subgrade, the Soils CQA Consultant will perform tests to confirm that the subgrade is compacted to at least 95% of the Standard Proctor (ASTM D 698) maximum dry density, within ±3% of optimum moisture content.

G. Upon completion of the prepared subgrade by the CONTRACTOR, the double liner system shall be placed by CONTRACTOR in accordance with Section 02776, GCL, Section 02775, HDPE Geomembrane, and Section 02777, Drainage Composite. The CONTRACTOR shall be responsible for maintaining moisture, density, and integrity of the completed compacted base. Any damage shall be repaired at the CONTRACTOR's sole expense.

H. Exposure to construction traffic after completion of prepared subgrade placement shall be minimized and shall include only equipment submitted to and approved by the OWNER. The GCL shall not be placed on saturated soil. Saturated subgrade surfaces shall be aerated, dried back to acceptable moisture levels, and re-compacted immediately prior to installing the GCL.

I. The CONTRACTOR shall sequence operations to allow for systematic completion of the liner system as soon as possible after compacted base completion.

3.5 LEACHATE COLLECTION GRAVEL AT LEACHATE COLLECTION/DETECTION PIPES

A. Leachate drainage aggregate shall be placed around leachate pipes as detailed on the Drawings. Leachate pipes shall be stabilized as necessary to prevent displacement or movement of piping during placement of aggregate backfill. Aggregate shall be placed in loose lifts and the leachate piping shall not be harmed or damaged during placement. Material shall be worked in and shall provide constant contact with and support to the pipe. Gravel shall be covered with geotextile separation layer as indicated on the Drawings.

3.6 STRUCTURAL FILL AND LOW-PERMEABILITY SOIL

A. CONTRACTOR shall place and compact structural fill/low permeability soil to the lines and grades shown on the Drawings and as specified in this Section.

B. Structural fill soil shall be placed in lifts that results in a compacted lift thickness not more than 6 IN. Anchor trench and the corridor shall be compacted with 2 passes using a

walk-behind vibrating plate compactor with lift thickness not more than 12-in using low permeability soil supplied by the OWNER.

C. Each lift of structural fill/low permeability soil shall be compacted to at least 95 percent of the maximum dry unit weight determined from the standard Proctor compaction test (ASTM D 698). The soil material shall be compacted at moisture content within plus or minus 3 percent of the optimum moisture content.

D. If a defect is related to adverse site conditions, such as overly wet soils or surface desiccation, the Soils CQA Consultant will define the limits and nature of the defect. If the moisture content of the structural fill/low permeability soil is outside of the acceptable range, the soil shall be wetted or dried as appropriate. Wetting shall be accomplished using a water truck and spray nozzle, unless the Soils CQA Consultant approves an alternative method. During wetting or drying, the soil shall be regularly disced or otherwise mixed so that uniform moisture conditions are obtained.

E. CONTRACTOR shall moisture-condition structural fill/low permeability soil in either the stockpile area or work area. Any delays in progress due to moisture conditioning (wetting or drying) of soil, however, are the responsibility of CONTRACTOR.

F. No structural fill/low permeability shall be placed over a lift that has not been tested and approved by the Soils CQA Consultant. Should the CQA tests indicate that the dry density of any layer of fill, or portion thereof is below the minimum acceptable value, the particular layer, or portion thereof, shall be reworked and recompacted at no cost to OWNER.

3.7 PROTECTIVE COVER LAYER (SAND DRAINAGE LAYER)

A. Place protective cover layer in one lift with a minimum thickness as shown on the drawings. The CONTRACTOR shall exercise caution in keeping construction equipment off the geomembrane liner system. Provide sufficient thickness of protective cover layer to maintain the minimum specified thickness and to maintain the surface grades shown. The protective cover layer shall not be compacted or tested for compaction.

B. Track-mounted equipment with low ground pressure treads (less than 5 psi), no larger than a Caterpillar Model D-6 or equal, shall be used for spreading. No tracked equipment shall be allowed to operate on less than 12 IN of protective cover over the geomembrane liner system. No other equipment, including dump trucks or scrapers, will be permitted to travel on the liner and sand layer. The CONTRACTOR shall avoid sharp turns, sudden starts or stops, spinning and digging of tracks, or any other operation that could damage the lining system. Articulated trucks are permitted to travel over the protective cover layer provided a minimum 3-foot thickness is maintained.

C. The protective cover layer shall be placed in such a manner that no air is trapped underneath the lining. The CONTRACTOR shall provide and maintain a means of continuously observing the depth of the sand drainage layer, such as by freestanding markers at intervals of 50 feet maximum each way or other means as approved by the OWNER. Sharpened stakes shall not be allowed. Markers shall be removed after use and shall not be abandoned in-place.

D. The CONTRACTOR shall take precautions necessary to preclude any damage to the liner system due to thermal expansion or contraction during all phases of liner construction and especially during placement of the protective cover layers.

3.8 TOPSOIL AND VEGETATION

A. All unlined areas affected by construction shall be graded and sodded in accordance with the Contract specifications.

B. The CONTRACTOR shall place topsoil to the lines and grades shown on the Drawings and/or as specified in this section.

C. The total thickness of the vegetative topsoil shall be a minimum of 6 IN.

D. Vegetative topsoil shall not be over compacted so that it inhibits growth of vegetation.

E. CONTRACTOR shall moisture-condition vegetative topsoil in either the stockpile area or work area. Any delays in progress due to moisture conditioning (wetting or drying) of soil, however, are the responsibility of CONTRACTOR.

F. No vegetative topsoil shall be placed over a lift that has not been tested and approved by the Soils CQA Consultant.

3.9 DISPOSAL OF EXCESS EXCAVATION

A. Excavated materials shall be stored in an area approved by OWNER and disposed at the active working face as directed by the OWNER. The OWNER will apply a tipping fee for on-site disposal of wastes generated during construction.

3.10 GROUND PRESSURE RESTRICTIONS OVER GEOSYNTHETICS

A. Rubber tired light equipment driven directly on geosynthetics (e.g., GCL, geomembrane, geotextile, geocomposite) shall be preapproved by OWNER.

B. Unless otherwise specified, all equipment operating on earthen materials overlying geosynthetics shall comply with Table 02300-1:

Table 2300-2 Requirement for Equipment Over Synthetics

ALLOWABLE EQUIPMENT OVERLYING PRESSURE (PSI)	THICKNESS OF COMPACTED SOIL (FT)
5	specific approval required
10	specific approval required
20	2.0
20	3.0

END OF SECTION

SECTION 02310
DEWATERING

PART 1 - GENERAL

1.1 SUMMARY

A. This section covers the work necessary to dewater the cell prior to Cells 11A, 11B and 12 construction.

B. This section also covers dewatering required to facilitate excavation of the pond.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. All work in this section shall be done in accordance with the requirements of the Environmental Resource Permit and Water Use Permit as issued by the Florida Department of Environmental Protection (FDEP) South District.

B. The General and Special Conditions of these specifications are a part of this section as if incorporated herein.

1.3 SUBMITTALS

A. Within 15 days of receiving the notice to proceed, the CONTRACTOR shall submit to the ENGINEER a dewatering plan. At a minimum, the plan shall include the following:
   1. Duration of dewatering for each area.
   2. Number and size of pumps.
   3. Method of dewatering each area.
   4. Methods for routing/containing the discharge.
   5. Methods of isolating dewatering areas.
   6. Time dewatering structure will be in place.
   7. Proposed discharge points.
   8. Monitoring requirements

B. Five copies of the plan shall be submitted to the ENGINEER for record purposes only.

1.4 QUALIFICATIONS OF WORKMEN

A. At least one person shall be present at all times during the execution of this portion of the work and who shall be thoroughly familiar with the dewatering system being installed, the referenced standards, the requirements of this work, and who shall direct all work performed under this section.

B. It shall be the responsibility of the CONTRACTOR to determine the water level at the time prior to beginning excavation and construction.

1.5 REFERENCE MATERIAL

A. Design of the dewatering system shall be the sole responsibility of the CONTRACTOR. The CONTRACTOR shall be responsible for performing whatever investigations they see necessary, prior to bidding, to design the dewatering system. Inaccuracies in this information shall not be the basis for a claim by the CONTRACTOR as it is the CONTRACTOR’s responsibility to verify these data with their own investigations.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 DEWATERING SYSTEM

A. The dewatering system shall be adequate to pre-drain the soils to be excavated to the extent that the piezometric water level in the construction area is a minimum of 3 FT below the bottom of the excavation, side slopes of excavations, or bottom of the footings at all times, or as otherwise required to obtain the specified compaction and installation conditions. Pipeline trenches must be dewatered at least 6 IN below the trench bottom. The anticipated normal groundwater elevation in the project area is approximately 30 FT NGVD 1929.

B. In the event of layered soils, the hydrostatic head in the zone below the subgrade elevation shall be relieved to prevent uplift.

C. Unless otherwise noted and prior to any excavating below or within 2 FT above the groundwater level, a dewatering system shall be placed into operation to lower water levels to the extent specified previously, and then shall be operated continuously 24 hours per day, 7 days a week, throughout the duration of the contract to maintain and protect all work, until the work has been completed to the satisfaction of the OWNER.

D. Where used, well points shall be installed in an approved manner and in sufficient numbers to provide the necessary removal of water as stated previously. Well points and header piping shall be installed in such a manner that traffic on public thoroughfares and site access roads will not be impeded.

E. The CONTRACTOR shall be solely responsible for the arrangement, location, and depths of the dewatering system necessary to accomplish the specified work. The dewatering system shall stay in full operation until groundwater dewatering pipe and sump system is installed and operational.

F. The CONTRACTOR shall install observation wells/piezometers as shown in the project plans to monitor groundwater levels within the excavation footprint. The CQA monitor will review water levels to confirm requirements in this section are met before and during excavation. Upon completion of subbase preparation, the piezometer casing shall be pulled out of ground and filled the open hole with granular bentonite followed by hydration.

G. To prevent excessive noise, exhaust from all pumps and engines shall be silenced and muffled.

H. Wellpoint or surface water pump discharge shall be controlled to prevent erosion, undermining, and all other damage, and be piped to approved locations.

I. The CONTRACTOR is responsible to follow requirements of the facility dewatering permit issued to facilitate construction activities as attached to the construction documents.

J. The CONTRACTOR shall perform all dewatering work in strict compliance with Environmental Resource Permit.

K. The CONTRACTOR shall dewater in such a manner as to prevent damage to existing work. Any damage resulting from the dewatering activities of the CONTRACTOR shall be repaired or replaced, as approved by the ENGINEER, at no additional cost or time to the OWNER.

3.2 OBSERVATION WELLS

A. The CONTRACTOR shall install observation wells as may be required to record accurate water levels.

B. The CONTRACTOR shall be responsible for maintaining all observation wells and observing and recording the elevation of the piezometric water levels daily.

C. Wells damaged or destroyed shall be replaced at no additional cost to the OWNER.

3.3 CLEANUP

A. Upon completion of dewatering work elsewhere on the Project, the CONTRACTOR shall remove all equipment and leave the project site in a neat, clean, and acceptable condition, satisfactory to the OWNER. Wellpoint holes, observation wells, and excavations shall be adequately backfilled with bentonite at depth and compacted soil near surface to prevent settlement. No well points shall be left underneath the geosynthetic liner.

END OF SECTION

This page intentionally left blank.

SECTION 02485
SODDING

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section covers the work necessary to provide for sodding.

1.2 REFERENCES

A. The 2022 edition of the Florida Department of Transportation (DOT) Standard Specifications for Road Bridge Construction (Standard Specifications) shall be referred to for both specific and general standards for materials, construction, workmanship, and quality control as specified herein with exceptions, as noted herein.

B. The latest edition of FDOT Roadway and Traffic Design Standards.

1.3 SUBMITTALS

A. Soil Analysis: If necessary to utilize fertilizer on sodding, the CONTRACTOR shall furnish a soil analysis for each borrow source or distinct on-site soil type used as topsoil for sod placement. The analysis shall be made by a qualified independent soil-testing agency, to be approved by the ENGINEER. The analysis shall state percentages of organic matter, inorganic matter (silt, clay, and sand), deleterious material, pH, and mineral and plant-nutrient content of the soils. The analysis shall state recommended quantities of nitrogen, phosphorus, and potash nutrients and any soil amendments to be added to produce satisfactory topsoil. The CONTRACTOR shall perform soil test 30 days prior to mobilizing for landscape construction.

1.4 RELATED WORK

A. The General and Supplementary Conditions of these specifications are a part of this section as if incorporated herein.

PART 2 - PRODUCTS

2.1 FERTILIZER

A. Fertilizer for grassing shall conform to Section 982 of the FDOT Standard Specifications.

B. Fertilizer shall be granulated so that 80 percent is held on a 16-mesh screen, uniform in composition, dry, and free flowing. The CONTRACTOR shall test screen one bag of fertilizer per source and per shipment.

2.2 SODDING

A. The following sections of the FDOT Standard Specifications shall apply:
   1. Section 570-1, 4, 5, 6
   2. Section 981-1, 981-3 and 981-5, Materials

B. Sod shall be recognized Bermuda grass conforming to requirements FDOT Standard Specification’s Section 981-5 and shall be well matted with roots and shall be of firm

tough texture having a compact top growth and heavy root development. It shall not contain weeds or any other objectionable vegetation. Other sodding species may be utilized pursuant to the Project's product substitution procedures. The soil embedded in the sod shall be good, clean earth and free from stones and debris. The sod shall be free from fungus, vermin and other plant diseases and shall have been mowed at least three times with an approved lawn mower, with final mowing not more than seven days before the sod is cut. The sod shall be sufficiently thick to ensure a dense stand of live grass. The sod shall be live, fresh and uninjured at the time of planting. It shall be planted as soon after being dug up as possible and shall be shaded and kept moist from the time it is dug up until the time it is planted.

2.3 WATER

A. Water for sodding shall conform to Section 983 of the FDOT Standard Specifications. In addition, watering is required for sod installed above erosion control mat until vegetation is established.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. All areas within the limits of work and all areas disturbed by the CONTRACTOR's operations shall be sodded unless otherwise indicated on the Drawings. Staging areas and stockpile areas shall be seeded or sodded to meet predevelopment conditions.

B. Areas to be sodded shall be graded to remove construction debris, litter, depressions, undulations, and irregularities in the surface before sodding and in accordance with the Drawings. Grading activities shall be conducted such that the minimum required thickness of topsoil is maintained.

3.2 SODDING

A. Sodding shall be placed within the entire disturbed area and any other areas that require sod in accordance with Drawings.

B. The following sections of the FDOT Standard Specifications shall apply:
Section 570-3, Construction Methods

C. Exceptions:
1. Section 570-3.3, Placing Sod; do not plant dormant sod or if ground is frozen. Rolled sod shall be placed parallel to contours. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod strips; do not overlap. Stagger strips to offset joints in adjacent courses. The offsets of individual staggered strips shall not exceed 6 IN. Work sifted soil into minor cracks between pieces of sod; remove excess to avoid smothering of adjacent grass. The sod must be pegged using suitable wooden pegs. The pegs should be driven through the sod strips into firm earth, at a minimum frequency of 2 pegs per commercial rectangle (i.e., 2 FT by 3 FT) and 1 peg per 50 SF for rolled sodding. The pegs shall not be longer than 15 IN and shall be driven through the sod strips into firm earth, at suitable intervals. It is the responsibility of the CONTRACTOR to determine if the peg frequency should be increased and that sodding will not be displaced by gravity, low friction with the underlying topsoil, the flow of water or other means. The CONTRACTOR shall ensure that the pegs do not puncture or damage the underlying geosynthetics.

Water sod thoroughly with a fine spray immediately after planting. Roll sod within 24 hours of placement to ensure contact between sod and subgrade.

2. Section 570, Applicable Sections; replace the word “Department” with the Word “County” in the last sentence. The cost of resodding shall be borne exclusively by the CONTRACTOR.
3. Section 570-3.4, Maintenance shall be performed as specified herein.

3.3 CLEANUP

A. All excess sod materials, stones, and other waste shall be removed from the site weekly and shall not be allowed to accumulate.

3.4 MAINTENANCE

A. Maintenance shall include watering, mowing, resodding, repair of erosion, and all other work necessary to produce a uniform stand of grass. During construction and for a period of 45 days after substantial acceptance of the project, the CONTRACTOR shall water the sod daily (or as necessary to support growth), maintain original grades, repair erosion damage and mow the sod. Sod will be considered for final acceptance when the sod roots are firmly anchored to underlying soil and the permanent grass is healthy and growing on 97 percent of the area with no bare areas wider than 12 IN, as determined by the ENGINEER. If the planted areas must be resodded, reshaped, or otherwise repaired, regardless of cause, the CONTRACTOR shall perform such work at the CONTRACTOR's expense. The period of sod establishment for areas that are resodded shall extend to 1 year after the completion of resodding unless otherwise authorized by ENGINEER.

B. Mowing shall be done with approved mowing machines and any time the grass height reaches 6 IN until final completion. Mowing shall leave the grass a minimum of 3 IN high. The water used in the sodding operations may be obtained from any approved spring, pond, lake, stream, canal, or municipal water system. The water shall be free of excess and harmful chemicals, acids, alkalies, or any substance which might be harmful to plant growth. Saltwater shall not be used.

END OF SECTION

This page intentionally left blank.

SECTION 02500
AGGREGATE

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. CONTRACTOR shall furnish all labor, materials, tools, supervision, transportation, and installation equipment necessary for the placement of gravel in the leachate collection and detection sumps, around the leachate collection pipes, around the toe drain pipes and access roads.

B. The Work shall include procurement, placement, and testing of all gravel and drainage aggregate.

1.2 RELATED SECTIONS

A. Section 01200 – Description of Schedule Values

B. Section 01050 – Field Engineering (Surveys)

C. Section 02225 - Trenching

D. Section 02716 - Geonet

E. Section 02778 - Geotextile

1.3 SUBMITTALS

A. CONTRACTOR shall submit the following information and samples to ENGINEER a minimum of 14 days prior to starting construction of components that require gravel and drainage aggregates.
   1. The proposed riprap, gravel/aggregate source(s).
   2. The results of a grain-size analysis on the proposed material, conducted in accordance with ASTM C 136.
   3. The results of tests conducted in accordance with ASTM D 3042 to determine insoluble residue of the proposed material.
   4. The results of tests conducted in accordance with ASTM C 88 to determine the soundness of the proposed material.
   5. The results of tests conducted in accordance with ASTM C 535 to determine the soundness, hardness and durability of the proposed material.
   6. The results of tests conducted in accordance with ASTM D 2434 to determine the permeability for the leachate collection and detection sump material and protective cover material.
   7. Demonstration that lime rock meets FDOT specification Sections 230 and 911.
   8. A 100-lb sample of the proposed material.

B. The testing in Paragraph 1.03A above shall be carried out by the CONTRACTOR’s independent geotechnical testing laboratory.

1.4 CONSTRUCTION QUALITY ASSURANCE

A. The installation of the gravel and drainage aggregate will be monitored and tested by the CQA Consultant as outlined in the Construction Quality Assurance (CQA) Plan.

B. CONTRACTOR shall be aware of the activities outlined in the CQA Plan and shall account for these CQA activities in the construction schedule.

PART 2 - PRODUCTS

2.1 MATERIAL

A. Aggregate shall consist of hard, strong, durable, non-carbonate particles that are free of any metal, roots, concrete, debris, organics, and other deleterious materials and coatings. Gravel and drainage aggregates shall be used for the following components:
   1. cell access drive, monitoring station access ramp and utility corridor (lime rock as specified is also acceptable);
   2. construction entrance and check dams;
   3. leachate collection gravel around the leachate collection pipes;
   4. gravel around the toe drain pipes;
   5. leachate collection/detection sumps; and
   6. backfilling under all precast and cast-in-place concrete structures and slabs
   7. rip-rap slope stabilization

B. The aggregate around leachate collection pipes, within the sumps, and around the toe drains shall have less than 10 percent loss of weight when tested in accordance with ASTM D3042.

C. The leachate collection and detection sump gravel shall meet the gradation limits of AASHTO No. 3 coarse aggregate.

D. The toe drain gravel shall meet the gradation limits of AASHTO No. 57 aggregate.

E. Rip-rap shown in the drawings shall meet the following gradation:

Table 02500-1 Rip-Rap Gradation

STANDARD SIEVE SIZES (INCHES)	% BY WEIGHT PASSING
12	100
10	70-100
6	60-80
3	30-50
1	0-15

PART 3 - EXECUTION

3.1 FAMILIARIZATION

A. Prior to implementing any of the work described in this section, CONTRACTOR shall become thoroughly familiar with the site, the site conditions, and all portions of the work falling within this section.

B. Inspection:
   1. Prior to implementing any of the work in this section, CONTRACTOR shall carefully inspect the installed work of all other sections and verify that all work is complete to the point where the work of this section may properly commence without adverse impact.
   2. If CONTRACTOR has any concerns regarding the installed work of other sections, it should immediately notify ENGINEER prior to the initiation of gravel placement.

Failure to notify ENGINEER in writing will be construed as CONTRACTOR's acceptance of the related work of all other sections.

3.2 FIELD QUALITY ASSURANCE

A. The CQA Consultant will visually observe the placement of aggregate.

B. The CQA Consultant will perform conformance testing as described in the CQA Plan.

3.3 INSTALLATION

A. The aggregate shall be placed as shown on the Drawings.

B. Placement of the aggregate shall be performed manually or using a piece of equipment approved by ENGINEER. The maximum drop height shall be 18 IN.

C. Equipment on geosynthetic liner shall meet requirements specified in Section 02300.

3.4 SURVEYING AND CONSTRUCTION TOLERANCES

A. CONTRACTOR shall retain a Surveyor who shall be responsible for all surveying associated with CONTRACTOR's work.

B. The Surveyor shall prepare as-built documentation in accordance with the requirements in Section 01050 of these Specifications.

3.5 PRODUCT PROTECTION

A. CONTRACTOR shall use all means necessary to protect all prior work and materials and completed work of other sections.

B. In the event of damage, CONTRACTOR shall immediately make all repairs and replacements necessary to the approval of the CQA Consultant and at no additional cost to OWNER.

END OF SECTION

This page intentionally left blank.

SECTION 02716
GEONET

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Installation of the geonet in the landfill leachate detection system.

B. Related Sections:
   1. Section 02300 - Earthwork
   2. Section 02775 - HDPE Geomembrane
   3. Construction Quality Assurance Plan

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM).
      a. ASTM D792, Standard Test Method for Density and Specific Gravity (Relative Density) of Plastics by displacement.
      b. ASTM D1505, Standard Test Method for Density of Plastics by the Density-Gradient Technique.
      c. ASTM D1603, Standard Test Method for Carbon Black in Olefin Plastics.
      d. ASTM D4218, Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique.
      e. ASTM D4716, Standard Test Method for Determining the (In-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head.
      f. ASTM D5199, Standard Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes.
      g. ASTM D7179, Standard Test Method for Determining Geonet Breaking Force.

B. Qualifications:
   1. Each manufacturing firm shall demonstrate 5 years continuous experience, including a minimum of 10,000,000 SF of geonet installation in the past 3 years.
   2. Installing firm shall demonstrate that the site Superintendent or Foreman has had responsible charge for installation geonet on several projects of a similar scope.
   3. INSTALLER shall attend pre-installation conference.

1.3 DEFINITIONS

A. MANUFACTURER: MANUFACTURER producing geonet from resin and additives.

B. INSTALLER: The INSTALLERS are the individuals performing the hands-on work in the field.

C. MARV: Minimum Average Roll Value

1.4 SUBMITTALS

A. Prior to manufacturing any geonet, CONTRACTOR shall submit to OWNER the following documentation on the raw materials used to manufacture the geonet.

1. Copies of quality control certificates issued by the raw material supplier including the production dates of the raw material and origin of the raw materials used to manufacture geonet for the project.
2. Results of tests conducted by the Geonet MANUFACTURER to verify the quality of the resin used to manufacture the geonet rolls assigned to the Project and the origin of the resin and quality control certificates issued by the resin supplier.
3. A certification that no reclaimed polymer is added to the resin during the manufacture of the geonet to be used in this Project.

B. Prior to manufacturing any geonet, CONTRACTOR shall submit to OWNER a statement listing:
1. certified minimum property values of the proposed geonets and the tests used to determine those properties; and
2. production capacity available and projected delivery dates for this project.

C. Prior to the shipment of the geonet rolls, CONTRACTOR shall submit to OWNER the following information on geonet production.
1. Manufacturing quality control certificates for each shift's production signed by responsible parties employed by the Geonet MANUFACTURER (such as the production manager).
2. The quality control certificates shall include:
   a. roll numbers and identification;
   b. sampling procedures; and
   c. results of quality control tests, including descriptions of test methods used.
3. The Geonet MANUFACTURER quality control tests to be performed are outlined in Part 2.2 of this Section.
4. A warranty from the Geonet MANUFACTURER as specified in Part 1.6 of this Section shall be submitted.

D. Prior to the shipment of geonet rolls, the Geonet MANUFACTURER shall submit documentation that the geonet meets the property values listed in Table 02716-1, and that the geonets shall:
1. Retain their structure during handling, placement, and long-term service;
2. Be capable of withstanding ultraviolet exposure for at least one year; and
3. Be chemically inert when immersed in the leachate from a typical sanitary landfill.

1.5 CONSTRUCTION QUALITY ASSURANCE

A. The installation of the geonets will be monitored and tested by the Geosynthetics CQA Consultant as outlined in the Construction Quality Assurance (CQA) Plan.

B. Any material that does not conform to these specifications, whether tested by CONTRACTOR or the Geosynthetics CQA Consultant, shall be rejected and shall be replaced by CONTRACTOR at no cost to OWNER.

C. CONTRACTOR shall be aware of the activities outlined in the CQA Plan and shall account for these CQA activities in the construction schedule.

1.6 RESPONSIBILITY

A. CONTRACTOR shall be responsible for purchasing, delivery, receiving shipments, unloading, field handling, storing, installing, quality control, testing, and all other aspects of the installation of the geonet. Materials shall be stored such that Geosynthetics CQA Consultant can read and verify roll information.

B. The Geonet MANUFACTURER shall be a well-established firm with more than five years' experience in the manufacture of geonets and production of a minimum of 10,000,000 SF of geonet for at least 20 completed facilities.

C. CONTRACTOR shall accept and retain full responsibility for all materials and installation and shall be held responsible for any defects in the Work.

D. CONTRACTOR shall be responsible for field handling, storing, installing, and all other aspects of the installation of the geonet.

1.7 WARRANTY

A. CONTRACTOR shall furnish OWNER with an acceptable 1-year written warranty against defects in the material.

PART 2 - PRODUCT

2.1 GEONET MATERIAL PROPERTIES

A. The geonet shall meet or exceed the "Minimum Average Roll Values" specified in Table 02716-1. The Geonet MANUFACTURER shall provide test results for these procedures, as well as a certification that the materials meet or exceed the specified values. The geonet provided by the Geonet MANUFACTURER shall be stock products. The Geonet MANUFACTURER shall not furnish products specifically manufactured to meet the Specification of the Project unless authorized by OWNER.

2.2 MANUFACTURING QUALITY CONTROL

A. The geonet shall be manufactured with quality control procedures that meet generally accepted industry standards.

B. The Geonet MANUFACTURER shall sample and test the geonet, at least once every 100,000 SF to demonstrate that the material conforms to all requirements in Table 02716-1. Transmissivity testing shall be completed at least once every 540,000 SF.

C. Sampling shall, in general, be performed on sacrificial portions of the geonet material such that repair is not required.

D. If a geonet sample fails to meet the quality control requirements of this section, the Geonet MANUFACTURER shall sample and test each roll manufactured in the same lot, or at the same time, as the failing roll. Geonet rolls not meeting the required specifications shall be rejected.

E. Additional sample testing may be performed at the Geonet MANUFACTURER's discretion and expense to more closely identify any non-complying rolls and/or to qualify individual rolls.

2.3 PACKING AND LABELING

A. Geonet material shall be supplied in rolls wrapped in waterproof and opaque protective covers.

B. Geonet rolls shall be labeled with the following information:
   1. MANUFACTURER's name;
   2. product identification;
   3. lot number;
   4. roll number; and

5. roll dimensions.

2.4 TRANSPORTATION

A. CONTRACTOR shall be responsible for transportation of the geonet. CONTRACTOR shall be liable for all damages to the materials incurred prior to and during transportation to the site.

B. Geonet material shall be delivered to the site at least 14 days before the scheduled date of deployment to allow the Geosynthetics CQA Consultant adequate time to inventory and sample the geonet rolls and perform conformance testing on the samples.

2.5 HANDLING AND STORAGE

A. Handling, storage, and care of the geonet prior to and following installation at the site, is the responsibility of CONTRACTOR. CONTRACTOR shall be liable for all damages to the materials incurred prior to final acceptance CONTRACTOR's work by OWNER.

B. CONTRACTOR shall be responsible for storage of the geonet material at the site. The geonet material shall be stored off the ground and out of direct sunlight, and shall be protected from mud, dirt, and dust. CONTRACTOR shall be responsible for any additional storage procedures required by the Geonet MANUFACTURER or Geosynthetics CQA Consultant.

2.6 CONFORMANCE TESTING

A. Samples of the geonet will be removed by the Geosynthetics CQA Consultant at the site and sent to the Geosynthetics CQA Laboratory for testing to assure conformance with the requirements of this section. This testing must be completed prior to deployment of geonet. If mutually agreed upon by OWNER, and CONTRACTOR, samples may be shipped from MANUFACTURER to the Geosynthetics CQA Laboratory, provided that adequate chain-of-custody documentation is prepared and submitted, including origin and destination of sample, lot number, roll number, product name, project name, date of production, and date of shipment, at a minimum.

B. Samples and tests shall be selected by the Geosynthetics CQA Consultant in accordance with this section and the procedures outlined in the CQA Plan.

C. Samples shall be taken at a minimum frequency of one sample per 100,000 SF with a minimum of one sample per lot. If the Geonet MANUFACTURER ships geonet that requires sampling and testing at a frequency greater than one per 100,000 SF, then CONTRACTOR shall pay for the additional CQA sampling and testing beyond one per 100,000 SF.

D. The Geosynthetics CQA Consultant may increase the frequency of sampling in the event that test results do not comply with the requirements of Part 2.1 of this section. CONTRACTOR shall bear the expense of this additional testing.

E. Any geonets that are not certified in accordance with Part 1.4 of this section, or that conformance testing indicates does not comply with Part 2.1 of this section, will be rejected by the Geosynthetics CQA Consultant. The Geonet MANUFACTURER shall replace the rejected material with new material, at no additional cost to OWNER.

PART 3 - EXECUTION

3.1 HANDLING AND PLACEMENT

A. The geonet shall be handled in such a manner as to prevent damage to the geonet.

B. Precautions shall be taken to prevent damage to underlying layers during placement of the geonet.

C. CONTRACTOR shall ballast the geonet layers with sandbags to prevent displacement of the geonet by wind. Such sandbags shall be installed during placement and shall remain on the geonet until it is covered with the succeeding layer. Care shall be exercised when handling sandbags, to prevent rupture or damage of the sandbags.

D. The geonet shall be installed in such a manner as to continually keep the geonet in tension.

E. The geonet shall be positioned by hand after being unrolled to minimize wrinkles.

F. Care shall be taken during placement of geonet material not to trap dirt or excessive dust in the geonet that could cause clogging. If dirt or excessive dust is entrapped in the geonet, it should be cleaned prior to placement of the next material on top of it.

G. Geonet materials shall only be cut using cutting tools approved by the Geonet MANUFACTURER and the Geosynthetics CQA Consultant.

H. Geonet materials shall not be welded.

I. Use nylon ties, plastic fasteners or polymer braid to join stacks together maximum 5-FT along downslope.

J. CQA monitor will monitor the following:
   1. Number of stacked layers
   2. All layers stacked together at the correct place during placement of subsequent layers
   3. Check for sufficient overlap visually
   4. Take pictures.

K. Tools shall not be left on or in the geonet.

L. After unwrapping the geonet material from its opaque cover, the geonet material shall not be left exposed for a period in excess of 30 days unless a longer exposure period is approved by MANUFACTURER.

3.2 SEAMS AND OVERLAPS

A. The geonet components shall be overlapped by at least 4 IN. These overlaps shall be secured by tying maximum 2 FT along cross slope.

B. Tying shall be achieved by nylon cable ties, plastic fasteners, or polymer braid. Tying devices shall be white or yellow for easy inspection. Metallic devices shall not be used.

3.3 REPAIR

A. Any holes or tears in the geonet material shall be repaired by placing a patch extending 1 FT beyond the edges of the hole or tear. The patch shall be secured by tying fasteners through the geonet requiring repair and the patch (the patch shall be secured every 6 IN with approved tying devices). If the hole or tear width across the roll is more

than 50% of the width of the roll, the entire damaged geonet panel shall be removed and replaced.

3.4 PRODUCT PROTECTION

A. CONTRACTOR shall use all means necessary to protect all prior Work and all materials and completed Work of other sections.

B. In the event of damage, CONTRACTOR shall immediately make all repairs and replacements necessary to the approval of the Geosynthetics CQA Consultant and at no additional cost to OWNER.

Table 02716-1 Geonet Drainage Material Property Values(1)

PROPERTIES	QUALIFIERS	SPECIFIED UNITS	TEST VALUES	METHOD
Polyethylene Content	minimum	%	95% by weight	-
Resin Density	minimum	g/cc	0.95	ASTM D 1505/D 792
Carbon Black Content	range	%	2.0 - 3.0	ASTM D 1603/D 4218
Thickness	minimum	mils	300	ASTM D 5199
Tensile Strength	minimum	lb/in	75	ASTM D 7179
Transmissivity (2)	minimum	m^2/sec	2×10^{-3}	ASTM D 4716

(1) All values represent minimum average roll values (i.e., test results for samples collected from any roll in a lot should meet or exceed the values in this table).

(2) Gradient of 0.1, normal load of 10,000 psf, water at 70 degrees F, between steel plates for 15 minutes.

END OF SECTION

SECTION 02775
HDPE GEOMEMBRANE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Purchasing, delivery, receiving shipments, installation, quality control, and testing of a HDPE geomembrane for a landfill bottom liner system.

B. Related Sections include but are not necessarily limited to:
   1. Section 02300 – Earthwork
   2. Section 02777 – Drainage Composite
   3. Section 02776 – Geosynthetic Clay Liner (GCL)
   4. Construction Quality Assurance Plan.

1.2 QUALITY STANDARDS

A. Referenced Standards:
   1. ASTM International (ASTM).
      a. ASTM D792, Standard Test Method for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
      b. ASTM D1004, Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting.
      c. ASTM D1238 Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.
      d. ASTM D1505 Standard Test Method for Density of Plastics by the Density-Gradient Technique.
      e. ASTM D1603 Standard Test Method for Carbon Black in Olefin Plastics.
      f. ASTM D3895 Test Method for Oxidative Induction Time of Polyolefins by Thermal Analysis.
      g. ASTM D4218 Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique.
      h. ASTM D4833 Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
      i. ASTM D5397 Procedure to Perform a Single Point Notched Constant Tensile Load – Appendix (SP-NCTL) Test.
      j. ASTM D5596 Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics.
      k. ASTM D5885 Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High Pressure Differential Scanning Calorimetry.
      l. ASTM D5994 Test Method for Measuring the Core Thickness of Textured Geomembranes.
      m. ASTM D6392 Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods.
   2. The Geosynthetic Research Institute (GRI).
      a. GRI GM6 Pressurized Air Channel Test for Dual Seam Geomembranes.

b. GRI GM13 Standard Specification for Test Properties, Testing Frequency, and Recommended Warranty for High Density Polyethylene (HDPE) Smooth and Textured Geomembrane.
c. GRI GM19a Standard Specification for Seam Strength and Related Properties of Thermally Bonded Homogenous Polyolefin Geomembranes/Barriers.

B. Qualifications:
1. Each manufacturing and fabricating firm shall demonstrate 5 years continuous experience on at least 20 completed facilities with a minimum of 10,000,000 SF of HDPE geomembranes.
2. INSTALLER:
a. Demonstrate 5 years continuous experience on at least 20 completed facilities with a minimum 5,000,000 SF of HDPE geomembranes.
b. Trained and certified by at least one of the named manufacturers in this Part 2.1 of this Specification (not necessarily the manufacturer supplying materials for this Project).
c. Geomembrane INSTALLER Personnel Qualifications:
1) Installation Superintendent shall have worked in a similar capacity on at least five HDPE geomembrane liner jobs similar in size and complexity to the project described in the Contract Documents and supervised the installation of a minimum of 2,000,000 SF of HDPE geomembrane.
2) The Master Seamer shall have completed a minimum of 2,000,000 SF of HDPE geomembrane seaming work using the type of seaming apparatus proposed for use on this Project.
3) Other welders shall have seamed a minimum of 1,000,000 SF of HDPE geomembrane.
3. Geosynthetics CQA Laboratory shall demonstrate 3 years of continuous experience in geosynthetic materials testing similar to the testing contained herein.

C. Quality Assurance:
1. The OWNER or OWNER's representative will conduct independent testing to support construction quality assurance program and to provide documentation of such to appropriate regulatory agencies.
2. Unless specifically superseded by these contract documents or approved plans submitted by the CONTRACTOR, the geosynthetic materials shall be manufactured, stored, placed, seamed, tested and protected as described in EPA/600/R-93/182 and EPA/530/SW-91/051.
a. This specifically includes:
1) Material Composition.
2) Manufacturing.
3) Handling and Packaging.
4) Shipment.
5) Storage (Manufacturer and Site).
6) Placement:
a) Seaming and Joining.
b) Destructive and Non Destructive Testing.
c) Protection, Backfilling and Covering.
7) Conformance Testing.
8) Anchoring and Anchor Trenches.
9) Access Roads/Ramps.

D. CQA Plan Implementation: Construction Quality Assurance will be performed in accordance with the Specifications and permitted CQA Plan prepared for this project. The CONTRACTOR and Geomembrane INSTALLER should familiarize themselves with the CQA Plan.

E. Certifications:
   1. Certifications are required for various aspects of the project related to the HDPE geomembrane liner system construction.
      a. Unless alternately approved, the certificates provided at the end of this section shall be used and no alterations, additions, deletions, or exception shall be made to the specified language.

F. INSTALLER's construction quality control programs to include, but not be limited to, installation testing, including both nondestructive and destructive quality control field testing of the sheets and seams during installation of the geomembrane, proposed methods of testing geosynthetic joints and connections at appurtenances for continuity, documentation and changes, alterations, repairs, retests, and acceptance.

G. Geomembrane INSTALLER's installation manual to include:
   1. Ambient temperature at which the seams are made
   2. Control of panel lift up by wind
   3. Acceptable condition of the subsurface beneath the geomembrane
   4. Quality and consistency of the welding material
   5. Proper preparation of the liner surfaces to be joined
   6. Cleanliness of the seam interface (e.g., the amount of airborne dust and debris present)
   7. Proposed details for connecting the HDPE liner to appurtenances, i.e. penetrations of the containment facilities.
   8. A complete description of seaming by extrusion welding and hot-wedge welding.
   9. Requirements of the MANUFACTURER's Installation Manual unless exceptions are noted.

1.3 DEFINITIONS AND RESPONSIBILITIES

A. CONTRACTOR shall be responsible for purchasing, delivery, receiving shipments, unloading, field handling, storing, installing, quality control, testing, and all other aspects of the installation of the geomembrane. Materials shall be stored such that Geosynthetics CQA Consultant can read and verify roll information.

B. Geomembrane MANUFACTURER: MANUFACTURER of geomembranes producing geomembrane sheets from resin and additives. The manufacturer is responsible for producing geomembrane sheet which complies with these Specifications. These responsibilities include but are not limited to:
   1. Acceptance of the resin and additives from chemical formulators. Testing of the raw resin and additives to ensure compliance with the manufacturer's specifications and with this Specification.
   2. Formulation of the resin and additives into geomembrane sheeting using mixing and extrusion equipment.
   3. Testing of the geomembrane sheet to ensure compliance with manufacturer's specification and this Specification.
   4. Shipping of the geomembrane sheet to INSTALLER or OWNER designated facilities.
   5. Certification of the raw materials and finished geomembrane sheet to comply with this Specification.

6. Certification of installer's training, experience, and methods for welding and inspection of geomembrane installations in compliance with manufacturer's standards.

C. Geomembrane INSTALLER. INSTALLER of geomembranes is responsible for handling, fitting, welding, and testing of geomembrane sheets or blankets in the field. These responsibilities include but are not limited to:
   1. Acceptance (in writing) of the geomembrane from the manufacturer.
   2. Acceptance (in writing) subgrade followed by GCL surface layer will serve as a base for the geomembrane. This acceptance shall precede installation of the geomembrane and shall state that the installer has inspected the surface, and reviewed the Specifications for material and placement, and finds all conditions acceptable for placement of geomembrane liners. The written acceptance shall explicitly state any and all exceptions to acceptance.
   3. Handling, welding, testing, and repair geomembrane liners in compliance with this Specification and the Geomembrane INSTALLER's Installation Procedures Manual.
   4. Performance of QC testing and record keeping as required by the approved Geomembrane INSTALLER's Field Installation Procedures Manual.
   5. Repair or replacement of defects in the geomembrane as required by the Geosynthetics CQA Consultant.

D. Inspector:
   1. Inspectors of HDPE geomembrane are the individuals responsible for observing field installation of the geosynthetic materials and providing the MANUFACTURER, INSTALLER, Geosynthetics CQA Consultant, and OWNER with verbal and written documentation of the compliance of the installation with this specification and with written procedures manuals prepared by the MANUFACTURER or INSTALLER.

E. Geosynthetics CQA Laboratory shall:
   1. Perform conformance testing and destructive testing of the HDPE geomembrane.

F. INSTALLER’s QC Consultant: Responsible for observing field installation of the geomembrane and performance of material conformance and CQC testing to provide the CONTRACTOR with verbal and written documentation of the compliance of the installation with these Specifications. The CQC Consultant reports to the CONTRACTOR and is part of this contract.

G. Geosynthetics CQA Consultant: Responsible for implementing CQA Plan including reviewing material conformance testing, review destructive testing, field installation of the geomembrane, and CQC activities, and to perform limited CQA conformance testing to provide OWNER with verbal and written documentation of the compliance of the installation with these Specifications. The Geosynthetics CQA Consultant will use the written results of the CQC program and the CQA program in the preparation of the Project Certification Document. The Geosynthetics CQA Consultant reports to the OWNER and is not part of this contract.

H. Refer to the accompanying CQA Plan for additional definitions.

1.4 SUBMITTALS

A. Shop Drawings:
   1. At least 14 days prior to installation submit for OWNER's approval Shop Drawings, including:

a. MANUFACTURER's certification that raw materials and sheet materials comply with required materials, mil thickness, and material properties. Original certificates are required.
b. MANUFACTURER/Fabricator/INSTALLER quality control requirements.
c. Qualifications and experience of key personnel per 1.2 B of this section.
d. MANUFACTURER's written acceptance of Geomembrane INSTALLER's qualifications for installation of the HDPE geomembrane.
e. HDPE Geomembrane panel layout plan with proposed size, number, position and sequencing of liner panels and showing the location and direction of all field or factory joints.
    1) Proposed details for connecting the geosynthetic materials to appurtenances.
    2) Proposed methods of welding, seaming or jointing geosynthetic materials.
    3) Proposed method and sequencing for placement of geomembrane on top of GCL.
    4) Proposed method and sequencing for placement of geocomposite on top of the HDPE geomembrane liner.
    5) Proposed method of testing HDPE geomembrane and other geosynthetic materials, joints and connections at appurtenances for continuity.
    6) Proposed details for anchor trench if different than included in Contract Documents.

B. Miscellaneous:
1. Test results:
    a. Resin test, tests of sheet material and factory seam tests at frequency specified in respective quality control manuals.
        1) Results shall include or bracket the rolls delivered for use in the Work.
    b. Daily test seam results.
    c. Daily results of production seam testing.
    d. At least 14 days prior to geomembrane deployment, manufacturing quality control certificates for each shift's production shall be submitted. The certificates shall identify the origin of the resin and the manufacturer of geomembrane. The certificates shall be signed by responsible parties employed by the manufacture (such as the production manager). The quality control certificate shall include:
        1) roll numbers and identification;
        2) sampling procedures; and
        3) results of quality control tests, including a description of the test methods used.
    e. At least 14 days prior to shipment of the geomembrane, leachate compatibility test data shall be submitted to OWNER.
    f. Warranties as described below.
2. Submit written certifications that:
    a. Utilize certification forms from this section unless alternately approved. Make appropriate number of copies, as required.
    b. The HDPE geomembrane material delivered to site meets the requirements of this Specification.
    c. The HDPE geomembrane were received and accepted in undamaged condition from shipper.
    d. The subgrade has been properly prepared and acceptable for the placement of the HDPE geomembrane.

e. The HDPE geomembrane liner was installed in accordance with this Specification, Project Drawings and with approved Shop Drawings.
f. The HDPE geomembrane joints were inspected, tested for strength and continuity, and passed all inspections and tests.
g. All test and inspection data shall be incorporated into this certification.
h. The geocomposite layer on top of the HDPE geomembrane liner was placed properly and carefully.

3. MANUFACTURER/INSTALLER's Field Installation Procedures Manual shall clearly identify any exceptions taken to the specified execution of the Work.
4. At least 14 days prior to shipment of the geomembrane, recommendations for unloading, field handling, and stockpiling of the geomembrane shall be submitted.
5. During the installation, the Geosynthetics INSTALLER shall be responsible for the timely submission to the Geosynthetics CQA Consultant of:
   a. quality control documentation;
   b. panel layout with destructive tests, panel boundaries and repairs shown; and
   c. subgrade acceptance certificates, signed by the INSTALLER, for each area to be covered by the geomembrane
6. Record Drawings: Submit reproducible drawings of record showing changes from the approved installation drawings. The record drawings shall include the identity and location of each repair, cap strip, penetration, boot, and sample taken from the installed geosynthetic for testing. The record drawings shall show locations of each type of material, anchor trenches and the construction baseline.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Unused or stockpiled HDPE geomembrane shall be stored in accordance with the manufacturer's recommendations.

B. Each roll shall be labeled with the manufacturers name, type, lot number, roll number, and roll dimensions (length, width, gross weight).
   1. HDPE geomembrane or plastic wrapping damaged as a result of storage or handling shall be repaired or replaced, as directed.
   2. HDPE geomembrane shall not be exposed to temperatures in excess of 60 DegC (140 DegF) or less if authorized by the MANUFACTURER.

C. No hooks, tongs or other sharp instruments shall be used for handling the HDPE geomembrane.
   1. Rolls shall not be lifted by use of cables or chains in contact with the HDPE geomembrane.
   2. HDPE geomembrane shall not be dragged along the ground.

1.6 PROJECT CONDITIONS

A. When the weather is of such a nature as to endanger the integrity and quality of the installation, whether this is due to rain, high winds (exceeding 20 MPH), cold temperatures, or other weather elements, the installation of the geomembrane shall be halted at the direction of, or with the concurrence of, the OWNER until the weather conditions are satisfactory.

B. Ensure that adequate dust control methods are in effect to prevent the unnecessary accumulation of dust and dirt on geosynthetic surfaces which hamper the efficient field seaming of geosynthetic panels or performance.

C. Maintain natural surface water drainage diversions around the work area and provide for the disposal of water which may collect in the work area directly from precipitation falling within the area or from inadequate diversion structures or practices.

D. Coordinate the installation of the leachate collection system which shall be in accordance with Geomembrane INSTALLER's Installation Manual and as specified in these Specifications and shown on the Contract Drawings.

E. Vehicles, other than those specifically approved, will not be allowed on HDPE membrane liner unless at least 24 IN of protective soil cover has been placed over these materials.
   1. No vehicle shall access the completed Work unless it can be demonstrated that its weight, movement or activities will not damage the Work.
   2. When damage is suspected uncover area, repair damage if required, and recover area at no cost to OWNER.
   3. Suspect areas may be identified by OWNER.

1.7 WARRANTIES

A. Written warranties addressing HDPE geomembrane material and installation workmanship shall be furnished by the CONTRACTOR and shall be made to the OWNER.

B. Submit material samples and warranties prior to shipment.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS AND/OR GEOMEMBRANE INSTALLERS

A. Subject to compliance with the Contract Documents, the following manufacturers and installers are acceptable:
   1. HDPE Geomembrane liners manufacturers:
      a. AGRU America, Inc.
      b. Solmax.
      c. Poly-Flex Inc.
   2. HDPE Geomembrane Liner Installers:
      a. Authorized installers of approved manufacturers.
      b. Other installers may qualify by providing references for a minimum of 10,000,000 SF of liner installations.

B. Submit requests for substitution to OWNER for approval.

2.2 RESIN

A. Reclaimed polymer shall not be added to the resin; however, the use of polymer recycled during the manufacturing process shall be permitted if approved by OWNER and if the recycled polymer does not exceed 2 percent by weight of the total polymer weight. The geomembrane shall be manufactured from new, first-quality polyethylene resin, and shall be designed and manufactured specifically for use in geomembranes. No additives or fillers may be added to the resin prior to or during manufacture of the HDPE geomembrane.

B. The resin shall comply with the following HDPE specified properties.
   1. Specific Gravity: 0.932 (ASTM D 1505 or ASTM D792 Method B)
   2. Melt Index: 1.0 g/10 minute, maximum (ASTM D1238 Condition E 190°C, 2.16 kg)

2.3 MATERIALS

A. HDPE Geomembrane Liner:
   1. Consists of unreinforced polyethylene.
   2. Thickness: 60 mils for bottom liner.
   3. No additives or fillers may be added to the resin prior to or during manufacture of the HDPE geomembrane.
   4. Manufactured to be free of holes, blisters, undispersed raw materials, or any sign of contamination by foreign matter.
      a. Any such defects shall be cause for rejection of the material.
      b. Minor defects may be repaired in accordance with Part 3.2.
   5. Manufactured as seamless rolls.
      a. Minimum width: 22 FT as delivered to the site.
   6. Prior to shipment, the geomembrane manufacturer will provide the Geosynthetics CQA Consultant and the INSTALLER's QC Consultant with a quality control certificate for each roll of geomembrane provided. The quality control certificate will be signed by a responsible party employed by the geomembrane manufacturer and will include:
      a. Roll numbers and identification; and
      b. The results of quality control tests performed under the MQC program.
   7. The INSTALLER's QC Consultant will verify that a control certificate has been received for each roll and that the certified roll properties meet the requirements of these Specifications.
   8. HDPE sheet with **texture** on both sides shall be used for the primary and secondary geomembranes.

B. Manufacturing Quality Assurance (QA): The geomembrane liner shall be manufactured in accordance with a written quality assurance/quality control program (QC). This QA/QC program shall be submitted to the OWNER or CQA Consultant, together with shop drawings showing the layout of geomembrane liner in the containment facility. After this QA/QC program has been approved by the OWNER or Geosynthetics CQA Consultant, the MANUFACTURER shall not deviate from the program without written approval of the OWNER or Geosynthetics CQA Consultant. The geomembrane liner material shall meet or exceed GRI GM13 and the requirements in Table 02775-1.

Table 02775-1 Geomembrane Property Requirements

ITEM	ASTM TEST METHOD	TEST VALUE	MIN. TEST FREQUENCY	
			MQC	CQA
Density (Resin)	D1505 or D792 Method B	>0.940 g/cc	1/200,000 lb	1/500,000 ft^2
Sheet Thickness (Note 1) •Minimum Average •Lowest Individual 8 of 10 •Lowest Individual 10 of 10	D5994	60 mil nominal - 5% nominal - 10% nominal - 15%	Per roll	1/100,000 ft^2
Asperity Height, Minimum Average	ASTM D7466	16 mil	Every 2nd roll	N/A

ITEM	ASTM TEST METHOD	TEST VALUE	MIN. TEST FREQUENCY	
			MQC	CQA
Minimum Tensile Properties • Yield Stress • Break Stress • Elongation at Yield • Elongation at Break (2 IN gage length)	ASTM D6693, Type IV	126 ppi 90 ppi 12% 100%	1/20,000 lb	1/100,000 ft^2
Min. Tear Resistance Initiation	D1004, Die C	42 lbs	1/45,000 lb	1/100,000 ft^2
Carbon Black Content	D1603 or D4218	2.0-3.0%	1/20,000 lb	1/100,000 ft^2
Carbon Black Dispersion	D5596	Category 1 or 2	1/45,000 lb	1/100,000 ft^2
Puncture Resistance, Minimum Average	D4833	90 lbs	1/45,000 lb	1/100,000 ft^2
Oxidative Induction Time, Minimum Average	D3895 or D5885	100 min. 400 min.	1/lot, and 1/200,000 lb	N/A
Stress Crack Resistance	D5397	500 hr	1/lot	N/A
UV resistance (high pressure)	ASTM D5885	50%	1/formulation	N/A
Oven Aging (high pressure, min ave)	ASTM D5885	80%	1/formulation	N/A

Notes:
1. Thickness shall be monitored continuously through the manufacturing process or measured physically at a frequency of not less than one per roll of manufactured geomembrane.
2. Routine testing of fabricated seams, where applicable, shall include seam shear strength and seam peel strength at a frequency of not less than one per 500 liner FT of seam. The Fabricator shall test all seams using one of the methods specified in Paragraph 3.2.C.2.

C. Extrusion rod shall be manufactured from identical resin to that used in geomembrane manufacture. Manufactured extrusion rod shall be tested for carbon black, specific gravity and melt index at a frequency of not less than one test per batch.

D. The MANUFACTURER shall reject resin shipments which do not conform with the density and melt index requirements of the approved QA/QC program. The MANUFACTURER shall reject manufactured geomembrane which does not conform to the sheet physical requirements of the approved QA/QC program. The MANUFACTURER shall reject fabricated seams, where applicable, which do not exhibit seam shear strength of greater than 120 lbs per inch of width, and seam peel strength of greater than 91 lbs per inch of width (hot wedge) or 78 lbs per inch of width (extrusion).

2.4 MANUFACTURING QUALITY CONTROL

A. Resin:
   1. The MANUFACTURER shall sample and test the resin to demonstrate that the resin complies with the Specifications. The MANUFACTURER shall certify in writing that the resin meets the Specifications and shall be held liable for any non-compliance.
   2. Any geomembrane manufactured from non-complying resin shall be rejected.
   3. Conformance testing, as defined in Part 2.7 of this section and in the CQA Plan, will be carried out by the Geosynthetics CQA Consultant. If the MANUFACTURER's

and Geosynthetics CQA Consultant test results differ, the tests will be repeated by the Geosynthetics CQA Consultant, and the MANUFACTURER will be allowed to monitor this testing. The results of this latter series of tests will prevail, provided that the applicable test methods, as detailed in the CQA Plan, have been followed.

B. Rolls:
   1. The MANUFACTURER shall continuously monitor geomembranes during the manufacturing process for inclusions, bubbles, or other defects.
   2. The MANUFACTURER shall continuously spark test geomembranes during the manufacturing process to confirm that no defects were found.
   3. No geomembrane shall be accepted that exhibits any defects.
   4. The MANUFACTURER shall continuously monitor the geomembrane thickness during the manufacturing process.
   5. No geomembrane shall be accepted that fails to meet the specified minimum thickness.
   6. The MANUFACTURER shall sample and test the geomembrane, at a minimum, test frequencies specified in GRI Test Method GM13, subject to any revisions.
      a. Samples taken from stored rolls shall be taken across the entire width of the roll and shall not include the first wrapping or outer layer of the roll (about 3.3 FT).
      b. Samples taken at the time of manufacturing can be obtained from the end of the roll.
      c. Unless otherwise specified, samples shall be 2 FT long by the roll width. The MANUFACTURER shall mark the machine direction on the samples with an arrow.
   7. Any geomembrane sample that does not comply with the Specifications will result in rejection of the roll from which the sample was obtained. CONTRACTOR shall replace any rejected rolls at no additional cost to OWNER.
   8. If a geomembrane sample fails to meet the quality control requirements of this Section, the MANUFACTURER shall sample and test each roll manufactured, in the same resin batch, or at the same time, as the failing roll. Sampling and testing of rolls shall continue until a pattern of acceptable test results is established.
   9. Additional testing may be performed at the MANUFACTURER's discretion and expense, to more closely identify the non-complying rolls and/or to qualify individual rolls.

2.5 EQUIPMENT AND ACCESSORIES

A. Welding and Seaming Equipment:
   1. Equipped with gages showing temperatures at the nozzle (extrusion welder) or at the wedge (wedge welder).
   2. Maintained in adequate numbers to avoid delaying work.
   3. Supplied by a power source capable of providing constant voltage under a combined-line load.
   4. Electric generator shall not be placed directly on the HDPE geomembrane.

B. Field Tensiometer:
   1. Provide a tensiometer for on-site shear and peel testing of HDPE geomembrane seams.
      a. Tensiometer shall be in good working order.
      b. Built to ASTM specifications.
      c. Accompanied by evidence of calibration of equipment and gages within the past six months. The evidence of calibration shall be submitted to the CQA consultant.

2. Tension meter:
   a. Motor driven.
   b. Jaws capable of traveling a measure rate of 2 IN per minute.
   c. Equipped with a gauge that measures the force in unit pounds exerted between the jaws.
   d. Digital readout.

C. Punch Press:
   1. Provide a punch press for the onsite preparation of specimens for testing.
   2. Capable of cutting specimens in accordance with ASTM D6392.

D. Vacuum Box:
   1. Provide a vacuum box for onsite testing of HDPE geomembrane seams in accordance with ASTM D5641.

E. Equipment necessary to perform "Pressurized Air Channel Evaluation of Dual Seamed Geomembranes" in accordance with ASTM D5820.

F. Gages:
   1. Calibrated within past six months.
   2. Specified test values reading near mid-range of the gage scale.

2.6 MANUFACTURER'S RESPONSIBILITIES

A. The MANUFACTURER is responsible for producing geomembrane sheet that complies with this Specification. These responsibilities include but are not limited to:
   1. Resin and additive quality control:
      a. Acceptance of the resin and additives from chemical formulators.
      b. Testing of the raw resin and additives to ensure compliance with the MANUFACTURER's specifications and with this Specification.
   2. Formulation of the resin and additives into sheeting using mixing and extrusion equipment.
   3. Testing of the sheet material to ensure compliance with MANUFACTURER's specifications and this Specification.
   4. Shipping of the sheet material to INSTALLER.
   5. Certification of the raw materials and finished sheet to comply with this Specification.
   6. Certification of INSTALLER's training (unless INSTALLER is certified by other acceptable manufacturer list herein), experience and methods for welding, seaming, joining and inspecting geosynthetic materials installations in compliance with MANUFACTURER's standards and with Quality Assurance requirements of this Specification Part 1.2.

2.7 CONFORMANCE TESTING

A. Samples of the geomembrane will be removed by the Geosynthetics CQA Laboratory or MANUFACTURER's QC Officer at the MANUFACTURER's plant during production of the geomembrane. Samples will be sent to the Geosynthetics CQA Laboratory for testing to assure conformance with the requirements of this section. If mutually agreed upon by OWNER, CONTRACTOR, and FDEP, samples may be shipped from MANUFACTURER to the Geosynthetics CQA Consultant's designated laboratory, provided that adequate chain-of-custody documentation is prepared and submitted, including origin and destination of sample, lot number, roll number, product name, project name, date of production, and date of shipment, at a minimum.

B. Samples and tests will be selected by the Geosynthetics CQA Consultant or MANUFACTURER's QC Officer in accordance with this section and with the procedures outlined in the CQA Plan.

C. Samples will be taken at a minimum frequency of one sample per 100,000 SF with a minimum of one sample per lot. If the MANUFACTURER ships geomembrane that requires sampling and testing at a frequency greater than one per 100,000 SF, then the MANUFACTURER shall pay for the cost of the additional CQA sampling and testing beyond one sample per 100,000 SF.

D. The Geosynthetics CQA Consultant may increase the frequency of sampling in the event that test results do not comply with the requirements of Parts 2.2 and 2.3 of this section. CONTRACTOR shall bear the expense of this additional testing.

E. At a minimum, the geomembrane tests will include those identified in Table 02775-1.

F. Any geomembranes that are not certified in accordance with Part 1.3 of this section, or that do not comply with Parts 2.2, 2.3 and 2.4 of this section, will be rejected by OWNER. CONTRACTOR shall replace the rejected material with new material, at no additional cost to OWNER.

PART 3 - EXECUTION

3.1 GEOSYNTHETIC LINER SYSTEM

A. Subgrade:
   1. Protect GCL, subgrade, and other underlying geosynthetics at all times from damage until such time as the placement of HDPE geomembrane liner and other components of the geosynthetic liner system are complete.
   2. The subgrade shall be prepared in a manner consistent with proper subgrade preparation techniques for the installation of HDPE Geomembrane.
      a. The subgrade shall be properly compacted so as not to settle and cause excessive strains in the HDPE Geomembrane or other synthetic liner materials.
      b. Prior to installation, ensure a surface free of debris, roots, or angular stones larger than 1/2 IN.
      c. In addition, ensure that the subgrade has been rolled to provide a uniform surface.
      d. During installation, ensure that rutting or ravelling is not caused by installation equipment or weathering.
      e. Do not drag geomembrane above GCL or other underlying geosynthetics. Damages to the GCL or other underlying geosynthetics caused by the CONTRACTOR shall be repaired by the CONTRACTOR at the CONTRACTOR's expense.

B. Anchor Trenches:
   1. Geosynthetic materials placed on side slopes shall be anchored into trenches as detailed on the Contract Drawings.
   2. Excavation, backfill and compaction shall be in accordance with Section 02300.

C. HDPE Geomembrane:
   1. Do not deploy geomembrane until all inspections of the GCL layer and other underlying geosynthetics are complete and approval has been given by the OWNER. The OWNER shall be notified a week in advance of initial deployment of geomembrane.

2. General:
   a. INSTALLER of HDPE geomembranes is responsible for handling, fitting, welding, seaming, jointing and testing of geosynthetic materials sheets or blankets in the field in accordance with the CQA Plan.
   b. These responsibilities include but are not limited to:
      1) Acceptance (in writing) of the geosynthetic materials sheets or blankets from the transporter.
      2) Acceptance (in writing) of the subgrade soil layer which will serve as a base for the HDPE geomembrane.
         a) This acceptance shall precede installation of the HDPE geomembrane.
         b) Shall state that the INSTALLER has inspected the surface, and reviewed the Specifications for material and placement, and finds all conditions acceptable for placement of HDPE geomembrane liners.
         c) Shall explicitly state any and all exceptions to acceptance.
      3) Handling, welding, seaming, jointing, testing and repair of HDPE geomembrane liners and other geosynthetic materials are in compliance with this Specification and with written procedures manuals prepared by the MANUFACTURER.
         a) Manual shall be submitted to the OWNER together with Shop Drawings showing the layout of HDPE geomembrane within the facility.
         b) Do not deviate from the procedures included in the manual.
         c) HDPE Geomembrane shall not be placed upon frozen foundation, standing water or other conditions which will result in deterioration of the foundation.
         d) HDPE Geomembrane liner materials shall be laid out according to plans previously approved by the OWNER.
         e) Adjacent rolls of HDPE geomembrane shall overlap a minimum of 3 IN for extrusion seaming and 5 IN for fusion seaming, provided that greater overlap may be required to allow seaming in accordance with the MANUFACTURER's instructions.
      4) Repair or replacement of defects in the geosynthetic materials as required by the Inspector or the OWNER.
      5) INSTALLER and MANUFACTURER may be the same firm.
3. Panel deployment:
   a. Only those panel/sheets that can be seamed in 1 day shall be deployed.
   b. Place panels with minimal handling.
      1) Orient sheets to eliminate or minimize number of horizontal seams on side slopes.
      2) Protect panels from tear, puncture or abrasion.
      3) No seams will be permitted in the leachate collection trench.
   c. Equipment used to deploy the geomembrane shall not damage or rut the subgrade layer.
      1) A rut is defined as a 1/4 IN depression over a 10 FT straight-edged length.
   d. No vehicular traffic is permitted on unprotected HDPE geomembrane, except for low-ground pressure equipment necessary for deployment and installation of overlying geosynthetic layers.
   e. Minimize foot traffic.
      1) Do not allow personnel access to wet or slippery liners without adequate safety precautions.
      2) Do not allow footwear that may damage the geomembrane.

f. Ballast with sandbags to prevent wind uplift as recommended by MANUFACTURER based on local climatic conditions.
   1) Remove and replace all wind damaged panels at no additional cost to OWNER.
   2) If wind causes panels to be displaced, displaced panel may not be reused.
g. Install HDPE geomembrane in stress free, tension free and relaxed condition.
   1) Account for temperature and weather-related impacts when deploying and covering.
   2) Stretching to fit and folding are not permitted.
h. Do not allow HDPE geomembrane to bubble, fold, or create ripples as a result of deployment of drainage layer or protective soil cover placement.
   1) Except as noted on Contract Drawings no folds in HDPE geomembrane will be allowed.
i. Any panel exhibiting stretching caused by placement, covering techniques, or wind shall be removed and may not be incorporated in the final construction.
j. Field seaming:
   1) Field seaming shall be done in accordance with seaming recommendations furnished by the geomembrane MANUFACTURER and GRI GM-19.
   2) Each piece of seaming equipment and each operator shall perform demonstration seams at the start of a shift, whenever equipment is switched on or seaming is interrupted for more than ten minutes, and at other times at the discretion of the INSTALLER and Inspector.
   3) Demonstration seams shall use the same seaming materials and methods to be used in the actual construction.
   4) Surfaces to be seamed shall be clean and dry at the time of seaming.
      a) Precipitation and ponding of water on the HDPE geomembrane shall cause termination of seaming operations.
      b) HDPE geomembrane shall not be seamed when ambient temperatures are below 41 DegF or above 104 DegF, without written consent of HDPE geomembrane MANUFACTURER and OWNER.
   5) HDPE geomembrane sheets shall be seamed continuously without fishmouths or breaks in the seam.
      a) Where fishmouths are unavoidable, the sheet shall be slit to a point such that the sheet lies flat and with no remaining wrinkle.
      b) The two edges of the slit shall be seamed together provided that the overlap for this seam shall be a minimum of 6 IN.
      c) Areas of the slit which do not achieve an overlap of 6 IN, including the terminus of the slit, shall be provided with a patch as discussed below.
   6) All HDPE geomembranes shall be seamed by thermal fusion methods as recommended by the HDPE geomembrane MANUFACTURER and/or INSTALLER.
      a) HDPE geomembrane seaming shall be double wedge weld unless otherwise approved or prohibited by construction.
   7) MANUFACTURER's and/or INSTALLER’s seaming instructions shall specifically address subgrade preparation, seaming materials, temporary and permanent jointing, seaming temperatures including temperatures for seaming materials, seam finishing and curing.
   8) A copy of MANUFACTURER's and/or INSTALLER’s seaming instructions shall be available on site at all times and shall not be deviated from without written approval of the MANUFACTURER/INSTALLER and OWNER.

9) All panels/sheets should be overlapped a minimum of 3 IN for extrusion seaming and 5 IN for fusion seaming.
   a) If horizontal seams are required on side slopes, the upper panel should be lapped over the lower panel.
10) Seaming shall not be conducted in the presence of standing water and/or soft subgrades.
   a) The seamed area shall be cleaned of dust, dirt and foreign material prior to and during the seaming operation.
11) Seaming shall extend to the outside edge of panels/sheets to be placed in anchor and/or drainage trenches.
12) Tack welds shall conform with manufacturers seaming techniques and shall not damage underlying membrane.

k. Patching:
   1) Defects in and damage to HDPE geomembrane sheets shall be repaired by seaming a patch over the defect.
      a) The patch material shall consist of an undamaged piece of HDPE geomembrane cut to provide a minimum of 6 IN of overlap in all directions from the defect.
      b) Round corners shall be utilized on all patches. No bead or spot patching will be accepted.
      c) Torn or permanently twisted HDPE geomembrane shall be replaced at no expense to the OWNER.
   2) Test all patch seams using one of the following nondestructive tests: vacuum tests; spark tests; or ultrasonic tests.
      a) Test patch seams destructively at a frequency of ten percent or a minimum of one test per seaming personnel per day.
      b) This destructive testing may be accomplished using demonstration seams performed adjacent to the liner installation.
l. Smoking is not permitted while on the geomembrane.
m. Field Panel Identification: The INSTALLER's QC Consultant will document that the Geomembrane INSTALLER labels each field panel with an "identification code" consistent with the approved panel layout plan. The location of the label and the color of marker used must be as agreed to in the QA/QC Preconstruction Meeting.

3.2 FIELD QUALITY CONTROL

A. Inspector shall not be a part of the installation program and shall not serve as a substitute for performing the duties or certification required of the MANUFACTURER and INSTALLER.
   1. Inspector's responsibilities include, but are not limited to:
      a. Inspection of the material and the handling and field installation of the geomembranes. Inspection of all welds, repairs and quality control test results.
      b. All exceptions to material or installation shall be documented and furnished to the Geosynthetics CQA Consultant in writing within 48 hours of discovery.
      c. Inspection and Certification of HDPE geomembrane integrity until completion of placement of protective soil cover.

B. Trial Seam Testing:
   1. Trial seams shall be made at the beginning of each seaming period, and at least once every five hours, for each seaming apparatus used in the seaming period. A trial seam shall also be made in the event that the ambient temperature varies

more than +/- 18 DegF since the last passing trial seam or if any seaming apparatus is turned off for any reason.

a. The location of trial seam shall be in an area proposed for the day's production seaming.
b. Equipment, methods and personnel shall be the same as proposed for the day's seaming.

2. Test four replicates (1 IN wide specimens) cut from trial seam a minimum of 6 IN apart. Two replicates shall be tested in shear and two in peel. Field seaming cannot begin until successful trial seams have been completed.
   a. To be acceptable, all four replicate test specimens must meet specified seam strength requirements. The break must occur in the liner material itself, not through peel separation (FTB).
   b. If the field tests fail to meet these requirements, the entire operation shall be repeated.
   c. If the additional test seams fail, the seaming apparatus or seamer shall not be accepted or used for seaming until the deficiencies are corrected and two consecutive successful test seams are achieved.

C. Non-Destructive Seam Testing:
   1. All field seams shall be non-destructively tested over their full length.
      a. Seam testing shall be performed as the seaming work progresses, not at the completion of field seaming.
      b. All testing shall be documented. Any seams which fail shall be repaired and documented.
   2. Non-destructively test all field seams continuously using one of the following nondestructive seam tests: vacuum box; and pressurized air channel test.
      a. Vacuum Testing:
         1) a. The equipment shall comprise the following.
            a) A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, port hole or valve assembly, and a vacuum gauge.
            b) A steel vacuum tank and pump assembly equipped with a pressure controller and pipe connections.
            c) A rubber pressure/vacuum hose with fittings and connections.
            d) A bucket and applicator.
            e) A soapy solution.
         2) The following procedures shall be followed.
            a) Energize the vacuum pump and reduce the tank pressure to approximately 5 psi gauge.
            b) Wet a strip of geomembrane seam having an area larger than the vacuum box assembly with the soapy solution.
            c) Place the box over the wetted area.
            d) Close the bleed valve and open the vacuum valve.
            e) Ensure that a leak tight seal is created.
            f) Examine the geomembrane through the viewing window for the presence of soap bubbles for not less than 10 seconds.
            g) If no bubbles appear after 10 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 3-in. overlap, and repeat the process.

h) All areas where soap bubbles appear shall be marked with a marker that will not damage the geomembrane and repaired in accordance with Paragraph 3.3 of this section.

b. Air Pressure Testing (For Double Fusion Seams Only):
   1) The following procedures are applicable to those processes that produce a double seam with an enclosed space and shall be performed in accordance with GRI GM6..
   2) The equipment shall comprise the following.
      a) An air pump (manual or motor driven), equipped with a pressure gauge, capable of generating and sustaining a pressure between 25 and 30 psi, mounted on a cushion to protect the geomembrane.
      b) A rubber hose with fittings and connections.
      c) A sharp hollow needle, or other approved pressure feed device.
   3) The following procedures shall be followed.
      a) Seal both ends of the seam to be tested.
      b) Insert needle, or other approved pressure feed device, into the channel created by the fusion weld.
      c) Insert a protective cushion between the air pump and the geomembrane.
      d) Energize the air pump to a pressure between 25 and 30 psi, close valve, allow two minutes for pressure to stabilize, and sustain the pressure for not less than 5 minutes.
      e) If loss of pressure exceeds 3 psi, or if the pressure does not stabilize, locate faulty area and repair in accordance with Paragraph 3.3 of this section.
      f) Cut opposite end to verify continuity of seam, remove needle, or other approved pressure feed device, and seal repair in accordance with Paragraph 3.3 of this section.
      g) If upon checking for complete airflow it is found that there is a blockage in the channel, vacuum test the entire seam.

D. Destructive Seam Testing:
   1. A minimum of one destructive test per 500 linear FT of seam, and as many other samples as Geosynthetics CQA Consultant determines appropriate, shall be obtained at locations specified by the Geosynthetics CQA Consultant. Minimum frequency shall be extended up to 1000 FT if electrical leak location survey method is used.
      a. Sample locations shall not be identified prior to seaming.
      b. The samples shall be a minimum of 12 IN wide by 48 IN long with the seam centered lengthwise. Sample size will be adjusted for double track seams or dual hot wedge seams to include both sets of seams.
      c. Each sample shall be cut into three equal pieces with one piece retained by the INSTALLER, one piece given to a Geosynthetics CQA Laboratory, and the remaining piece given to the Geosynthetics CQA Consultant for quality assurance testing and/or permanent record.
      d. Each sample shall be numbered and recorded on the final panel layout record drawing, and cross-referenced to a field log which identifies:
         1) Panel/sheet number.
         2) Seam number.
         3) Top sheet.
         4) Date and time cut.

5) Ambient temperature.
6) Seaming unit designation.
7) Name of seamer.
8) Seaming apparatus temperature and pressures (where applicable).

2. A minimum of four 1 IN wide replicate specimens shall be cut from the INSTALLER's sample.
   a. A minimum of 2 specimens shall be tested for shear strength and 2 for peel adhesion using an approved field quantitative tensiometer. Jaw separation speed shall be 2 IN per minute.
   b. To be acceptable, all replicate test specimens must meet the specified seam strength requirements and fail as Film Tear Bond.
   c. If the field tests pass, 5 specimens shall be tested at the Geosynthetics CQA Laboratory for shear strength and 5 for peel adhesion in accordance with ASTM D6392.
   d. To be acceptable, all 5 replicate test specimens must meet the specified seam strength requirements and fail as Film Tear Bond.
3. The minimum required seam strengths are:

Table 02775-2 Required Seam Strengths

DESCRIPTION	TEST METHOD	REQUIRED VALUE (LBS/IN WIDTH)
HDPE Peel (Hot Wedge)	ASTM D6392	91
HDPE Shear (all)	ASTM D6392	120
HDPE Peel (Extrusion)	ASTM D6392	78

4. If the field or laboratory tests fail, the seam shall be repaired in accordance with the MANUFACTURER's Quality Control manual.
   a. In addition, all destructive seam sample holes shall be repaired the same day as cut.
   b. Certified test results on all field seams shall be submitted to and approved by the Geosynthetics CQA Consultant prior to acceptance of the seam.
5. Repaired areas shall be destructively tested at a minimum of every 500 linear FT of extrusion weld. Minimum frequency shall be extended up to 1000 FT if electrical leak location survey method is used.
   a. All repaired areas shall be non-destructively tested.
6. Destructive testing shall be performed by a Geosynthetics CQA Laboratory not employed by the INSTALLER.
7. A map showing the locations, number and type of all patches shall be prepared and provided to the OWNER.
8. Documentation: The following documentation must be maintained at the project site for review by the Geosynthetics CQA Consultant, OWNER, or Inspector.
   a. Geomembrane INSTALLER's Documentation:
      1) Daily Log: daily record that summarizes panels deployed, seams completed, seam testing, seam repair, personnel on site, weather conditions, and equipment on site.
      2) Material Conformance: maintain original conformance certificate(s) from geomembrane manufacturer.
      3) Subgrade Acceptance Log: maintained originals of subgrade acceptance forms for each panel and signed by the Geomembrane INSTALLER.

4) Panel Log: provides geomembrane roll number used and subgrade acceptance for each panel deployed.
5) Seam Testing Log: provides a complete record of all nondestructive and destructive seam tests performed as part of the Geomembrane INSTALLER's QC program.
6) Seam/Panel Repair Log: provides a complete record of all repairs and vacuum box testing of repairs made to defective seams or panels.
7) As-Built Drawing: maintain an as-built drawing updated on a weekly basis.

E. Destructive Test Failure:
1. The following procedures shall apply whenever a sample fails a destructive test, whether the test is conducted by the Geosynthetics CQA Laboratory, the Geosynthetics Installer's laboratory, or by a field tensiometer. The Geosynthetics Installer shall have two options, as described below.
2. The Geosynthetics Installer can reconstruct the seam (e.g., remove the old seam and reseam) between any two passed test locations.
3. The Geosynthetics Installer can trace the welding path to an intermediate location, a minimum of 10 ft from the location of the failed test (in each direction) and take a small sample for an additional field test at each location. If these additional samples pass the tests, then full laboratory samples shall be taken. If these laboratory samples pass the tests, then the seam shall be reconstructed between these locations. If either sample fails, then the process shall be repeated to establish the zone in which the seam should be reconstructed. In any case, all acceptable seams must be bounded by two locations from which samples passing laboratory destructive tests have been taken. In cases where the length of reconstructed seam exceeds 150 ft, a destructive sample taken from within the reconstructed zone must pass destructive testing. Whenever a sample fails, the Geosynthetics CQA Consultant may require additional tests for seams that were formed by the same seamer and/or seaming apparatus or seamed during the same time shift.
4. CONTRACTOR shall bear the cost of the destructive testing by the Geosynthetics CQA Consultant for those seam samples associated with the above procedure.

3.3 DEFECTS AND REPAIRS

A. All seams and non-seam areas of the geomembrane will be examined by the Geosynthetics CQA Consultant for evidence of defects, holes, blisters, undispersed raw materials and any sign of contamination by foreign matter. The surface of the geomembrane shall be clean at the time of examination. The geomembrane surface shall be swept or washed by the Geosynthetics INSTALLER if surface contamination inhibits examination. The Geosynthetics INSTALLER shall ensure that this examination of the geomembrane precedes any seaming of that section.

B. Each suspect location, both in seam and non-seam areas, shall be nondestructively tested using the methods described Paragraph 3.2 of this section, as appropriate. Each location that fails nondestructive testing shall be marked by the Geosynthetics CQA Consultant and repaired by the Geosynthetics INSTALLER. Work shall not proceed with any materials that will cover repaired locations until laboratory test results with passing values are available.

C. When seaming of a geomembrane is completed (or when seaming of a large area of a geomembrane is completed) and prior to placing overlying materials, the Geosynthetics CQA Consultant shall identify excessive geomembrane wrinkles. The

Geosynthetics INSTALLER shall cut and reseam all wrinkles so identified. The seams thus produced shall be tested like any other seams.

D. Repair Procedures:
   1. Any portion of the geomembrane exhibiting a flaw, or failing a destructive or nondestructive test, shall be repaired by the Geosynthetics INSTALLER. Several repair procedures are specified below. The final decision as to the appropriate repair procedure shall be agreed upon between the Geosynthetics CQA Consultant and the Geosynthetics INSTALLER. The procedures available include:
      a. patching - used to repair large holes, tears, undispersed raw materials, and contamination by foreign matter;
      b. abrading and reseaming - used to repair small sections of extruded seams;
      c. spot seaming - used to repair small tears, pinholes, or other minor, localized flaws;
      d. capping - used to repair long lengths of failed seams; and
      e. removing bad seam and replacing with a strip of new material seamed into place (used with long lengths of fusion seams).
   2. In addition, the following shall be satisfied:
      a. surfaces of the geomembrane that are to be repaired shall be abraded no more than one hour prior to the repair;
      b. all surfaces must be clean and dry at the time of repair;
      c. all seaming equipment used in repair procedures must be approved by OWNER;
      d. the repair procedures, materials, and techniques shall be approved in advance, for the specific repair, by the Geosynthetics CQA Consultant and Geosynthetics INSTALLER;
      e. patches or caps shall extend at least 6 IN beyond the edge of the defect, and all corners of patches shall be rounded with a radius of at least 3 IN.; and
      f. the geomembrane below large caps shall be appropriately cut to avoid water or gas collection between the two sheets.

E. Each repair shall be numbered and logged and shall be nondestructively tested using the methods described in Paragraph 3.2 of this section, as appropriate. Repairs that pass the nondestructive test shall be taken as an indication of an adequate repair. Failed tests will require the repair to be redone and retested until a passing test result is achieved. At the discretion of the Geosynthetics CQA Consultant, destructive testing may be required on large caps at no additional cost to OWNER.

F. The Geosynthetics INSTALLER shall repair damage to the existing HDPE liner tie-in locations. Repairs shall be made according to this Specification.

3.4 MATERIAL IN CONTACT WITH GEOMEMBRANE

A. The Geosynthetics INSTALLER shall take all necessary precautions to ensure that the geomembrane is not damaged during its installation or during the installation of other components of the liner system or by other construction activities. If approved by the Geosynthetics CQA Consultant, additional loosely placed geotextile sections may be used by the Geosynthetics INSTALLER to protect the geomembrane.

B. No granular materials shall be placed directly on the geomembranes at any time. A nonwoven geotextile or geocomposite shall be installed between aggregate and geomembrane and between geonet edges and geomembrane.

C. Unless otherwise specified by OWNER, all equipment operating on earthen materials overlying geosynthetics shall comply with the following:

Table 02775-3 Requirement for Equipment Over Synthetics

ALLOWABLE EQUIPMENT GROUND PRESSURE (PSI)	THICKNESS OF OVERLYING COMPACTED SOIL (FT)
<5	Specific approval required
<10	Specific approval required
<20	2.0
<20	3.0

D. In heavily trafficked areas such as access ramps, and in areas trafficked by rubber tire vehicles, the thickness of overlying compacted fill shall be at least 3 ft.

E. Connection of the geomembrane to appurtenances shall be made according to these Specifications and as shown on the Drawings. Extreme care shall be taken while seaming around appurtenances since neither nondestructive nor destructive testing may be feasible in these areas. The Geosynthetics INSTALLER shall ensure that the geomembrane has not been damaged while making connections to appurtenances.

3.5 GEOSYNTHETIC LINER SYSTEM ACCEPTANCE

A. CONTRACTOR shall retain all ownership and responsibility for the geosynthetic bottom liner system until final acceptance by the OWNER.
   1. OWNER will accept the geosynthetic liner system installation when the installation is finished and all required warranties, test results, and documentation from the CONTRACTOR, MANUFACTURER, Inspector and INSTALLER has been received and approved, and verification of the adequacy of all field seams and repairs, including associated testing, is complete.

END OF SECTION

This page intentionally left blank.

SECTION 02776
GEOSYNTHETIC CLAY LINER (GCL)

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Purchasing, delivery, receiving shipments, installation, quality control, and testing of a GCL for a landfill bottom liner system.

B. Related Sections include but are not necessarily limited to:
   1. Section 02300 – Earthwork
   2. Section 02775 – HDPE Geomembrane

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. D2216, Moisture Content of Soil.
      b. D4643, Determination of Water Content of Soil by Microwave Owen Method.
      c. D4873, Identification, Storage and Handling of Geosynthetic Rolls.
      d. D5261, Measuring Mass Per Unit Area of Geotextiles.
      e. D5321, Standard Test Method for Determining the Shear Strength of Soil-Geosynthetic and Geosynthetic Interfaces by Direct Shear.
      f. D5887, Test Method for Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter.
      g. D5888, Guide for Storage and Handling of Geosynthetic Clay Liners.
      h. D5890, Swell Index of Clay Mineral Component of Geosynthetic Clay Liners.
      i. D5891, Fluid Loss of Clay Component of Geosynthetic Clay Liners.
      j. D5993, Test Method for Measuring Mass Per Unit Area of Geosynthetic Clay Liners.
      k. D6102, Guide for Installation of Geosynthetic Clay Liners.
      l. D6243, Test Method for Determining the Internal and Interface Shear Resistance of Geosynthetic Clay Liner by the Direct Shear Method.
      m. D6496, Determining Average Bonding Peel Strength Between Top and Bottom Layers of Needle Punched GCLs.
      n. D6768, Tensile Strength of Geosynthetic Clay Liner.
   2. Geosynthetic Research Institute (GRI):
      a. GCL-3, Test Methods, Required Properties, and Testing Frequencies of Geosynthetic Clay Liners (GCLs).

B. Quality Assurance:
   1. The Geosynthetics CQA Consultant will direct testing to support construction quality assurance program and to provide documentation of such to appropriate regulatory agencies.
   2. The Geosynthetics CQA Consultant will observe that the GCL is stored, placed, seamed, and protected as described in ASTM D4873, D5888 and D6102.

C. Qualifications:

1. Each manufacturing firm shall demonstrate 5 years continuous experience, including a minimum of 5,000,000 SF of manufacture/fabrication in geosynthetic lining systems. Aggregate experience shall not apply.
2. INSTALLER shall attend pre-installation conference.

1.3 DEFINITIONS

A. CONTRACTOR: CONTRACTOR shall be responsible for purchasing, delivery, receiving shipments, unloading, field handling, storing, installing, quality control, testing, and all other aspects of the installation of the GCL. Materials shall be stored such that Geosynthetics CQA Consultant can read and verify roll information.

B. MANUFACTURER: MANUFACTURER produces geosynthetic clay liner panels from first quality geotextiles and sodium bentonite. The MANUFACTURER is responsible for producing panels which comply with this Specification.

C. INSTALLER: INSTALLERs of GCLs are responsible for storing, handling, fitting, seaming and testing of GCL panels in the field. INSTALLER and MANUFACTURER may be the same firm.

D. Hydrated GCL is defined as material which has become soft as determined by squeezing the material with finger pressure, material which has exhibited swelling, or material which as a moisture content greater than 100 percent as determined by ASTM D2216.

1.4 SUBMITTALS

A. Shop Drawings:
   1. MANUFACTURER's documentation that bentonite, geotextiles and GCL comply with required material properties.
   2. MANUFACTURER and INSTALLER quality control manuals.

B. Miscellaneous Submittals:
   1. Test results:
      a. Bentonite, geotextile and GCL tests at frequency specified in respective quality control manuals. Results shall include or bracket the rolls delivered for use in the Work.
   2. Qualification documentation specified in Part 1.2.
   3. Submit written certifications that:
      a. The GCL delivered to site meets the requirements of this Specification.
      b. The GCL was received and accepted in undamaged condition from shipper.
      c. The subgrade has been properly prepared and acceptable for the placement of the GCL.
      d. The GCL was installed in accordance with this Specification and with approved shop drawings.
      e. The geomembrane on top of the GCL was placed properly and carefully.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Do not place GCL rolls directly on the ground.

B. Store and protect GCL from dirt, water, ultraviolet light, and other sources of damage.

C. Label, handle, and store GCL in accordance with ASTM D4873 and as specified herein.

1. Wrap each roll in an opaque and waterproof layer of plastic during shipment and storage.
2. Do not remove the plastic wrapping until deployment.

D. Label each roll with the MANUFACTURER's name, lot number, roll number, and roll dimensions (length, width, gross weight).
   1. Repair or replace GCL or plastic wrapping damaged as a result of storage or handling, as directed.
   2. Do not expose GCL to temperatures in excess of 71 DegC (160 DegF) or less than 0 DegC (32 DegF) unless recommended by the MANUFACTURER.

E. Do not use hooks, tongs or other sharp instruments for handling the GCL. Do not lift rolls by use of cables or chains in contact with the GCL. Do not drag GCL along the ground.

F. Damaged rolls may be rejected. If rejected, it must be verified that rejected material is removed from the site or stored at a location separate from accepted rolls. GCL rolls that do not have proper MANUFACTURER's documentation must be stored at a separate location until all documentation has been received and approved.

1.6 WARRANTY

A. The MANUFACTURER shall provide a 5-year warranty to the OWNER against manufacturing defects. The warranty shall include defective product found to be not in compliance with the requirements of this specification. Warranty shall not be prorated.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following MANUFACTURERS are acceptable:
   1. Geosynthetic Clay Liners:
      a. CETCO, 1500 W. Shore Drive, Arlington Heights, Illinois 60004.
      b. Solmax, 23 Truman Road, Barrie, Ontario L4M 3V7
      c. AGRU America, 500 Garrison Road, Georgetown, SC 29440

2.2 MATERIALS

A. Geosynthetic Clay Liner:
   1. The active ingredient of the GCL shall be natural sodium bentonite. Encapsulate bentonite between two geotextiles.
   2. Lock-stitch or light heat treatment and needle punched geotextile backed GCL with high strength polypropylene thread to provide internal shear strength reinforcing. The internal shear reinforcing mechanism shall resist failure due to thread pull-out over long-term creep situations.
   3. Continuously adhere the bentonite to both geotextiles to ensure that the bentonite will not be displaced during handling, transportation, storage and installation, including cutting, patching and fitting around penetrations. The bentonite sealing compound or bentonite granules used to seal penetrations and make repairs shall be made of the same natural sodium bentonite as the GCL and shall be as recommended by the GCL MANUFACTURER. The permeability of the GCL overlap seams shall be equal to or less than the permeability of the body of the GCL sheet.

4. Provide material meeting GRI-GCL 3 or as specified in Table 02776-1 below.
5. Internal shear specimens are hydrated for 24 hours and sheared at 200 psf and represent peak value.

Table 02776-1 GCL Properties

ITEM	ASTM TEST METHOD	TEST VALUE	MIN. TEST FREQUENCY	
			MQC	CQA
Geotextile Property				
Cap Nonwoven, mass/unit area	ASTM D5261	6 oz/sy	1/200,000 ft^2	1/100,000 ft^2
Carrier Scrim Nonwoven, mass/unit area	ASTM D5261	6 oz/sy	1/200,000 ft^2	1/100,000 ft^2
Bentonite Property				
Swell Index	ASTM D5890	24 ml/2 g min	1/100,000 lbs	1/100,000 ft^2
Maximum Moisture Content	ASTM D4643 or D2216	12%	1/100,000 ft^2	---
Maximum Fluid Loss	ASTM D5891	18 mL	1/100,000 lbs	---
Finished GCL Property				
Maximum Hydraulic Conductivity (MARV)	ASTM D5887 @5 psi max. confining stress	$5x10^{-9}$ cm/s	1/100,000 ft^2	1/100,000 ft^2
Minimum Bentonite Content (MARV)	ASTM D5993 (@ 0% moisture)	0.75 lb/sf	1/40,000 ft^2	1/100,000 ft^2
Typical Internal Shear Strength[1]	ASTM D6243	500 psf (when hydrated)	1/project	---
Minimum peel strength, MD (MARV)	ASTM D6496	5.3 lbs/in	1/40,000 ft^2	---
Tensile strength, MD (MARV)	ASTM D6768	45 ppi	1/40,000 ft^2	---

2.3 SOURCE QUALITY CONTROL

A. Interface Friction Tests.
   1. This material is part of a system. The system shall meet the requirements before the component material can be deemed acceptable. Testing in accordance with ASTM D5321 and D6243 will include the interfaces between the following adjacent materials:
      a. Subgrade/GCL
      b. GCL/60 mil Textured HDPE Geomembrane
      c. 60 mil HDPE Geomembrane/Geocomposite
      d. Geocomposite/Protective Cover
   2. Interface friction angle testing is the responsibility of the CONTRACTOR. All failing tests shall be the CONTRACTOR's responsibility. Requirements are based on standard practice and permit conditions.

B. The testing shall be performed as follows.

1. Conduct one set of three direct-shear interface friction tests on each of the interfaces listed above. Normal stresses of 5,000 psf, 10,000 psf, and 20,000 psf shall be used during hydration and shearing. Samples shall be allowed to hydrate for a minimum of 3 days prior to shear testing. Orient all geosynthetic materials such that the shear force is parallel to the downslope orientation of these components in the field.
2. A minimum friction angle of 18 degrees is required for each interface in the system defined in Paragraph A.
3. Test interface friction between the GCL and adjacent materials in accordance with ASTM D6243, Procedure B.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Construct, inspect, and test geosynthetic clay liner in accordance with MANUFACTURER's recommendations, this specification and ASTM D6102.

B. Halt installation when the weather is of such a nature as to endanger the integrity and quality of the installation.

C. Assure adequate dust control methods are in effect to prevent the unnecessary accumulation of dust and dirt.

D. Maintain natural surface water drainage diversions around the work area and provide for the disposal of water which may collect in the work area directly from precipitation falling within the area or from inadequate diversion structures or practices.

E. Do not allow vehicles in direct contact with the deployed GCL.

F. Subgrade Preparation:
   1. Prepare subgrade in a manner consistent with proper subgrade preparation techniques for the installation of GCL.
   2. Properly compact the subgrade so as not to settle and cause excessive strains in the GCL or other synthetic liner materials.
   3. Prior to installation, ensure a surface free of debris, roots, or angular stones larger than 1/2 IN.
   4. Subgrade soils proof-rolled with a ten (10) ton drum roller, two (2) passes in each of two (2) perpendicular directions or as directed by Soils CQA Consultant. The subgrade shall be compacted and proof-rolled under observation of the Soils CQA Consultant to assure the maximum practical compaction under the existing field conditions has been achieved. See specification Section 02300 for project specific compaction requirement.
   5. Ensure rutting or raveling is not caused by installation equipment or weather.
   6. Ensure that lines and grades have been verified by the CONTRACTOR and a subgrade acceptance form has been submitted.

G. Construct and backfill anchor trenches.

H. Deploy GCL in a manner to ensure it is not damaged.

I. On slopes, anchor the GCL securely and deploy it down the slope in a controlled manner.

J. Weight the GCL with sandbags or equivalent in the presence of wind.

K. Minimize cutting GCL. Whenever possible, overlap instead of cutting material. If cutting is required, cut GCL with a cutter or other approved device. Seal all cut edges, as recommended by MANUFACTURER, to prevent loss of bentonite. Protect adjacent materials from potential damage due to cutting of GCL.

L. During GCL deployment, do not entrap in or beneath GCL, stones, trash, or moisture that could damage GCL.

M. Visually examine entire GCL surface. Ensure no potentially harmful foreign objects, such as needles, are present.

N. Do not place GCL in the rain or at times of impending rain.

O. Do not place GCL in areas of ponded water.

P. Remove and replace GCL which has been hydrated (above 100% per ASTM 4643) prior to being covered.

Q. In general, only deploy GCL that can be covered during that day.

R. If applicable, face the GCL's woven carrier geotextile against soil of prepared subgrade.

S. Overlaps:
   1. Reinforced GCL shall be overlapped a minimum of 12 IN along the sides and a minimum of 18 IN on butt seams or as recommended by MANUFACTURER, whichever is greater.
   2. For reinforced needle-punched GCLs, add additional granular bentonite to overlapped area at a rate specified by the MANUFACTURER.
   3. All GCL upper geotextiles shall be continuously sewn using polymeric thread.
   4. No horizontal seams will be allowed on side slopes steeper than 10 percent.

T. Defects and Repairs:
   1. On slopes steeper than 10 percent, a patch made from the same GCL shall be seamed into place no closer than 1 IN (25 mm) from any edge. Should any tear exceed 10 percent of the width of the roll, that roll shall be removed from the slope and replaced.
   2. On slopes flatter than 10 percent, a patch made from the same GCL shall be placed with a minimum of 2 FT (0.6-m) overlap in all directions.
   3. Care shall be taken to remove soil or other material that may have penetrated the torn GCL.
   4. Ensure that all defects and defect corrective actions (panel rejected, patch installed, etc.) are recorded, and corrective actions are performed in accordance with this specification.

U. The Geosynthetics CQA Consultant shall observe that the equipment used to install geocomposite does not damage it during handling, deployment, or due to leakage of hydrocarbons or other means.

V. Crews working on the GCL may not smoke, wear shoes that could damage the GCL, or engage in activities that could damage the GCL.

END OF SECTION

SECTION 02777
DRAINAGE COMPOSITE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Purchasing, delivery, receiving shipments, installation, quality control, and testing of a geocomposite (heat bonded geonet/geotextile) for a landfill bottom liner system.

B. Related sections include but are not necessarily limited to:
   1. Section 02300 – Earthwork
   2. Section 02775 – HDPE Geomembrane
   3. Section 02778 - Geotextiles
   4. Construction Quality Assurance Plan

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. ASTM D1238 - Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer.
      b. ASTM D 1505 Standard Test Method for Density of Plastics by the Density-Gradient Technique.
      c. ASTM D4355 - Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus.
      d. ASTM D4491 - Test Method for Water Permeability of Geotextiles by Permittivity.
      e. ASTM D4533 - Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
      f. ASTM D4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
      g. ASTM D4716 - Standard Test Method for Determining the (In-Plane) Flow Rate Per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head.
      h. ASTM D4751 - Standard Test Method for Determining Apparent Opening Size of a Geotextile.
      i. ASTM D5199 - Standard Test Method for Measuring Nominal Thickness of Geosynthetics.
      j. ASTM D5261 - Standard Test Method for Mass Per Unit Area of Geotextiles.
      k. ASTM D6241 - Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe.
      l. ASTM D7005 - Standard Test Method for Determining the Bond Strength (Ply Adhesion) of Geocomposite.

B. Qualifications:
   1. INSTALLER shall attend pre-installation conference.

1.3 DEFINITIONS

A. CONTRACTOR: CONTRACTOR shall be responsible for purchasing, delivery, receiving shipments, unloading, field handling, storing, installing, quality control, testing, and all other aspects of the installation of the drainage composite. Materials shall be stored such that Geosynthetics CQA Consultant can read and verify roll information.

B. MANUFACTURER: MANUFACTURER producing drainage composites from geonet cores and geotextiles.

C. INSTALLER: The INSTALLERs are the individuals performing the hands-on work in the field.

1.4 SUBMITTALS

A. INSTALLER/MANUFACTURER shall submit to OWNER the following documentation on the geocomposite or equal, as indicated below. Approval of the geocomposite will be made by OWNER, based on the documentation, at the sole discretion of OWNER. The geocomposite MANUFACTURER quality control tests to be performed are outlined in Part 2.4 of this section.
   1. As part of the bid a written statement listing:
      a. A certification, accompanied by test results, that the geocomposite or equal material meets or exceed the minimum average roll property values listed in Table 02777-1, for leachate collection and detection geocomposites; and
      b. Production capacity available for this Contract.
   2. A least 14 days prior to manufacturing the geonet component of the geocomposite, the following resin quality control data for each batch of resin assigned for use under this Contract shall be submitted. The certificates shall be signed by responsible parties employed by the MANUFACTURER (such as the production manager). The following shall be included:
      a. Copies of quality control certificates issued by the resin supplier including the production dates of the raw material and origin of the raw materials used to manufacture the geonet for this Contract;
      b. Results of resin density and polymer melt index tests conducted by the resin supplier to verify the quality of the resin used to manufacture the geonet rolls assigned to this Contract and the origin of the resin and quality control certificates issued by the resin supplier; and
      c. A written certification stating that no reclaimed polymer is added to the resin during the manufacture of the geonet assigned for this Contract.
   3. At least 14 days prior to manufacture of the geotextile component of the geocomposite, manufacturing quality control certificates for each batch of resin and each shift's production shall be submitted. The certificates shall identify the origin of the resin and the MANUFACTURER of the resin. The certificates shall be signed by responsible parties employed by the MANUFACTURER (such as the production manager). The quality control certificate shall include:
      a. roll numbers and identification;
      b. sampling procedures; and
      c. results of quality control tests, including a description of the test methods used.
   4. Prior to shipment of the geocomposite, MANUFACTURER's quality control certificates for each shift's production of geotextile, geonet, and geocomposite, signed by a responsible party employed by the MANUFACTURER (such as the

production manager) shall be submitted. The quality control certificate shall include roll numbers of the material manufactured.

5. Prior to shipment of the geocomposite, documentation shall be submitted that the geocomposite furnished meets the property values listed in Table 02777-1, for leachate collection and leak detection geocomposites, that will:
   a. Retain their structure during handling, placement, and long-term service; and
   b. Be capable of withstanding direct exposure to sunlight for a minimum of 30 days with no measurable deterioration.
6. At least 14 days prior to shipment of the geocomposite, recommendations for unloading, field handling, and stockpiling of the geocomposite shall be submitted.
7. At least 14 days prior to shipment of the geocomposite, leachate compatibility test data shall be submitted to OWNER.
8. At least 14 days prior to shipping geocomposite, INSTALLER shall provide the following information to OWNER in writing, regarding the Geosynthetic INSTALLER:
   a. Corporate background, qualifications and other information contained herein; and
   b. Copy of INSTALLER’s letter of approval or license by geocomposite MANUFACTURER allowing the INSTALLER to install the geocomposite.
9. Friction angles of selected interfaces of liner for selected geosynthetics and site specific soil shall be submitted as specified in Part 2.3 at least 14 days prior to shipment of geosynthetics. The friction angles shall be above the minimum angles specified.

1.5 DELIVERY, STORAGE AND HANDLING

A. Label, handle, and store drainage composites in accordance with ASTM D4873 and as specified herein.

B. Wrap each roll in an opaque and waterproof layer of plastic during shipment and storage. Do not remove the plastic wrapping until deployment.

C. Label each roll with the MANUFACTURER's name, drainage composite type, lot number, roll number, and roll dimensions (length, width, gross weight).

D. Repair or replace, as directed by the OWNER, drainage composite or plastic wrapping damaged as a result of storage or handling.

E. Do not expose drainage composite to temperatures in excess of 71 DegC (160 DegF) or below 0 DegC (32 DegF) unless recommended by the MANUFACTURER.

F. Do not use hooks, tongs or other sharp instruments for handling the drainage composite.

G. Do not lift rolls by use of cables or chains in contact with the drainage composite.

H. Do not drag drainage composite along the ground or across textured geomembranes.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. The recommended product for the project is 330 mil high-density biplaner geonet product manufactured by Skaps Industries identified as TN330 or approved equal. If an

equivalent product is proposed, then the product information should be submitted with the bid per Part 2.2 D.

2.2 MATERIALS AND MANUFACTURE

A. Geonet Core:
   1. The geonet core should be a standard product of the MANUFACTURER. Specifically manufactured cores that meet project specifications are not acceptable.
   2. Use non-thermally degraded polyethylene polymer which is clean and free of any foreign contaminants.
   3. Manufactured geonet to conform to the property requirements listed in Table 02777-1, and be free of defects including tears, nodules or other manufacturing defects which may affect its serviceability.

B. Geotextile:
   1. Cover geonet core on both sides with a geotextile complying with requirements specified in Table 02777-1.

C. Drainage Composite:
   1. Create a composite by heat bonding geotextiles to the geonet. Minimum requirements for geocomposite are specified in Table 02777-1, for leachate collection and leak detection geocomposites.

D. Equivalent Material:
   1. CONTRACTOR may submit a substitution request for equivalent material that meets the minimum requirements as specified in Table 02777-1. Following should be considered when estimating the equivalency:
   2. Minimum thickness 330 mil +/-15%.
   3. Minimum transmissivity based on Table 02777-1.
   4. 10,000 hr Creep Reduction Factor for geonet core at 15,000 PSF and 40°C shall be less than 1.18.

2.3 SOURCE QUALITY CONTROL

A. Transmissivity Testing:
   1. Measure transmissivity according to ASTM D 4716 as described in Table 02777-1.
   2. Attach geotextiles to the geonet in the same configuration as will be used in the field.
   3. Boundary conditions for geocomposite are protective cover (or Ottawa Sand) interface on the upper geotextile and 60 mil textured HDPE geomembrane against the lower geotextile.
   4. The testing shall be conducted at 10,000 psf loading for a minimum period of 100 hour.

B. Interface Friction Tests.
   1. Refer to Section 02776, Geosynthetic Clay Layer (GCL) for test requirements.

2.4 MANUFACTURING QUALITY CONTROL

A. The gecomposite and its components shall be manufactured with quality control procedures that meet generally accepted industry standards.

B. The geocomposite MANUFACTURER shall sample and test the geocomposite, and its components, to demonstrate that the material complies with this Specification. Sampling shall, in general, be performed on sacrificial portions of the geocomposite material such that repair is not required.

C. The geocomposite MANUFACTURER shall sample and test the geocomposites, at the specified frequency, to demonstrate that its properties confirm to the values specified in Table 02777-1 for leachate collection and leak detection zones.

D. The geocomposite MANUFACTURER shall provide test results to OWNER demonstrating that the geocomposite MANUFACTURER performed the tests and that results were obtained that meet or exceed the transmissivity value required in Table 02777-1, for leachate collection and leak detection zones.

E. Any geocomposite sample that does not comply with the Specifications will result in rejection of the roll from which the sample was obtained. MANUFACTURER shall replace any rejected rolls at no additional cost to OWNER.

F. If a geocomposite sample fails to meet the quality control requirements of this section, the geocomposite MANUFACTURER shall sample and test each roll manufactured in the same lot, or at the same time, as the failing roll. Sampling and testing of rolls shall continue until a pattern of acceptable test results is established.

G. Additional sample testing may be performed, at the geocomposite MANUFACTURER's discretion and expense, to more closely identify any non-complying rolls and/or to qualify individual rolls.

2.5 CONFORMANCE TESTING

A. Samples of the geocomposite will be removed by the Geosynthetics CQA Consultant or Geosynthetics CQA Laboratory Representative at MANUFACTURER's plant during production of the geocomposite. The Geosynthetics CQA Consultant or Geosynthetics CQA Laboratory Representative will sample the geotextile and geonet components before the components are bonded together and will sample the geocomposite material after the individual components are bonded. Samples will be sent to the Geosynthetics CQA Laboratory for testing to assure conformance with the requirements of this section. If mutually agreed upon by OWNER, CONTRACTOR, and FDEP, samples may be shipped from MANUFACTURER to the Geosynthetics CQA Consultant's designated laboratory, provided that adequate chain-of-custody documentation is prepared and submitted, including origin and destination of sample, lot number, roll number, product name, project name, date of production, and date of shipment, at a minimum.

B. Samples and tests shall be selected by the Geosynthetics CQA Consultant in accordance with the procedures outlined in the CQA Plan.

C. Samples shall be taken at a minimum frequency as indicated in the CQA Plan with a minimum of one sample per lot. If CONTRACTOR ships geocomposite that requires sampling and testing at a frequency greater than that required in the CQA Plan, then CONTRACTOR shall pay for the additional CQA sampling and testing beyond the CQA Plan requirements.

D. The Geosynthetics CQA Consultant may increase the frequency of sampling in the event that test results do not comply with the requirements of this section. CONTRACTOR shall bear the expense of this additional testing.

E. As a minimum, tests listed in Table 02777-1 shall be performed.

F. Any geocomposite material that is not certified in accordance with Part 1.4 of this section, or that conformance testing indicates do not comply with Part 2 of this section,

will be rejected by OWNER. CONTRACTOR shall replace the rejected material with new material, at no additional cost to OWNER.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Prior to placement of the drainage geocomposite, clean the surface of all soil, rock, and other materials which could damage the geocomposite.

B. The geocomposite shall be placed only on geomembrane that has been approved by the Geomembrane INSTALLER and accepted by the Geosynthetics CQA Consultant.

3.2 INSTALLATION

A. Install geocomposite in accordance with manufacturer's written recommendations.

B. Deploy the drainage composite ensuring that the drainage composite and underlying materials are not damaged. Replace or repair faulty or damaged drainage composite as directed by OWNER.

C. Unroll drainage composite downslope keeping in slight tension to minimize wrinkles and folds. The bottom layers of geotextile shall be overlapped.

D. Maintain free of dirt, mud, or any other foreign materials at all times during construction. Clean or replace rolls which are contaminated.

E. Place adequate ballast to prevent uplift by wind.

F. Overlap adjacent rolls a minimum of 4 inches. Overlap new drainage composite over existing as shown on the drawings.

G. Use nylon cable ties, plastic fasteners, or polymer braid to join adjacent rolls. Metallic fasteners will not be allowed. Space fasteners a maximum of 5 feet along downslope roll overlaps and a maximum of 2 feet along cross slope roll overlaps. Space fasteners every 6 inches in the anchor trench and at tie-ins with previously deployed material from a former project. Space fasteners every 10 feet on horizontal surfaces. Use fasteners of contrasting color from the drainage composite to facilitate visual inspection. Do not weld drainage composite to geomembranes.

H. The top layers of geotextile will be continuously sewn. The geotextiles may be heat-bonded in lieu of sewing at the discretion of the ENGINEER.

I. Any holes or tears in the geocomposite material shall be repaired by placing a patch extending 1 foot beyond the edges of the hole or tear. The patch shall be secured by tying fasteners through the bottom geotextile and the geonet of the patch, and through the top geotextile and geonet on the slope. The patch shall be secured every 6 inches using ties as indicated in Part 3.2g by the INSTALLER. The top geotextile component of the patch shall be thermally bonded to the top geotextile of the geocomposite needing repair. If the hole or tear width across the roll is more than 50 percent of the width of the roll, the entire damaged geocomposite panel shall be removed and replaced.

J. Penetration details shall be as recommended by the MANUFACTURER and as approved by the OWNER.

Table 02777-1 Double Sided Geocomposite Property Values for Leachate Collection and Leak Detection Zone(1)

Properties	Qualifiers	Units	Values	Test Method	Test Frequency	
					MQC	CQA
Geonet Component						
Resin Polymer Melt Index	maximum	g/10 min.	1.0	ASTM D1238	1 per batch	n/a
Polymer Density (geonet)	Minimum	g/cc	0.94	ASTM D 1505	1/100,000 SF	1/100,000 SF
Carbon Black Content	range	%	2.0 - 3.0	ASTM D 1603	1/100,000 SF	1/100,000 SF
Thickness	minimum	mils	330 +/-15%	ASTM D 5199	1/100,000 SF	1/100,000 SF
Tensile Strength (MD and TD)	minimum	lb/in	75	ASTM D 7179	1/100,000 SF	1/100,000 SF
Geotextile Component						
Polymer Composition	minimum	%	95 polyester or polypropylene	-	n/a	n/a
Mass Per Unit Area	minimum	oz/yd^2	6	ASTM D 5261	1/100,000 SF	1/100,000 SF
Apparent Opening Size	maximum	US Sieve	#70	ASTM D 4751	1/100,000 SF	n/a
Flow Rate(4)	minimum	$gal/min./ft^2$	110	ASTM D 4491	1/500,000 SF	n/a
Permittivity(4)	minimum	sec^{-1}	1.2	ASTM D 4491		1/500,000 SF
Grab Strength	minimum	lb	160	ASTM D 4632	1/100,000 SF	1/100,000 SF
CBR Puncture Strength	minimum	lb	435	ASTM D 6241	1/100,000 SF	1/100,000 SF
Tear Strength	minimum	lb	65	ASTM D 4533	1/100,000 SF	1/100,000 SF
UV Resistance	minimum	% retained	70	ASTM D 4355 (after 300 hours)	n/a	n/a
Geocomposite						
Transmissivity@10,000 psf(3)	minimum	m^2/s	2.0×10^{-3}	ASTM D 4716	1/500,000 SF	1/500,000 SF
Ply Adhesion	minimum	lb/in.	1.0	ASTM D 7005	1/100,000 SF	1/500,000 SF

Notes:

1) All values represent minimum average roll values (i.e., test results for samples collected from any roll in a lot should meet or exceed these values).
2) The density of the net resin shall not exceed that of the geomembrane (see Section 02775).
3) Transmissivity @ 100hour: Measure transmissivity using water at 68 DegF with a normal compressive load of 10,000 psf and a hydraulic gradient of 0.02 (ASTM D 4716). Boundary conditions are provided in Section 2.3. Measurements shall be taken 100 hour after application of confining pressure if satisfies the requirements given in Part 2.3A.
4) Either flow rate requirement or permittivity requirement shall be met.

END OF SECTION

This page intentionally left blank.

SECTION 02778
GEOTEXTILES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Non-woven geotextile material (except for the geotextile bonded to geocomposite).
   2. Woven geotextile material.

B. Related Sections:
   1. Section 02300 – Earthwork
   2. Construction Quality Assurance Plan.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. D4491, Water Permeability of Geotextiles by Permittivity.
      b. D4533, Trapezoid Tearing Strength of Geotextiles.
      c. D4632, Grab Breaking Load and Elongation of Geotextiles.
      d. D4751, Determining Apparent Opening Size of a Geotextile.
      e. D4759, Determining the Specification Conformance of Geosynthetics.
      f. D4873, Identification, Storage, and Handling of Geosynthetic Rolls.
      g. D5261, Test Method for Measuring Mass Per Unit Area of Geotextiles.
      h. D6241, Standard Test Method for static Puncture strength of Geotextiles and Geotextile-Related Products using a 50-mm Probe.
      i. D7238, Standard Test Method for Effect of Exposure of Unreinforced Polyolefin Geomembrane Using Fluorescent UB Condensation Apparatus.

B. Qualifications:
   1. Each manufacturing, fabricating firm shall demonstrate 5 years continuous experience, including a minimum of 10,000,000 SF of geotextile installation in the past 3 years.
   2. Installing firm shall demonstrate that the site Superintendent or Foreman has had responsible charge for installation geotextile on several projects of a similar scope.
   3. INSTALLER shall attend pre-installation conference.

1.3 DEFINITIONS

A. CONTRACTOR: CONTRACTOR shall be responsible for purchasing, delivery, receiving shipments, unloading, field handling, storing, installing, quality control, testing, and all other aspects of the installation of the geotextiles. Materials shall be stored such that Geosynthetics CQA Consultant can read and verify roll information.

B. MANUFACTURER: MANUFACTURER producing geotextile sheets from resin and additives.

C. INSTALLER: The INSTALLERS are the individuals performing the hands-on work in the field.

D. MARV: Minimum Average Roll Value

1.4 SUBMITTALS

A. Shop Drawings:
   1. MANUFACTURER's documentation that raw materials and roll materials comply with required geotextile physical properties.
   2. MANUFACTURER and INSTALLER quality control manuals.
   3. Original test results for resins, roll material and factory seam tests at frequency specified in respective quality control manuals. Results shall include or bracket the rolls delivered for use in the Work.
   4. Proposed details of anchoring and overlapping if different than included in Contract Documents.

B. Miscellaneous Submittals:
   1. Provide same certifications specified in Section 02777. No alterations, additions, deletions, or exception shall be made to the specified language.
   2. For needle punched geotextiles, the MANUFACTURER shall certify that the geotextile has been continuously inspected using permanent on-line full-width metal detectors and does not contain any needles which could damage other geosynthetic layers.
   3. Qualification documentation.

1.5 DELIVERY, STORAGE AND HANDLING

A. Label, handle, and store geotextiles in accordance with ASTM D4873 and as specified herein.

B. Wrap each roll in an opaque and waterproof layer of plastic during shipment and storage. Do not remove the plastic wrapping until deployment.

C. Label each roll with the MANUFACTURER's name, geotextile type, lot number, roll number, and roll dimensions (length, width, gross weight).

D. Repair or replace geotextile or plastic wrapping damaged as a result of storage or handling, as directed.

E. Do not expose geotextile to temperatures in excess of 71 DegC (160 DegF) or less than 0 DegC (32 DegF) unless recommended by the MANUFACTURER.

F. Do not use hooks, tongs or other sharp instruments for handling geotextile. Do not lift rolls lifted by use of cables or chains in contact with the geotextile. Do not drag geotextile along the ground.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Solmax
   2. Thrace-LINQ
   3. Mirafi (Ten Cate Geosynthetics)
   4. Propex
   5. SKAPS Industries
   6. Tenax Corp

2.2 MATERIALS AND MANUFACTURE

A. Geotextile:
   1. Woven or non-woven pervious sheet of polymeric material.
   2. Geotextile fibers:
      a. Long-chain synthetic polymer composed of at least 85 percent by weight polyolefins, polyesters, or polyamides.
      b. Filaments resistant to deterioration by ultraviolet light, oxidation, and heat exposure.
      c. Do not use reclaimed or recycled fibers or polymer to the formulation.
   3. Form geotextile into a network such that the filaments or yarns retain dimensional stability relative to each other, including the selvages.
   4. The geotextile physical properties shall equal or exceed the minimum average roll values listed in Tables 02778-1 and 02778-2. Values shown are for the weaker principal direction. Acceptance of geotextile shall be in accordance with ASTM D4759.

Table 02778-1 Cushion Geotextile (Nonwoven, Needlepunched) Properties

Property	Test Method	Marv	Min. MQC Test Frequency
Mass per Unit Area, oz/sy	ASTM D5261	16	1 per 100,000 SF
UV Resistance, % retained @ 500 hrs	ASTM D7238	70	1per 100,000 SF
Trapezoidal Tear, lbs	ASTM D4533	145	1 per 100,000 SF
Grab Tensile, lbs	ASTM D4632	370	1 per 100,000 SF
Grab Elongation, %	ASTM D4632	50	1 per 100,000 SF
CBR Puncture Strength, lbs	ASTM D6241	900	1 per 100,000 SF

Table 02778-2 Separation Geotextile Properties

Property	Test Method	Marv[1]	Min. Mqc Test Frequency
UV Resistance, % retained @ 500 hrs	ASTM D7238	80	1per 100,000 SF
Trapezoidal Tear, lbs	ASTM D4533	112/79	1per 100,000 SF
CBR Puncture Strength, lbs	ASTMD6241	630/440	1per 100,000 SF
Grab Tensile, lbs	ASTM D4632	315/203	1per 100,000 SF
Sewn Seam Strength, lbs	ASTM D4632	283/180	1per 100,000 SF
AOS, in. (max ave. roll value)	ASTM D4751	0.024	1per 100,000 SF
Permitivity, sec^{-1}	ASTM D4491	0.02	1per 100,000 SF

[1.] The first value in the column apply to geotextiles that break at <50% elongation (ASTM D4632). The second value in the column apply to geotextiles that break at ≥ 50% elongation (ASTM D4632).

B. Thread:
   1. High-strength polyester, nylon, or other approved thread type.
   2. Equivalent chemical compatibility and ultraviolet light stability as the geotextile.
   3. Contrasting color with the geotextile.

2.3 CONFORMANCE TESTING

A. Samples of the geotextile shall be removed by the Geosynthetics CQA Consultant and sent to the Geosynthetics CQA Laboratory for testing to assure conformance with the requirements of this section. This testing shall be completed prior to deployment of geotextile. If mutually agreed upon by OWNER, ENGINEER, CONTRACTOR, and FDEP, samples may be shipped from MANUFACTURER to the Geosynthetics CQA Laboratory, provided that adequate chain-of-custody documentation is prepared and submitted, including origin and destination of sample, lot number, roll number, product name, project name, date of production, and date of shipment, at a minimum.

B. Samples and tests will be selected by the Geosynthetics CQA Consultant in accordance with the procedures outlined in the CQA Plan.

C. Samples shall be taken at the minimum frequencies indicated in the CQA Plan with a minimum of one sample per lot. If the Geotextile MANUFACTURER ships geotextile that requires sampling and testing at a frequency greater than indicated in the CQA Plan, then the Geotextile MANUFACTURER shall pay for the cost of the additional CQA sampling and testing beyond the minimum frequency indicated in the CQA Plan.

D. The Geosynthetics CQA Consultant may increase the frequency of sampling in the event that test results do not comply with requirements of Part 2.2 of this section. The Geotextile MANUFACTURER or CONTRACTOR shall bear the expense of this additional testing.

E. Any geotextile that is not certified in accordance with Part 1.4 of this section, or that conformance testing indicates does not comply with Part 2.2 of this section, will be rejected by the Geosynthetics CQA Consultant. The Geotextile MANUFACTURER shall replace the rejected material with new material, at no additional cost to OWNER.

PART 3 - EXECUTION

3.1 PREPARATION

A. Construct the surface underlying the geotextiles smooth and free of ruts or protrusions which could damage the geotextiles.

3.2 INSTALLATION

A. Install geotextiles in accordance with MANUFACTURER's written recommendations.

B. Handling shall be in accordance with ASTM D4873.

C. No equipment will be permitted to traffic in direct contact with the geotextile.

D. Lay geotextile smooth so as to be free of tensile stresses, folds, and wrinkles.

E. Protect geotextiles from clogging, tears, and other damage during installation.

F. Overlap geotextiles at a minimum of 6 in prior to seaming.

G. Overlapping geotextiles shall be continuously sewn or thermally bonded.

H. Sewing shall be done using polymeric thread.

I. No horizontal seams will be allowed on side slopes steeper than 10 percent except as part of a patch.

J. Geotextile Repair:

1. On slopes steeper than 10 percent, place a patch of the same type of geotextile which extends a minimum of 12-in beyond the edge of the damage or defect.
2. On slopes flatter than 10 percent, a patch made from the same geotextile will be spot-seamed in place with a minimum of 2-ft overlap in all directions.
3. Fasten patches continuously using thermal bonding, sewn seam or other approved method.
4. Align machine direction of the patch with the machine direction of the geotextile being repaired.
5. Replace geotextile which cannot be repaired.

K. Use adequate ballast (e.g. sand bags) to prevent uplift by wind.

L. Do not use staples or pins to hold the geotextile in place.

M. Geotextile left uncovered for more than 14 days shall be removed and replaced at the CONTRACTOR's expense.

END OF SECTION

This page intentionally left blank.

SECTION 03300
CONCRETE CONSTRUCTION

PART 1 - GENERAL

1.1 WORK INCLUDED

A. All cast-in-place concrete work is governed by this section, including slabs, pump stations, cleanout saddles, inlets and foundations for the leachate monitoring station.

B. Concrete reinforcement and accessories are included in this section.

C. Formwork, shoring, bracing, and anchorage for concrete work are included in this section.

1.2 GENERAL REQUIREMENTS

A. All concrete construction exposed to leachate (includes the monitoring station slab) are to be constructed for water tightness. The concrete mix designs, formwork, pouring sequence, and all other aspects of this construction shall be as required by these specifications and as required for water tightness.

1.3 RELATED WORK

A. Other related specification sections contained herein are as listed below:
   1. Section 01350 - Submittals
   2. Section 02300 - Earthwork
   3. Section 05500 - Miscellaneous Metals

1.4 REFERENCES

A. Reference standards and recommended practices referred to herein or in ACI 301 shall be the latest revision of any such document.

B. Standards referenced herein are listed below:
   1. ACI 211.1, Standard Practice for Selecting Proportions for Normal Heavy Weight, and Mass Concrete
   2. ACI 301, Specifications for Structural Concrete Buildings
   3. ACI 302, Guide for Concrete Floor and Slab Construction
   4. ACI 305, Hot Weather Concreting
   5. ACI 306, Cold Weather Concreting
   6. ACI 315, Detailing Manual (SP 66)
   7. ACI 318, Building Code Requirements for Reinforced Concrete
   8. ACI SP 66, ACI Detailing Manual
   9. ANSI/ASTM, Steel Welded Wire Fabric, Plain, for A 185 Concrete Reinforcement
   10. ASTM A 497, Welded Deformed Steel Wire Fabric for Concrete Reinforcement
   11. ASTM A 615, Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
   12. ASTM C 31, Making and Curing Concrete Test Specimens in the Field
   13. ASTM C 33, Concrete Aggregates
   14. ASTM C 94, Ready-Mixed Concrete
   15. ASTM C 109, Compressive Strength of Hydraulic Cement Mortars
   16. ASTM C 143, Slump of Portland Cement Concrete
   17. ASTM C 150, Portland Cement
   18. ASTM C 172, Sampling Fresh Concrete
   19. ASTM C 173, Air Content of Freshly Mixed Concrete by the Volumetric Method

20. ASTM C 231, Air Content of Freshly Mixed Concrete by the Pressure Method
21. ASTM C 260, Air Entraining Admixtures for Concrete
22. ASTM C 293, Flexural Strength of Concrete (Using Simple Berm with Center-Point Loading)
23. ASTM C 309, Liquid Membrane-Forming Compounds for Curing Concrete
24. ASTM C 497, Concrete Pipe, Manhole Sections or Tile
25. ASTM C 579, Compressive Strength of Chemical-Resistant Mortars, Grout, Monolithic Surfacing's, and Polymer Concrete
26. ASTM C 618, Coal Fly Ash
27. ASTM C 806, Restrained Expansion of Expansive Cement Mortar
28. ASTM C 827, Early Volume Change of Cementitious Material
29. ASTM C 878, Restrained Expansion of Shrinkage-Compensating Concrete
30. ASTM D 638, Tensile Properties of Plastics
31. ASTM D 746, Brittleness Temperature of Plastics and Elastomers by Impact
32. ASTM D 994, Preformed Expansion Joint Filler for Concrete (Bituminous Type)
33. ASTM D 169, Environmental Stress-Cracking of Ethylene Plastics
34. ASTM D 224, Rubber Property-Durometer Hardness
35. ASTM D3282, Standard Practice for Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes

1.5 QUALITY ASSURANCE

A. Concrete work shall conform to the requirements of ACI 301 and ACI 318.

B. Tests shall be performed to determine if the concrete conforms to the requirements of these specifications. The CONTRACTOR shall furnish labor and materials necessary for taking and/or casting test samples. An independent testing agency, approved by the ENGINEER, shall be retained by the CONTRACTOR to perform tests on specimens provided by the CONTRACTOR. The number of the tests shall be as specified herein and as directed by the ENGINEER during construction. The CONTRACTOR shall coordinate activity with the ENGINEER and the testing agency to permit testing as directed in the presence of the ENGINEER. The cost of any and all retests due to failure to achieve specified requirements is not included in the cost indicated in the Contract Documents, and shall be borne by the CONTRACTOR. All testing agency activities shall be performed under the direction and supervision of a Professional Engineer, licensed in the state of Florida. The cost of all testing achieving specified requirements shall be borne by the CONTRACTOR.

C. Testing shall conform to the following requirements.
   1. Compressive strength tests shall be performed in accordance with ASTM C 39 on standard cylinder specimens molded and cured in accordance with ASTM C 31. One specimen shall be tested at 7 days for information, two shall be tested at 28 days for acceptance, and one shall be held in reserve, for a total of four specimens to be molded and cured for each sampling event.
   2. The CONTRACTOR shall take field samples in accordance with ASTM C 172. Compressive strength samples shall be taken for each 50 cubic yards of concrete or for each pour, whichever is greater, and for each change in mix design. At least one set of cylinders shall be made for each day concrete is poured. Air content tests shall be performed with each set of cylinders taken. Slump tests shall be performed on each truckload of concrete.
   3. The CONTRACTOR shall coordinate activity with the ENGINEER and the testing agency to permit sampling and field testing in the presence of the ENGINEER.

D. The test reports shall be transmitted directly by the testing agency ENGINEER. The reports shall include the project title; project location; location of concrete pour; temperature; air content and slump of the sample; truckload waybill number; amount of water, if any, added at the project site; time and dates of sampling and testing; test results; and other information, as may be required by the ENGINEER.

E. The ENGINEER shall have sole responsibility for interpretation of all test results.

F. The CONTRACTOR shall remove and replace, at no cost to the OWNER, all materials and work which tests indicate do not conform to these specifications.

1.6 SHOP DRAWINGS AND SUBMITTALS

A. Submittals shall be in accordance with Section 01350 and shall be in sufficient detail to show full compliance with these specifications.

B. Submit reinforcing steel shop Drawings and MANUFACTURER’s coupon test results. Shop Drawings shall indicate sizes, spacings, locations, quantities, bending and cutting schedules, and splicing. Reinforcement for which shop Drawings have not been approved shall not be installed. The CONTRACTOR shall notify the ENGINEER, in writing, a minimum of 48 hours prior to date approval is required. Shop Drawings shall be prepared in accordance with ACI SP66.

C. The CONTRACTOR shall submit concrete mix design and supplier for ENGINEER's approval for each mix proposed for use. The mix design submittal shall include materials per cubic yard of mix, aggregate gradation and moisture content, MANUFACTURER's product data and recommended dosage for all proposed admixtures, and other certification and material data required to document conformance with these specifications. Test data shall be provided to certify past performance of the mix with regard to compressive strength, slump range, and air content.

D. The proposal to use admixtures for cast-in-place concrete shall include a detailed listing of the uses (areas, location, elements, etc.) for which its use is proposed and the anticipated benefits to be derived from the use of the admixture in each instance.

E. Anchor bolt setting plans, where required, shall be submitted for the ENGINEER's approval.

F. The CONTRACTOR shall submit all grout and repair materials MANUFACTURER's printed data, including installation instructions, for the ENGINEER's approval.

PART 2 - PRODUCTS

2.1 FORM MATERIALS

A. Design, engineering, and construction of the formwork shall be the responsibility of the CONTRACTOR. Formwork shall conform to the requirements of ACI 301.

B. Plywood forms shall be APA Grade B-B plyform, exterior class, sized as required. Sheets shall be sound and undamaged.

C. Lumber shall be Southern Pine or Douglas Fir species, construction grade with grade stamp clearly visible.

D. Form ties for watertight concrete shall be double strut, wire coil, combination form tie and spreader with waterstops on each strut and a tapered plastic setback cover on each end. "Snap" or other breakaway type ties shall not be used. Ties shall be sized

such that the embedded portion of the ties shall terminate not less than 1.5 IN from the formed faces of the concrete. Form tie holes shall be filled with grout as specified herein under Miscellaneous Materials.

E. Form facing material in contact with concrete to be exposed to view shall be plywood as specified above.

F. Form facing material in contact with concrete to be permanently unexposed to view shall be tongue-and-groove lumber or plywood, as specified above.

G. Use of earth cuts as forms for vertical surfaces shall not be allowed.

2.2 CONCRETE MATERIALS - PORTLAND CEMENT CONCRETE

A. Cement shall be Type II or Type IIA Portland cement conforming to ASTM C 150.

B. Water for concrete mix shall be clean, potable, and free from injurious amounts of oil, alkali, organic matter, or other deleterious material.

C. Fine aggregate for normal-weight concrete shall consist of natural sand, free from silt, clay, loam, friable or soluble material, and organic matter. Grading limits shall be in accordance with ASTM C 33, except that not more than 15 percent shall pass the No. 50 sieve and not more than 5 percent shall pass the No. 100 sieve.

D. Coarse aggregate shall be gravel, crushed gravel, crushed stone, air-cooled blast furnace slag, or a combination thereof; ASTM C 33 Size Numbers 67, 57, or 467 graded, as specified in ASTM C 33. Limits for deleterious substances including clay, fines, coal, and lignite shall be in accordance with ASTM C 33 in addition to the following:
   1. Maximum soft particles: 2.0%
   2. Maximum chert as a soft impurity (less than 2.40 sp gr SSD): 1.0%
   3. Maximum total of chert as a soft impurity and soft particles: 2.0%
   4. Maximum flat and elongated particles(long dimension equal to or greater than 5 times the short dimension): 15.0%

E. Fly ash may be used to replace up to 20 percent by weight of the cement content in accordance with the following conditions:
   1. Fly ash shall conform to ASTM C 618, Type C or Type F, except that the loss on ignition for Type F shall not exceed 6 percent.
   2. The CONTRACTOR shall assume full responsibility for obtaining concrete having the minimum strength requirements set forth in the specifications.

F. The materials used in the concrete mixes shall contain no hardened lumps or crusts and no material containing frost.

G. The proposed use of approved High Range Water Reducer (HRWR) admixtures shall be Type F or Type G. The proposal to use HRWR admixtures shall include certification from the HRWR supplier that the HRWR admixture meets the requirements of ASTM C 494, Type F or G and is included on the Florida Department of Transportation's (DOT's) list of approved admixtures. The certificate shall state that the 1-year test representing the admixture to be supplied has been performed by an independent laboratory approved by the Cement and Concrete Reference Laboratory and records of such tests will be furnished to the ENGINEER on request. The certification shall also include an additional statement from the HRWR supplier that the proposed HRWR admixture is compatible with all other admixtures to be included in the concrete design mix. When HRWR admixture is proposed for use in the design mix, the CONTRACTOR shall submit, for approval, a target slump value with a target range

value of ±1.5 IN. The target slump shall not exceed 6.5 IN. The CONTRACTOR shall demonstrate that the concrete plant can produce concrete consistently meeting specified slump, air content, and compressive strength requirements.

H. Admixtures designated by the CONTRACTOR shall be compatible with all other components of the concrete.

I. The use of air entraining admixtures for concrete shall be in accordance with ASTM C 260.

2.3 REINFORCEMENT

A. All steel reinforcing bars shall conform to ASTM A 615, Grade 60, deformed bars, unless otherwise indicated on the Drawings.

B. Welded steel wire fabric shall be in flat sheets, coiled rolls, uncoated finish. Welded deformed wire fabric shall conform to ASTM A 497. Welded plain-type, smooth-wire fabric shall conform to ANSI/ASTM A 185.

2.4 JOINT AND WATERSTOP MATERIALS

A. Expansion joint material shall be bituminous type, preformed expansion joint filler conforming to the requirements of ASTM D 994.

B. Waterstops shall be manufactured from polyethylene and shall be 6 IN wide, formed with serrations to key the waterstop into the concrete. Waterstops shall have a U-bulb at the center of the section designed to allow joint movement. Waterstop shall meet the following requirements:

Table 03300 Waterstop Requirements

TYPE	METHOD	REQUIREMENT
Tensile Strength (Finished Waterstop)	ASTM D 638	2,800 psi
Tensile Strength (Finished Waterstop)	ASTM D 638	2,800 psi
Hardness, Shore A	ASTM D 2240	85
Low Temperature Brittleness @ -100°C	ASTM D 746	0% failure
Environmental Stress Crack Resistance for 500 Hours	ASTM D 1693	0% failure

C. Waterstops shall be as manufactured by Greenstreak, W.R. Meadows, Vinylex, or equal, as approved by the ENGINEER.

2.5 GROUT MATERIALS

A. Nonshrink grout shall be nonmetallic and noncorrosive grout. The grout shall contain no calcium chloride or other salts, no metals, and no chemical additives, gypsum, or expansive cements which may be detrimental or may result in harmful expansion after set. The grout shall be guaranteed by the MANUFACTURER to never shrink below its original placement volume when tested in accordance with ASTM C 827. The grout

shall have a minimum compressive strength of 9,000 pounds per square IN (psi) at 28 days when tested in accordance with ASTM C 109.

B. Grout shall be a portland cement, coarse aggregate, and natural sand mix (1:2½:2½ parts volume, respectively) and water. Mix shall have a water to cement ratio of 0.40 by weight and an aggregate to cement ratio of 3, by weight. Maximum coarse aggregate size shall not exceed ½ the minimum topping thickness.

C. Epoxy grout shall be pourable, nonshrink, 100% solids epoxy system consisting of 3 components: resin, hardener, and specially-blended aggregate. All components shall be premeasured and prepackaged by the MANUFACTURER. Resin component shall not contain any nonreactive diluents or highly volatile or hazardous reactive diluents. The mixed epoxy grout shall have a minimum "working life" of 45 minutes at 75°DegF. The grout shall be guaranteed by this MANUFACTURER to never shrink below its original placement volume and to have a maximum 4% expansion when tested in accordance with ASTM C 827. The hardened epoxy grout shall attain a minimum compressive strength of 5,000 psi in 24 hours and 10,000 psi in 7 days when tested in accordance with ASTM C 579, Method B.

2.6 FILL MATERIALS

A. Sand (granular) fill for slabs, structures, or as otherwise required by the drawings shall comply with the requirements for Soil Group A-4, as described in ASTM D 3282. The sand shall be free of loam, friable or soluble materials, rocks, foreign material, debris, peat, roots, and organic material.

B. Backfill shall be subsoil which is free from alkali, salt, petroleum products, roots, stones, rocks, and building debris. Excavated material from the site may be used if suitable and if free from deleterious matter, as approved by the ENGINEER. Gradation shall be suitable for compaction with a maximum of 40 percent passing the No. 200 sieve, unless otherwise required herein or on the drawings. Maximum particle size shall not exceed 1/2 IN.

C. Unsatisfactory soil materials shall mean ASTM D 3282; Soil Classification Groups A-1, A-2, A-4, A-5, A-6, and A-7; peat and other highly organic soil; and soil materials of any classification that have a moisture content at the time of compaction beyond the range of 1 percentage point below and 3 percentage points above the optimum moisture content of the soil material as determined by moisture-density relations test.

D. Gravel bedding shall be as specified in Section 02300, Earthwork.

2.7 MISCELLANEOUS MATERIALS

A. Bonding agent shall be polyvinyl acetate, rewettable type such as Weld-Crete by Larsen Products, or equal as approved by the ENGINEER.

B. Form release agent shall be a colorless material which will not stain concrete or absorb moisture.

C. Reference Section 05500 for materials for anchorage to concrete.

2.8 CURING MATERIALS

A. Water shall be of the same quality as used in Concrete.

B. Absorptive mat shall be cotton fabric, burlap fabric, or burlap-polyethylene.

A. Membrane curing compound shall be ASTM C 309, Type 1D, Class A, acrylic type, and clear.

2.9 CONCRETE MIX - PORTLAND CEMENT CONCRETE

A. The proportions of ingredients shall be selected either on the basis of field experience or by laboratory trail batches. Mix design shall be developed by procedures described in ACI 211.1 and shall provide concrete of the following characteristics.
   1. Concrete shall have a minimum 28-day compressive strength of 4,000 psi.
   2. Total air content, as measured in accordance with ASTM C 173 or C 231, shall be within the following limits:
      a. 5.0% plus or minus 1% for coarse aggregate Size No. 467
      b. 6.0% plus or minus 1% for coarse aggregate Size Nos. 67 and 57
   3. The water-cement ratio shall not exceed 0.44.
   4. The minimum cement content shall be:
      a. 517 pounds per cubic yard for coarse aggregate Size No. 467
      b. 564 pounds per cubic yard for coarse aggregate Size Nos. 67 and 57
   5. Slump, as determined in accordance with ASTM C 143, shall be as follows:
      a. 1 IN minimum
      b. 3 IN maximum for footings, caissons, substructure walls
      c. 4 IN maximum for slabs, beams, reinforced walls, columns

B. Ready-mixed concrete shall be batched, mixed, and delivered in conformance with ASTM C 94. The supplier of ready-mixed concrete shall have a plant of sufficient capacity and adequate transit-mixing equipment to assure delivery at the rate required to permit continuous, uninterrupted placing throughout each scheduled pour. Any concrete not placed within a reasonable time period after the mixing of water is added to the dry ingredients shall be rejected and disposed of at the CONTRACTOR 's expense. Heat of hydration shall be used to determine reasonable time when in question. All waybills for ready-mixed concrete shall have the time of plant loading affixed. The CONTRACTOR shall provide the ENGINEER with a copy of each waybill.

C. Each waybill shall include the following information:
   1. Name and location of ready-mix batch plant.
   2. Serial number of ticket.
   3. Date and truck number.
   4. Name of CONTRACTOR.
   5. Job number.
   6. Specific class or designation of concrete.
   7. Quantity of concrete (cubic yard).
   8. Time loaded, or of first mixing of cement and aggregates.
   9. Water added by receiver of concrete (if any), and his initials.
   10. Type and name of admixture, and amount of same.
   11. Mixing time, or reading of revolution counter at beginning and end of mixing period.
   12. Signature or initials of ready-mix representative.
   13. Type and brand of cement.
   14. Amount of cement.
   15. Total water content by producer (or W/C ratio).
   16. Maximum size of aggregate.
   17. Weight of fine and of coarse aggregate.
   18. Indication that all ingredients and mix proportions are certified as being previously approved.

PART 3 - EXECUTION

3.1 STORAGE OF MATERIALS

A. Store cement and aggregates in such a manner as to prevent deterioration or intrusion of foreign matter. Store accessories according to MANUFACTURER's recommendations.

B. Protect liquid admixtures from freezing and from settling out of solution.

C. Deteriorated or damaged material shall not be used for concrete.

3.2 EARTHWORK

A. Unsatisfactory soil materials shall be excavated and disposed.

B. Excavate subsoil in accordance with lines, elevations, and levels required for construction of the work within a tolerance of ±0.10 foot, including space for forms, bracing, and shoring.

C. If excavation is carried below the indicated or specified levels, it shall be backfilled as previously specified for unauthorized excavation.

D. Hand trim excavations and leave free from loose or organic matter.

E. Excavations are not to interfere with normal 45° bearing splay of any foundation unless specifically required by the drawings.

F. All disturbed areas adjacent to work items covered in this Contract shall be regraded with mounded fill for settlement and seeded.

G. Place and compact fill materials in continuous layers not exceeding 12 IN loose depth. Use a method so as not to disturb or damage services.

H. Backfill materials adjacent to structures shall be brought up evenly around structures and shall be carried up to the indicated elevations.

I. Backfill with suitable fill materials at areas to receive concrete slabs to gravel-bed or subgrade level and compact. Fill with gravel to concrete-slab level where indicated in the drawings. Smooth and level top surface of gravel fill and subgrade.

J. The soil fill utilized as the foundation for monitoring station shall be compacted. The compacted material shall exhibit moisture contents within ±3 percent of the material's ASTM D 698 optimum moisture content during the compaction operations. Compaction shall continue until densities of at least 95 percent of the Standard Proctor maximum dry density (ASTM D 698) have been achieved within the upper 2 feet. All fill shall be placed in loose lifts not exceeding 6 IN in thickness and compacted until densities of at least 95 percent of the Standard Proctor maximum dry density (ASTM D 698) have been achieved within each lift of the compacted backfill and fill material.

3.3 FORMWORK

A. Verify lines, levels, and measurement before proceeding with formwork. CONTRACTOR shall be responsible for all field engineering.

B. Align form joints.

C. Form surfaces that will be in contact with concrete shall generally be treated with a form coating which shall be nontoxic after 30 days. Do not apply form release agent where concrete surfaces receive special finishes or applied coatings which may be affected by agent.

D. Drainage trenches and/or sumps, as required, shall be cast integral with the slab for one piece, water-tight, and joint-free construction. Access door or other accessory MANUFACTURER's recommendations for forming shall be strictly adhered to in order to provide the MANUFACTURER specified clearances, anchorage, etc.

E. Weight-supporting formwork and shoring shall remain in place until the concrete, in combination with any remaining forming and shoring systems, has sufficient strength to support safely its weight and loads placed thereon. Sufficient strength may be demonstrated by field-cured test cylinders and by a structural analysis considering the proposed loads in relation to field-cured cylinder strengths and strengths of any remaining forming and shoring systems. Such analysis and strength test data shall be furnished by the CONTRACTOR to the ENGINEER. The analysis shall bear the seal and signature of a Professional Engineer, duly registered in the state of Florida.

F. Set expansion joint material in place prior to placing concrete. Provide space at joint surface for sealant.

G. Coordinate work of other sections in forming and setting openings, slots, recesses, chases, sleeves, bolts, anchors, and other inserts.

3.4 REINFORCEMENT

A. Fabrication and placement of reinforcing steel shall conform to the requirements of ACI 318.

B. Bars with kinks or bends not shown on the Drawings shall not be used.

C. Heating of bars will not be permitted.

D. Reinforcing bars shall be accurately located in the forms, and firmly held in place before and during the placing of concrete, by means of steel wire bar supports. Bar supports shall be sufficient in number and in strength to keep the reinforcement at the proper location and to prevent displacement during the course of construction. Chairs shall be fitted with continuous runners to prevent the legs from sinking into the earth. Welding shall not be permitted.

E. The location of reinforcement splices in slabs, walls, and other structural members shall be clearly indicated on the shop Drawings and shall be installed only as approved by the ENGINEER.

F. Unless otherwise indicated on the Drawings, lap lengths shall be:
   1. Bars: 40 times the nominal diameter
   2. Welded Wire Fabric: Side: 2 IN
   3. End: Overlap first lateral wire each end.

G. Maintain 3 IN concrete cover around reinforcing, or as designated on the Drawings, or as required by ACI 318.

H. Before placing concrete the CONTRACTOR shall ensure that reinforcing is clean, free of loose scale, dirt, or other foreign coatings.

3.5 CONVEYING

A. Concrete shall be handled from the mixer to the place of final deposit without delay and by methods which will prevent segregation.

B. Where chutes are used, they shall be metal or metal-lined and shall be used with moderate slope. Baffles shall be used as necessary to prevent segregation.

C. Concrete shall be deposited as near as practicable to its final position and in such a manner as to maintain a plastic surface which is more or less horizontal.

D. Substantial elevated runways or hoists shall be provided to convey the concrete to points of deposit, in order not to disturb the forms or reinforcing. Conveying equipment shall not be wheeled directly over any reinforcing.

E. Concrete shall not be dropped free more than 4 feet. Drop chutes shall be provided in section so that the outlet may be adjusted to proper heights during placing operations.

3.6 PLACING CONCRETE

A. The CONTRACTOR shall notify the ENGINEER, in writing, a minimum of 48 hours prior to commencement of concreting operations. The CONTRACTOR shall also notify the ENGINEER, in writing, a minimum of 24 hours prior to completion of excavations, forms, reinforcement, and embedded items' placement. Notification shall indicate that it is the CONTRACTOR 's opinion that the work is ready for the placement of concrete and a date and time for which a pour has been scheduled. A representative of the ENGINEER may be on the job during placement of concrete and concrete shall not be placed until the ENGINEER or his representative has been given the opportunity to be present via said notification. Reinforcement shall be securely and properly fastened in its correct position. Ties shall be checked and retightened, where necessary. All embedded items shall be in place and anchored and the forms and reinforcement shall be cleaned and clean-out openings closed before such inspection.

B. Sprinkle sand-filled areas with water just prior to placing the concrete.

C. Pour the concrete continuously between predetermined and ENGINEER -approved construction and/or expansion joints. Do not break or interrupt successive pours such that cold joints occur. Cold joints shall not be permitted without written approval by the ENGINEER. Horizontal joints in concrete retaining walls shall not be permitted.

D. Excessive honeycomb or embedded debris in concrete is not acceptable. Notify ENGINEER upon discovery.

E. Conform to ACI 305 when concreting during hot weather. Steps shall be taken to reduce water evaporation by proper attention to ingredients, production methods, handling, placing, protection, and curing.

F. Conform to ACI 306 when concreting during cold weather. Adequate equipment shall be provided for heating the concrete materials and protecting the concrete during freezing or near-freezing weather. All concrete materials and all reinforcement, forms, fillers, and ground with which the concrete is to come in contact shall be free from frost. No frozen materials or materials containing ice shall be used. Use accelerating admixture only with ENGINEER's written consent.

G. Concrete shall be placed in a manner that will prevent segregation, thoroughly embed all reinforcement and fixtures, fill all angles in the forms, and prevent formation of aggregate pockets or honeycomb. Where concrete in slabs is deposited on the ground, the subgrade shall be thoroughly compacted and moistened before concrete is placed. Completed sections shall conform to the details on the Drawings and the concrete shall be dense, uniform, and free of aggregate pockets or honeycomb.

A. All concrete shall be consolidated by mechanical vibrators.

B. Concrete placement shall not be allowed when weather conditions prohibit proper placement and/or consolidation. Forms shall be clean of dirt, construction debris, and/or water.

C. Concrete shall be deposited in approximate horizontal layers of 12 to 20 IN deep in a manner to preclude the formation of cold joints between successive layers. The method of depositing concrete shall be such as to avoid displacing the reinforcement and segregating and embedding fixtures and into corners and angles of the forms, with care being taken to avoid overworking which may result in segregation.

3.7 EMBEDDED ITEMS

A. The CONTRACTOR shall coordinate his work with all other contractors and subcontractors at the site and with all sections of the Drawings and specifications to ensure that built-in items are properly installed as the work progresses. Cutting and patching not previously approved by the ENGINEER will not be permitted. Installation of omitted items and/or correction of improperly installed items shall be performed entirely at the CONTRACTOR's expense and in a manner directed by the ENGINEER.

B. Anchors, bolts, sleeves, dowels, inserts, etc., shall be properly located and built in as the work progresses.

3.8 GROUT INSTALLATION

A. All grout MANUFACTURER's recommendations for the installation, surface preparation, curing, and set time shall be strictly adhered to. Grout shall be coated in accordance with the specifications for the adjacent surfaces. Nonmanufactured grouts shall conform to the requirements of this specification section.

B. Existing surfaces shall be thoroughly cleaned of all paint, dirt, grease, etc., and shall be mechanically scarified in a manner to be approved by the ENGINEER prior to grouting.

3.9 FINISHING OF CONCRETE SURFACES

A. Repair surface defects, including tie holes, minor honeycombing, or otherwise defective concrete, in accordance with ACI 301, Chapter 9. Clean areas to be patched. Cut out minor honeycombed or otherwise defective areas to solid concrete to a depth of a least 1 IN. Make the edges of the cut perpendicular to the surface of the concrete. Finish patches on exposed surfaces to match the adjoining surfaces after they have set. Cure patches as specified for the concrete. Protect finished surfaces from stains and abrasions. Provide finishes equal in workmanship, texture, and general appearance to that of the adjacent concrete. Completely remove and replace concrete with honeycombing which exposes the reinforcing steel or with defects which affect structural strength as determined by the ENGINEER and in a method approved by the ENGINEER.

B. The pump or other equipment pads shall be finished to a surface plane tolerance of 0.125 IN in 10 feet, or as otherwise required by the equipment MANUFACTURER.

C. Slabs and Foundations
   1. Spread, screed, and float concrete uniformly. Do not spread concrete by vibration.
   2. Bring the fines to the surface with a draby or float for proper finishing.
   3. Check the surface with a 16-foot straight edge and eliminate humps and hollows.
   4. Trowel the surface to a smooth, hard, and impervious surface after the water sheen has left.
   5. .Do not dust the surface with dry cement to sand or remove excess moisture.

D. All concrete surfaces exposed to view, except slabs, and ramps shall have a smooth rubbed finish. Exposed foundations shall have tooled edges.

E. Walls, slabs, equipment pads, and other exposed edges shall be chamfered 0.75 IN at 45°.

F. Ramps, walks, slabs, and equipment pads shall have a nonslip, uniform, lightly broomed finish, and tooled edges. Round all exposed edges of slabs with an edger unless chamfered as per above or required on the Drawings.

G. Slabs shall slope, as indicated on the Drawings, to prevent standing water. Birdbaths deeper than 0.125 IN shall be corrected by grinding the slab surface for a smooth, even finish. Saw-cutting grooves shall not be accepted.

3.10 JOINTS

A. Joints shall be located and constructed in strict accordance with the Drawings, or as otherwise approved by the ENGINEER. Joints placed that are not on the Drawings or the approved shop Drawings before placement shall be cause for rejection of the work.

3.11 PATCHING

A. Defects, except form tie holes, shall be brought to the attention of the ENGINEER before any corrective action is taken. Such defects shall be remedied, as directed by the ENGINEER, at the expense of the Contractor.

B. Form tie holes shall be filled in accordance with the nonshrink grout MANUFACTURER's written instructions.

3.12 CURING AND PROTECTION

A. Freshly placed concrete shall not be exposed to temperatures below 40°F, and shall be maintained in a moist condition for at least the first 10 days after placing. Methods for curing shall be one of the following or a combination of the following.
   1. Leaving forms on vertical surfaces in place.
   2. Ponding with water, applied as soon as the concrete surface has hardened sufficiently not to be damaged by the water.
   3. Cover surfaces with cotton mats or burlap blankets and keep water-soaked continuously for 10 days.
   4. Wet all surfaces thoroughly and immediately cover with non-staining waterproof plastic sheeting. Anchor sheeting down for protection.

B. Curing compound may be used only as directed by the ENGINEER and only with the written consent of the ENGINEER.

C. During the curing period, the concrete shall be protected from damaging mechanical disturbances such as load stresses, heavy shock, and excessive vibration. All finished concrete surfaces shall be protected from damage by construction equipment; materials; or methods, by application of curing procedures; and by rain or running water. Self-supporting structures shall not be loaded in such a way as to overstress the concrete.

D. Structures built to contain fluids shall not be used for fluid storage until the backfill has been fully installed and compacted. The compactive effort at the backfill shall be as specified in Section 02300, Earthwork.

END OF SECTION

SECTION 05500
MISCELLANEOUS METALS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This section covers work required for fabrication and installation of incidental metals construction such as grates, pipe supports, and anchorage systems.

1.2 RELATED WORK

A. The General and Supplementary Conditions of these specifications are a part of this section as if incorporated herein.

B. Other related specification sections contained herein are as listed below.
   1. Section 01350, Submittals
   2. Section 03300, Concrete Construction
   3. Section 15200, Pipe and Pipe Fittings

1.3 SHOP DRAWINGS, SUBMITTALS, AND TESTS

A. Submittals shall be in accordance with Section 01350, Submittals, and shall be in sufficient detail to show full compliance with these specifications.

B. Shop Drawings for miscellaneous metal fabrications and items addressed herein shall be submitted with the related equipment data. Shop Drawings shall include name and location of FABRICATOR, dimensions, finish, and all connection details.

C. MANUFACTURER's product data for prefabricated access covers, pipe support accessories, and anchors shall be submitted. The anchor submittal shall include the MANUFACTURER's load tables for the system and materials to be used.

D. Submit shop Drawings for pipe supports indicating location on the pipeline, dimensions, welds, elevations, accessories, and other pertinent data.

E. The CONTRACTOR shall submit the anchor bolt MANUFACTURER's written recommendations describing procedures for installing the anchors, including hole size, type, and cleaning requirements.

F. The CONTRACTOR shall provide mill test certificates indicating material meets or exceeds requirements listed herein. Material supplier's name and location shall be clearly stated.

1.4 QUALITY ASSURANCE

A. Fabrication, erection, and connection of steel shall be in accordance with the AISC Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings and the AWS D1.1 Structural Welding Code - Steel.

B. Fabrication, erection, and connection of aluminum shall be in accordance with the Specifications for Aluminum Structures by the Aluminum Association, Inc. and the AWS D1.6 Structural Welding Code - Stainless Steel.

1.5 REFERENCE STANDARDS

A. Reference standards and recommended practices referred to herein shall be the latest revision of any such documents.

B. Standards referenced herein are as listed below.
   1. AISC, Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings
   2. ASME B16.25, Buttwelding Ends
   3. ASTM A 53, Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless
   4. ASTM A 167, Specification for Stainless Steel and Heat Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
   5. ASTM A 276, Specification for Stainless Steel and Heat-Resisting Steel Bars and Shapes
   6. ASTM B 308, Specification for Aluminum-Alloy 6061-T6 Standard Structural Shapes, Rolled or Extruded
   7. ASTM B 429, Specification for Extruded Structural Pipe and Tube, Aluminum-Alloy
   8. ASTM F 593, Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
   9. ASTM F 594, Specification for Stainless Steel Nuts
   10. AWS D.1, Structural Welding Code-Steel
   11. AWS D1.6 ,Structural Welding Code – Stainless Steel

1.6 STORAGE AND HANDLING

A. Metals fabrications shall be protected from scratching, denting, or other damage during shipping, storage, or handling.

B. Anchor system components shall be stored out of direct sunlight and as otherwise recommended by the MANUFACTURER.

PART 2 - PRODUCTS

2.1 STAINLESS STEEL

A. Stainless steel materials shall conform to the requirements of the American Iron and Steel Institute (AISI) Grade 304 for nonwelded components and Grade 304L for welded construction. Refer to the Drawings for scheduling of material. Stainless steel bars and shapes shall conform to the requirements of ASTM A 276. Stainless steel plate, sheeting, and strips shall conform to ASTM A 167. Welds shall be of compatible, corrosion-resistant material.

B. Brushes, grinders, or other items used in the finishing of stainless steel fabrications shall be stainless steel.

C. Clamps shall be T316SS with T316SS drive screw.

2.2 ALUMINUM STRUCTURAL SHAPES AND PLATES

A. Aluminum shapes and plates shall conform to ASTM B308.

2.3 ANCHORAGE TO CONCRETE

A. Epoxy anchors shall be a two-part stud and epoxy injection system. The epoxy shall be solvent-free, low-odor, nonshrink, nonsag structural epoxy packaged for dispensing by a hand- or air-powered injection tool. The injection tool shall provide mixing of the epoxy. The stud assembly shall be Type 304 stainless steel, including the stud, nut, and washer. The stud shall have a double 45° chamfered point.

B. Epoxy anchors shall be CIA-gel, amine-based epoxy anchoring system as manufactured by Cover Operations, EPCON C6 mercaptan base epoxy as manufactured by ITW Ramset, or equal as approved by the ENGINEER.

2.4 FASTENERS

A. Stainless steel and aluminum bolted connections shall be made with ASTM F 593 and F 594 Type 316 stainless steel bolts and nuts.

PART 3 - EXECUTION

3.1 FABRICATION OF MISCELLANEOUS METAL ITEMS

A. Fabricate work true to shape, size, and tolerance as detailed on the Drawings, with straight lines, square corners, smooth bends, and free from twists.

B. Grind and dress edges and ends of metal smooth with no sharp edges and corners slightly rounded.

C. Provide holes and connections for work of other trades. Coordinate anchor bolt placement in concrete.

D. Preassemble items in the shop to the greatest extent possible; minimize field splicing and assembly. Disassemble units only to the extent necessary for shipping and handling limitations. Clearly mark units for reassembly. Field welding will not be accepted unless approved on the shop Drawings.

3.2 INSTALLATION BY THE FABRICATOR

A. Set miscellaneous metal items plumb, level, rigid, and in true alignment without warp or rack.

B. Anchor tight to substrate with anchors as recommended by equipment MANUFACTURER, as specified herein, or as shown on the Drawings.

C. Adequately brace items set in concrete to prevent displacement until concrete has attained design strength.

D. All welds shall be clean and ground smooth.

3.3 WELDING STAINLESS STEEL

A. Welding shall be performed by a qualified certified welder in accordance with AWS D1.6. Each weld shall be marked with a symbol which identifies the person who made the weld.

B. Prior to welding, edges shall be prepared, preferably by machine shaping or cutting with an aluminum oxide blade. Oxygen or arc cutting is acceptable only if the cut is reasonably smooth and true and all slag is removed either by chipping or grinding. Beveled ends for butt welding shall conform to ASME B16.25. Surfaces shall be clean and free of paint, oil, rust, scale, slag, or other material detrimental to welding. Prior to welding, wire brush joints to be welded with stainless steel wire brushes or stainless steel wool. Align ends to be joined within existing commercial tolerances on diameters, wall thicknesses, and out-of-roundness. Root opening of the joint shall be as stated in the procedure specification.

3.4 WELDING ALUMINUM

A. Aluminum shall be welded with Gas Metal Arc (MIG) or Gas Tungsten Arc (TIG) process in accordance with the MANUFACTURER's recommendations as approved and in accordance with the recommendations of the American Welding Society contained in the Welding Handbook, as last revised. Grind smooth all exposed aluminum welds.

3.5 ELECTROLYTIC PROTECTION

A. Where aluminum is in contact with dissimilar metals or concrete surfaces, it shall be protected. Allow paint to dry before installation of the material. Protect painted surfaces during installation; should coating become marred, prepare and touch up surface per paint MANUFACTURER's instructions.

END OF SECTION

SECTION 15100
PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. This section covers the work necessary to supply and install leachate collection, leachate detection, and master pump station pumps.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Iron and Steel Institute (AISI)
   2. American Standards Institute (ANSI)
   3. American Society for Testing and Materials (ASTM)
   4. Factory Mutual (FM)
   5. Hydraulic Institute Standards for Centrifugal, Rotary and Reciprocating Pumps (HI)
   6. National Electrical Manufacturer's Association (NEMA)
      a. 250, Enclosures for Electrical Equipment (1000) Volts Maximum)
      b. ICS 6, Enclosures for Industrial Controls
   7. National Fire Protection Agency (NAFPA)
   8. Underwriters Laboratories, Inc. (UL)
   9. It is the intentions of these Specifications that the pump, control panel, level controls and flow meter are provided by a sole MANUFACTURER with in-house testing facilities.

1.3 SUBMITTALS

A. Shop Drawings

B. Operation and Maintenance Manuals

PART 2 - PRODUCTS

2.1 LEACHATE PUMPING SYSTEMS

A. Leachate collection and detection pumps, including sensors and control panels, shall be designed and supplied by EPG Companies Inc., Maple Grove, MN (800-443-7426).

B. Flygt master pump station pumps, including sensors and control panels, shall be designed and supplied by Xylem, Inc., 1 International Drive, Rye Brook, NY.

2.2 MATERIALS

A. Furnish unit components meeting the following material specifications.
   1. EPG Model WSDPT SurePump™ Wheeled Sump Drainer with center mounted transducer holder for the sideslope risers.
      a. Major components made of 304 stainless steel
      b. Built –in check valve with nonmetallic seat
      c. E-Glide™ bearings and seals. Teflon or rubber not acceptable.
      d. Stainless steel shaft rotating on E-Glide™ bearings that are fluid lubricated.
      e. The diffuser chambers for each impeller shall be 304 stainless steel and fitted with E-Glide™ impeller seal rings.

f. The motor shall be submersible, stainless steel, hermetically sealed and capable of sustaining up to 100 starts per day.
g. The motor shall be connected to the pump by a motor adaptor and coupling of 304 stainless steel.
h. The motor lead shall be of non-splice with EPG's "CP" waterproof and chemically resistant jacket over 600-Volt insulation and be of the length as determined by the CONTRACTOR.
i. Provide Camlock disconnect fittings as shown in the drawings..

2. FLYGT NP3127.060HT submersible pump with RotoFloat 2-wire level sensors for pump stations.
   a. Pump housing and major castings gray cast iron.
   b. Stainless steel shaft.
   c. Semi-permanent wet well arrangement with pump installed on two guide bars.
   d. Automatic connection to discharge pipe.
   e. Double mechanical seal system.
   f. Epoxy surface treatment.

2.3 EQUIPMENT

A. Performance Requirements
   1. Two Submersible Leachate Collection Pumps EPG model WSDPT 14-2 for each cell sump location
      a. Design condition: 60 gpm at 40 ft. TDH
      b. Maximum horsepower 1.0 HP
      c. Drive Type: Constant speed.
      d. Flanged discharge nozzle: 2 IN NPT
      e. Submersible pump motor: 208 Volts, 3 phase, 60 Hertz
   2. One Submersible Leachate Detection Pump EPG model WSDPT 2-2 for each cell sump location
      a. Design condition: 8 gpm at 40 ft. TDH
      b. Maximum horsepower 0.5 HP
      c. Drive Type: Constant speed.
      d. Flanged discharge nozzle: 1.25 IN NPT
      e. Submersible pump motor: 208 Volts, 3 phase, 60 Hertz
   3. Two Submersible Pumps FLYGT NP3127 HT.060 for MPS-2
      a. Design condition: 200 gpm at 45 ft. TDH
      b. Maximum horsepower 7.5 HP
      c. Drive Type: Constant speed.
      d. Flanged discharge nozzle: 4 IN NPT Utilize guide rails to slide down into the position and seat on discharge connection.
      e. Submersible pump motor: 208 Volts, 3 phase, 60 Hertz

2.4 ACCESSORIES

A. Wheel Sump Drainer for EPG Pumps
   1. Pump shall include a stainless steel sump drainer housing with wheels on both ends.
   2. A removable transmitter mount shall be installed at the center bottom of the Sump Drainer for liquid level control.
   3. Provide stainless steel suspension cable of sufficient strength with stainless steel connections.
   4. The stainless steel horizontal Sump Drainer shall permit the unit to "pump down" to within 10 IN of the sump bottom for collection sump and within 8 IN of the sump

bottom for detection sump. The vertical pumps shall be pump down to minimum levels recommended by the MANUFACTURER.

B. FLYGT Submersible Pumps
   1. 2 IN 316 stainless steel upper guide bar brackets and cable holder
   2. 2 IN 316 stainless steel upper guide bar brackets
   3. 1/4 IN 316 stainless steel lifting cable
   4. 2 IN 316 stainless steel guide rails
   5. The pump control elevations are illustrated in the Drawings

C. Level Sensor
   1. The EPG submersible pressure transmitter level sensor shall have adequate range of operation with a 4-20MA output signal. Transmitter constructed with a stainless steel body, stainless steel diaphragm and Viton seals. Signal cable must be vented and chemical resistant. Transmitter circuit must be protected by intrinsically safe barriers.
   2. The Flygt pumps shall use RotoFloat 2-wire liquid level sensor.

D. Breakout Junction Boxes
   1. Furnish breakout box EPG Model BJBL625B for two level sensors, BJBP 525 for dual pump system in the collection sump, BJBP500 for single pump system in the detection sump and BJBL600B for detection system level sensor. Enclosures shall be NEMA4X non-metallic or stainless steel.
   2. Breakout junction boxes for the FLYGT submersible pumps shall be as recommended by the MANUFACTURER.

E. Discharge Pipe and Fittings
   1. Furnish and provide a complete discharge piping assembly to connect the pumps to the piping as shown on the plans.
   2. Discharge pipe shall be HDPE SDR 11.
   3. Furnish stainless steel discharge adapters with Camlock fittings.

2.5 CONTROL PANEL

A. The control panels for the leachate collection and detection sumps shall be YCL960PT EPG PumpMaster Control Panel, UL listed, 230 V, 30, NEMA 4X stainless steel enclosure to operate 2 ea. 1 HP **s**ubmersible pumps in lead-lag/alternating mode and a third 0.5 HP submersible pump independently with the following components:
   1. main disconnect
   2. padlocking handle
   3. pocket on inner door
   4. molded case circuit breakers
   5. surge suppressors
   6. NEMA rated starters
   7. amber power on light
   8. green run lights
   9. red motor overload lights
   10. elapsed time meters
   11. Operator Control Station (OCS)
   12. intrinsically safe barriers (2) for level sensors
   13. Option-009 surge protectors (2) for level sensors
   14. level sensor selector switch on inner door as addressed in the drawings
   15. flow meter displays (2)
   16. blue low flow, no flow, and current/phase monitor alarm lights

17. bottom mounted alarm horn
18. alarm silence push button
19. red top mounted common alarm strobe
20. blue top mounted alarm strobe
21. 20A duplex GFCI on inner door and weather tight duplex GFCI
22. 115 V power for flow meters
23. 115 V power supply and switch on side for 150W area light
24. panel layout drawing
25. data logging to USB on inner door with 2GB flash drive
26. 3kV A external mount stainless steel transformer.

B. The control panel for the master pump station shall consist of Duplex 7.5HP 3/60/460v stainless steel NEMA 4X enclosure with liquid level sensors with similar features as listed above for leachate collection and detection sump control panels as applicable. Control panel shall be manufactured by Flygt.

C. The main power and motor protection shall be fused per National Electrical Code (NEC) Article 409 to limit Arc Flash potential. The main power switch shall prevent opening of the control panel while power is on.

D. The “Hand-Off-Auto” selector switch allows manual or automatic operation. The selector switch shall be heavy duty; oil tight, NEMA 4 rated and shall be mounted on the inner door. The hand position shall be momentary with a spring return.

E. The motor starter shall be sized to the pump motor horsepower, and shall be equipped with built in, single phasing protection and an ambient compensated, quick-trip, Class 10, adjustable thermal overload.

F. The control transformer with fused primary and secondary shall isolate control circuit from power circuit and provide easier and safer field wiring of accessories. It shall lower incoming voltage to 120 Volts.

G. The run light shall indicate energization of motor circuit. It shall be heavy duty, oil tight, and NEMA 4 rated. The light shall be mounted on the inner door and will be green in color.

H. The motor overload light (three phase only) shall indicate motor not running due to overload condition. It shall be heavy duty, oil tight, and NEMA 4 rated. The light shall be mounted on the inner door and will be red in color.

I. Alarm lights shall indicate high sump level or pump remote disable. They shall be heavy duty, oil tight, and NEMA 4 rated. The lights shall be mounted on the inner door and will be red in color.

J. All interior panel lights to be LED.

K. A red top mounted light shall be provided and activated by any alarm condition.

L. A non-resettable elapsed time meter shall be mounted on the inner door and will record total pump run time in hours.

M. Control Panel must display a SCCR (short circuit current rating) per UL specifications.

N. The level simulator shall be mounted on the inner door. The level simulator shall be a built-in test circuit designed to simulate 4-20 mA loads to assist in level setup and troubleshooting.

O. The level sensor circuit shall be protected by intrinsically safe barriers.

P. A heater with adjustable thermostat shall promote even distribution of heat and elimination of hot spots and condensation. The heater element shall be mounted in space between the sub-panel and the back of the enclosure and provide a minimum of 100 IN square of heating area.

Q. A lightning arrestor shall be internally mounted and shall be grounded, metal-to-metal, to water strata. When properly grounded, the lightning arrestor will protect electrical equipment against lightning induced surges.

R. A labeled and numbered terminal strip shall provide easy connection of external components.

S. Inclusion of an industrial corrosion inhibitor emitter shall protect internal components of control panel from corrosion for up to one year and shall be replaceable.

2.6 SYSTEM LOGIC AND FUNCTION

A. EPG Pumps
   1. The controller is designed to start and stop a pump using operator control system with a submersible pressure transmitter. The pump starts at the pump start level set point and continues to run until the liquid level decreases to the pump stop level set point as programmed in the level control meter. At lag pump start level, the second pump will start to run along with the lead pump until liquid level decreases to the pump stop level. If the liquid level rises to the high level alarm set point, a high level will be annunciated. If the liquid level rises to the high-high level fail-safe set point, the pump motor will shut off. The pressure transmitter level sensor shall have a range of 0 to 11.5 feet with a 4-20 mA output signal with 125 foot Poly Lead. An elapsed time meter monitors total pump run time in hours

B. Flygt Pump
   1. The controller is designed to start and stop a pump using operator control system with float switches. The pump starts at the lead pump start level set point and continues to run until the liquid level decreases to the pump stop level set point in the float switch. The lag pump will start at Pump 2 start elevation (see drawings) and continue to run with the lead pump until liquid level decreases to the pump stop level set point. If the liquid level rises to the high-high level fail-safe set point, the pump motor will shut off.

PART 3 - EXECUTION

3.1 SOURCE QUALITY CONTROL

A. Test pump for 30 minutes in a tank operated by control panel.

B. Attach motor to cable and test for moisture seal to 150 psi.

3.2 INSTALLATION

A. Pump and control systems shall be installed by a factory trained INSTALLER.

B. Installation shall be properly grounded to meet all electrical codes.

3.3 WARRANTY

A. Wheeled Sump Drainer, Control Panel and accessories manufactured by EPG Companies and installed as a complete system shall be warranted for a period of 36 months from date of manufacture.

B. Flygt pumps and accessories shall be warranted for a period of 24 months from the date of delivery

C. MANUFACTURER to submit warranty with any required “as built shop drawings” and Operation and Maintenance Manuals.

END OF SECTION

SECTION 15160
FLOW METER AND PRESSURE GAUGES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This section covers the work necessary to furnish and install flow meter assemblies and pressured gauges in the proposed detection and leachate collection pumping systems and the proposed master pump station as indicated on the Drawings.

1.2 RELATED WORK

A. The Standard General and Supplemental Conditions of these specifications are a part of this section as if incorporated herein.

B. Other related specification sections contained herein are listed below:
   1. Section 15200, Pipe and Fittings

1.3 SUBMITTALS

A. CONTRACTOR shall submit printed MANUFACTURER's product data.

1.4 PROTECTION DURING STORAGE

A. The flow meter assemblies shall be stored in a manner that will protect them from the environment.

PART 2 - PRODUCTS

2.1 GENERAL

A. The flow meters shall be McCROMETER Ultra Mag with Procomm Convertor and consist of the following:
   1. 2 IN steel wafer style flow meter for leachate detection riser outlet pipe (Part # UM-0602FHM000A1). Add two wafer spools to facilitate flange connection to the pipe.
   2. 3-IN steel wafer style flow meter for leachate collection riser outlet pipe (Part # UM-0603FHM000A1). Add two wafer spools to facilitate flange connection to the pipe.
   3. 4 IN flow meter (Part# UM-0604WHM000A1) for master pump station.
   4. Flow meters shall be grounded as per MANUFACTURER recommendations
   5. Install 110V single phase power as recommended by the MANUFACTURER.

B. The pressure gauges for the leachate detection and collection pumps shall be 2 IN stainless steel encased Bourdon tube pressure gauges with an accuracy of ± 1.6%. Range shall be 0-50 psig.

C. The pressure gauges for the master pump station pumps shall be glycerin filled, 2-IN stainless steel encased Bourdon tube pressure gauges with an accuracy of ± 1.6%. The gauges shall be as manufactured by Kobold Instruments, Inc. Pittsburgh PA., or an OWNER approved equal. Other requirements are listed below.
   1. Range for the pump discharge shall be 0-100 psig.
   2. Dial shall be white painted aluminum with a black anodized pointer and a Plexiglas window.

3. Wetted parts shall be brass, but the sensing tube shall be 316L SS.
4. Exterior movement and housing shall be 304 SS.
5. Seals shall be Buna N for the housing, EPDM for the block, and Monoprene for the lens.
6. Protection shall be NEMA 4, UL listed.
7. The bottom fitting shall be 1/4 IN NPT.

PART 3 - EXECUTION

A. INSTALLATION

1. Install flow meters and pressure gauges in accordance with MANUFACTURER's recommendations in the locations shown on the Drawings and as herein specified with all equipment and necessary appurtenances to provide complete and working systems.
2. The flow meter assemblies shall be installed in the HDPE or ductile iron pipe as shown on the Drawings.
3. The CONTRACTOR shall be responsible for installation and in-place calibration of flow meters and related equipment. The CONTRACTOR shall provide written certification that the flow meter assemblies are properly calibrated and tested and meet the accuracy limits previously stated herein.
4. The pressure gauges shall be installed where indicated on the Drawings. The gauges shall be mounted in a vertical position and shall face perimeter road. The threaded connection to the piping system shall be sealed to prevent any leaks due to expansion/contraction.

END OF SECTION

SECTION 15200
PIPE AND PIPE FITTINGS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide and install piping systems as shown on the Drawings including fittings, accessories, and other appurtenances.

1.2 RELATED WORK

A. The General and Supplemental Conditions of these specifications are a part of this section as if incorporated herein.

B. Other related specification sections contained herein are as listed below.
   1. Section 02300 Earthwork

1.3 QUALITY ASSURANCE

A. Piping materials and manufacture shall adhere to the standards referenced herein.

B. MANUFACTURER's written installation, joining, and connection instructions shall be kept on site during all piping operations and shall be strictly adhered to.

C. Joining and laying of HDPE pipe is to be performed only by a CONTRACTOR or subcontractor with proven experience in working with HDPE pipe.

D. Upon completion of the non-pressurized HDPE piping, protective cover, and leachate collection gravel installation, the non-pressurized HDPE piping systems shall be inspected via videotaping and cleaned via high-pressure water-jetting. The CONTRACTOR or subcontractor shall have demonstrated experience water-jetting and video inspection of landfill leachate collection pipes. The videotape(s) shall be accompanied by a certification from the video operator that the piping systems are free of blockages and soil deposits. Cameras and equipment used for piping system cleaning and videotaping shall be explosion-proof, NEC Class 1, Division 1, Groups C and D. A letter report addressed from the water-jetting firm which contains a summary of the work and the results from the water-jetting for the new cell shall be submitted to the ENGINEER two weeks after water-jetting is completed. The ENGINEER and OWNER shall be notified seven days ahead of time of the scheduled video inspection and water-jetting.

1.4 SUBMITTALS AND TESTING

A. The MANUFACTURER's product data shall be provided for each pipe material which will become a permanent part of the work and shall include all fittings and accessories.

B. The CONTRACTOR shall submit INSTALLER qualifications and experience for himself or subcontractor with regard to HDPE pipe installation for record purposes.

C. The CONTRACTOR shall provide qualifications of the proposed firm(s) to be used in the jet-cleaning and video inspection of the HDPE piping for record purposes. The CONTRACTOR shall also submit the results of the cleaning two weeks after the jet-cleaning. Videotape shall be submitted upon system completion and shall be clearly labeled with videotaping date, pipe starting and ending point, name, address, and phone number of firm performing the videotaping. Each section of pipe that is videotaped shall

have a complete dialog dubbed onto the video tape which, as a minimum, describes: length of pipe videotaped; location of pipe videotaped; all welds; deflections; other features of interest.

D. Pressure test reports which include time, date, section tested, pressure reading, ambient temperature at time of pressure reading and witnesses to testing.

E. Drawings containing as-constructed pipe invert elevations shall be submitted for record purposes as specified herein.

1.5 HANDLING, STORAGE, INSPECTION, AND PROTECTION

A. Care shall be taken during transport of all pipes to protect pipe from kinks, cuts, end damage, and other defects. Binding and tie-down methods shall not damage or deflect pipe in any way. Pipe damaged during shipment shall be rejected.

B. Pipe shall be stored on level ground, preferably turf or sand, free of sharp objects which could damage the pipe. Stacking of any pipe shall be limited to a height that will not cause deformation of the lower layers of pipe under anticipated temperature conditions. When necessary due to ground conditions, the pipe shall be stored on wooden sleepers, spaced suitably and of such widths to prevent deformation of the pipe at the point of contact with the sleeper or between supports. Pipe shall not be removed from storage until bedding or subgrade work is complete and ready to receive the pipe.

C. The handling of the joined pipe shall be in such a manner that the pipe is not damaged by dragging it over sharp and cutting objects. Ropes, fabric, or rubber-protected slings and straps shall be used when handling pipe. Chains, cables, or hooks inserted into the pipe ends shall not be used. Two slings spread apart shall be used for lifting each length of pipe. Pipe or fittings shall not be dropped. Slings for handling the joined pipe shall not be positioned at butt-fused joints. Sections of the pipes with cuts and gouges shall be removed and the ends of the pipe rejoined.

D. Any plastic-type pipe stored on the job site shall be covered with canvas or other opaque material to protect it from sunlight. Air circulation shall be provided under the covering. HDPE pipe may be excluded from this requirement as recommended by the MANUFACTURER.

E. All pipe, fittings, and other accessories shall be inspected upon delivery and during the course of the work. Any defective or damaged materials found during field inspection or during tests shall be removed from the site and replaced by, and at the expense of, the CONTRACTOR.

F. The interior of all pipe, fittings, and other accessories shall be kept free from dirt and foreign matter at all times. Fittings shall be drained and stored in a manner that will protect them from damage by freezing.

G. MANUFACTURER's written instructions regarding handling and storage of pipe and fittings shall be adhered to and shall be kept on site for inspection as required.

1.6 REFERENCE STANDARDS

A. Reference standards and recommended practices referred to herein shall be the latest revision of any such document.

B. Standards referenced herein are as listed below.
   1. ANSI B16.5 Pipe Flanges and Flanged Fittings
   2. ANSI B18.2.1 Square and Hex Bolts and Screws

3. ASTM A 193 Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
4. ASTM A 194 Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service
5. ASTM D 635 Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
6. ASTM D 790 Standard Test Method for Flexural Properties of unreinforced and Reinforced Plastics and Electrical Insulating Materials
7. ASTM D 1238 Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer
8. ASTM D 1505 Standard Test method for Density of Plastics by the Density-Gradient Technique
9. ASTM D 2837 Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials
10. ASTM D 3261 Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
11. ASTM D 3350 Polyethylene Plastics Pipe and Fittings Material
12. ASTM F 714 Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
13. ASTM F 1473 Standard Test Method for Notch Tensile Test to measure the Resistance to Slow Crack Growth of Polyethylene Pipes and Resins
14. AWWA C906 Polyethylene (PE) Pressure Pipe and Fittings, 4 in. Through 65 in. (100 mm Throug 1,650 mm), for Waterworks

PART 2 - PRODUCTS

2.1 GENERAL

A. All pipe joints and fittings shall have the same or greater strength, pressure ratings, thermal resistance, chemical resistance, and other pertinent properties as the pipe being joined or connected. Plastic pipe fittings shall be manufactured of the same resin as used in the manufacture of the pipe being joined.

B. Fittings for use with plastic-type pipe material herein specified shall be provided by the same MANUFACTURER providing the pipe.

C. Each pipe length shall be clearly marked with MANUFACTURER's name or trademark, applicable ASTM ratings, size, and, where applicable, standard dimension ratio.

D. All flange bolts, nuts, and washers shall be ANSI Type 316 stainless steel, ASTM A 193, Grade B8M hex head bolts and ASTM A 194, Grade 8M hex head nuts. Bolts shall be fabricated in accordance with ANSI B18.2.1 and shall be provided with washers.

E. Field threading of pipes is not allowed.

F. Where threaded fittings are permitted, thread lubricant shall be Teflon tape.

G. Identify each length of pipe clearly at intervals of 5 FT or less.
   1. Include MANUFACTURER's name and trademark.
   2. Nominal size of pipe, standard dimension ratio, appurtenant information regarding polymer cell classification and critical identifications regarding performance specifications and NSF approvals when applicable.

2.2 HIGH DENSITY POLYETHYLENE (HDPE) PIPING MATERIALS

A. Black PE materials used for the manufacture of polyethylene pipe, tube and fittings shall be PE 4710 high density polyethylene meeting ASTM D3350 cell classification 445574C and shall be listed in the name of the pipe and fitting MANUFACTURER in PPI (Plastics Pipe Institute) TR-4 with a standard grade HDB rating of 1600 psi at 73°F. Additional requirements are listed below.

Table 15200-1 Pipe Material Physical Properties

PROPERTY	STANDARD	TYPICAL VALUE
Cell Classification	ASTM D3350	445574C (black)
Density	ASTM D1505	0.960 g/cc (black)
Melt Index	ASTM D1238	0.08 g/10 min
Flexural Modulus	ASTM D790	>120,000 psi
Tensile Strength	ASTM D635 Type IV	> 3500 psi
SCG (PENT)	ASTM F1473	>500 hours
HDB at 73^0F	ASTM D2837	1600 psi
Color; UV stabilizer	ASTM D3350	Black

B. The HDPE pipe and fittings shall be homogeneous throughout and free of visible cracks, holes, foreign inclusions, or other injurious defects. Any pipe or fitting with nicks, scrapes, or gouges deeper than 5 percent of the nominal wall thickness shall be rejected.

C. HDPE piping shall be provided in the sizes and shall have a Standard Dimension Ratio (SDR) as indicated on the drawings. Dimensions and workmanship shall conform to the requirements of ASTM F 714.

D. HDPE pipe and fitting joints shall be butt, heat fusion weld type only. No extrusion welds shall be permitted unless specifically noted on the drawings or specified herein. These criteria shall also apply to both the carrier piping and the containment piping for double-wall piping systems. All welds shall achieve full penetration.

E. HDPE fittings for single-wall piping systems shall be either molded or shop-fabricated type. Shop-fabricated fittings shall be made from pipe sections using butt, heat fusion welding. Fittings with extrusion welding shall not be permitted.

F. HDPE fittings used in single-wall piping systems and in carrier piping of double-wall piping systems shall be free of internal projections. Any and all internal projections resulting from molding or heat fusion fabrication shall be removed flush to the interior surface of the fitting at the factory or shop.

G. Flanged joints, where required, shall utilize molded HDPE flange adapters and 316 stainless steel backup rings with ANSI B16.5 drilling. Flange bolting shall be as specified herein. Flanged HDPE joints shall have flat ring type Viton gaskets with gasket thickness and hardness as recommended by the MANUFACTURER.

H. Molded fittings shall be manufactured and tested in accordance with ASTM D 3261 and shall be so marked. Molded fittings shall be tested in accordance with AWWA C906.

I. Fabricated fittings shall be made by heat fusion joining specially machined shapes cut from pipe, polyethylene sheet stock or molded fittings. Fabricated fittings shall be rated for internal pressure service at least equal to the full service pressure rating of the mating pipe. Fabricated fittings shall be tested in accordance with AWWA C906.

J. All fusion welding beads shall be ground smooth upon completion of welding.

2.3 PERFORATED HDPE PIPING MATERIALS

A. Perforated HDPE pipe shall conform to the requirements specified for HDPE pipe.

B. Perforations shall be drilled into the pipe at the pipe extrusion plant or fabrication shop. Any burrs remaining after drilling shall be removed. Perforations shall be drilled and deburred prior to pipe delivery to the job site. Job site perforation or perforation by the CONTRACTOR shall not be permitted.

C. Provide perforations as indicated on the Drawings.

2.4 FLEXIBLE CONNECTORS

A. Flexible connectors shall have Viton interiors, neoprene exteriors, 316 stainless steel retaining rings, and 316 stainless steel control units. Flexible connectors shall be Metraflex Style No. 300, or equal as approved by the ENGINEER.

2.5 APPURTENANCES

A. HDPE Flange Adapter: HDPE flange adapter shall be the same SDR and from the same resin as the pipe.

B. HDPE to Steel Pipe Transition: Use HDPE MANUFACTURER's factory-made transition.

C. All fasteners and hardware shall be stainless steel type 304 unless otherwise specified.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. All pipe shall be laid and maintained straight and true to line in strict conformance with the lines, grades, and elevations indicated on the drawings. Line and grade tolerances, where applicable, shall be in accordance with limits given for specific material. Grade shall be measured at the pipe invert, not at the top of the pipe, due to permissible variations in pipe wall thickness. CONTRACTOR shall supply the ENGINEER drawings showing as-constructed pipe invert elevations at every 50 feet of pipeline.

B. Trenching, bedding, and backfill shall be in accordance with Section 02300, Earthwork for Liner Construction and Section 02225, Trenching.

C. During laying operations, do not permit debris, tools, clothing, or similar items to be placed in pipes. Pipe interior shall be free of mud and kept clean at all times.

D. Pipe ends shall be kept clear and clean and the CONTRACTOR shall ensure that inside surfaces are maintained smooth and free from any projections that may interfere with joint assembly or flow through the completed line.

E. Care shall be exercised when lowering pipe into trenches or on subgrade to prevent damage or twisting of the pipe. After laying and prior to completion of backfill or cover operations, pipe shall be protected from any vehicular traffic.

F. Existing piping flanged joints which are disassembled by the CONTRACTOR shall be fitted with new gaskets, as specified, upon reassembly.

G. Laying of pipe and backfilling shall not be conducted in areas of standing water.

3.2 HDPE PIPING INSTALLATION

A. Line or grade shall not deviate from dimensions and elevations given on the drawings by more than 1/2 inch for line and 1/4 inch for grade at any point, provided that such variation does not result in a level or reverse sloping invert.

B. Pipe and fittings shall be joined together using butt heat-fusion techniques in accordance with the pipe MANUFACTURER's recommendations. The heat-fusion welds shall not project into the interior of the piping high enough to interfere with passage of cameras and equipment used or piping system cleaning and videotaping inspection, and in no event shall such projections exceed 0.25 inch.

C. Prior to final acceptance, completely flush and clean all parts of the system. Flushing water shall be properly disposed. Flushing water shall not be discharged to the leachate aeration/storage basins. The leachate collection and leak detection pumps shall not be used to handle water resulting from flushing operations. Remove all accumulated construction debris, rocks, sand, gravel, and other foreign material.

D. Pipe Testing – General (refer to individual piping sections for pipe-specific testing requirements):
   1. Test piping systems as follows:
      a. Test exposed, non-insulated piping systems upon completion of system.
      b. Test exposed, insulated piping systems upon completion of system but prior to application of insulation.
      c. Test concealed interior piping systems prior to concealment and, if system is insulated, prior to application of insulation.
      d. Test buried piping after backfilling has been complete.
   2. Utilize pressures, media and pressure test durations as specified on Piping Specification Schedules.
   3. Isolate equipment which may be damaged by the specified pressure test conditions.
   4. Perform pressure test using calibrated pressure gages and calibrated volumetric measuring equipment to determine leakage rates.
      a. Select each gage so that the specified test pressure falls within the upper half of the gage's range.
      b. Notify the ENGINEER 24 HRS prior to each test.
   5. Completely assemble and test new piping systems prior to connection to existing pipe systems.
   6. Acknowledge satisfactory performance of tests and inspections in writing to ENGINEER prior to final acceptance.
   7. Bear the cost of all testing and inspecting, locating and remedying of leaks and any necessary retesting and re-examination.

E. Pressure Testing:
   1. Testing medium: Unless otherwise specified in the Piping Specification Schedules, utilize the following test media.
      a. Liquid systems:

Table 15200-2 Pressure Testing Requirements

PIPE LINE SIZE (DIA)	GRAVITY OR PUMPED	SPECIFIED TEST PRESSURE	TESTING MEDIUM
Up to and including 48 IN	Gravity	25 psig or less	Air or water
Above 48 IN	Gravity	25 psig or less	Water
All sizes	Pumped	200 psig or less	Water

2. Allowable leakage rates:
   a. Leachate systems, groundwater pumping systems, all exposed piping systems, all pressure piping systems, and all buried, insulated piping systems which are hydrostatically pressure tested shall have zero leakage at the specified test pressure throughout the duration of the test.
   b. Hydrostatic exfiltration and infiltration for sanitary and stormwater sewers (groundwater level is below the top of pipe):
      1) Leakage rate: 200 GAL per inch diameter per mile of pipe per day at average head on test section of 3 FT.
      2) Average head is defined from groundwater elevation to average pipe crown.
      3) Acceptable test head leakage rate for heads greater than 3 FT: Acceptable leakage rate (gallons per inch diameter per mile per day) = 115 x (actual test head to the 1/2 power).
   c. Hydrostatic infiltration test for sanitary and stormwater sewers (groundwater level is above the top of pipe):
      1) Allowable leakage rate: 200 GAL per inch diameter per mile of pipe per day when depth of groundwater over top of pipe is 2 to 6 FT.
      2) Leakage rate at heads greater than 6 FT: Allowable leakage rate (gallons per inch diameter per mile of pipe per day) = 82 x (actual head to the 1/2 power).
   d. For low pressure (less than 25 psig) air testing, the acceptable time for loss of 1 psig of air pressure shall be as shown in the below table.

Table 15200-3 Pressure Drop Time Limits

PIPE SIZE (IN DIA)	TIME (MINUTES/100 FT)
2	0.2
4	0.3
6	0.7
8	1.2
10	1.5
12	1.8
15	2.1
18	2.4
21	3.0
24	3.6
27	4.2

PIPE SIZE (IN DIA)	TIME (MINUTES/100 FT)
30	4.8
33	5.4
36	6.0
42	7.3
48	7.6

3. Hydrostatic pressure testing methodology:
   a. General:
      1) All joints, including welds, are to be left exposed for examination during the test.
      2) Provide additional temporary supports for piping systems designed for vapor or gas to support the weight of the test water.
      3) Provide temporary restraints for expansion joints for additional pressure load under test.
      4) Isolate equipment in piping system with rated pressure lower than pipe test pressure.
      5) Do not paint or insulate exposed piping until successful performance of pressure test.
4. Air testing methodology:
   a. General:
      1) Assure air is ambient temperature.
   b. Low pressure air testing:
      1) Place plugs in line and inflate to 25 psig.
      2) Check pneumatic plugs for proper sealing.
      3) Introduce low pressure air into sealed line segment until air pressure reaches 4 psig greater than ground water that may be over the pipe.
         a) Use test gage conforming to ANSI B40.1 with 0 to 15 psi scale and accuracy of 1 percent of full range.
      4) Allow 2 minutes for air pressure to stabilize.
      5) After stabilization period (3.5 psig minimum pressure in pipe) discontinue air supply to line segment.
      6) Record pressure at beginning and end of test.
   c. Repeat test procedure for verification.

3.3 PERFORATED HDPE PIPING INSTALLATION

A. All sections of perforated HDPE pipe shall be thoroughly cleaned and deburred after perforating and before welding or delivery to the job site to ensure all drill cuttings are removed from the pipe.

B. Pipe shall be installed in gravel fill as specified in Section 02300, Earthwork.

C. Install perforated pipe in accordance with drawing details and as specified for HDPE pipe.

D. Prior to final acceptance, completely flush and clean all parts of the system. Flushing water shall be disposed of properly. The leachate collection and leak detection pumps shall not be used to handle water resulting from flushing operations. Remove all accumulated construction debris, rocks, sand, gravel, and other foreign material.

3.4 DOUBLE-WALL HDPE PIPING INSTALLATION

A. Install containment and carrier piping as per MANUFACTURER's directions and in accordance with specifications herein for HDPE piping installation.

END OF SECTION

This page intentionally left blank.

SECTION 15300
VALVES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This section covers the work necessary to furnish and install valves at the leachate collection and leak detection pumping systems, pump stations and at other locations as indicated on the drawings.

1.2 RELATED WORK

A. The General and Supplemental Conditions of these Specifications are a part of this section as if incorporated herein.

B. Other related specification sections contained herein are listed below:
   1. Section 02225 - Trenching
   2. Section 15200 - Pipe and Pipe Fittings

1.3 SUBMITTALS

A. CONTRACTOR shall submit printed MANUFACTURER's product data for review and approval by OWNER.

1.4 PROTECTION DURING STORAGE

A. The interior of valves shall be kept free from dirt and foreign material at all times. Valves shall be drained and stored in a manner that will protect them from damage by freezing.

1.5 REFERENCE STANDARDS

A. Reference standards and recommended practices referred to herein shall be the latest revision of any such document.

PART 2 - PRODUCTS

2.1 GENERAL

A. Each valve shall have the MANUFACTURER's name, address, model number, and serial number engraved or embossed on a nameplate securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable. The nameplate shall be 316 stainless steel, or other corrosion resistant material as approved by the OWNER.

2.2 CHECK VALVES

A. Silent check valves shall be provided for leachate service and shall protect against water hammer by closing while there is a positive pressure on the pump side of the valve. Valves shall permit free flow forward and provide a positive check against backflow.

B. The valve shall be global-style or wafer style depending on the pipe diameter with spring actuator. The flow through area of the valve shall be greater than the cross-sectional area of the upstream piping. The valve body shall be ductile iron with stainless steel trim, resilient Buna-N seating and stainless steel spring.

C. Check valves shall have a working differential pressure rating of at least 150 psi.

D. Check valves as manufactured by APCO/Valve and Primer Corporation, or equal as approved by the OWNER.

2.3 BALL VALVES

A. Ball valves shall be series 7000 as manufactured by Jamesbury, or equal as approved by the OWNER. Size shall be as shown on the drawings.
   1. For collection sump use part# 3”7150-312236XTZ1
   2. For detection sump use part# 2”7150-312236XTZ1
   3. For Master Pump Station (MPS) part # 4”7150-312236XTZ1

2.4 AIR RELEASE VALVE FOR FORCEMAIN

A. The air release valve (ARV) shall have 2-IN NPT inlet and 1-IN NPT outlet connections. The outlet shall have a shutoff valve. The body and cover shall be of 316 stainless steel. Internal components shall be stainless steel. The seat shall be of Buna-N. The exterior paint shall be universal metal primer.

B. The ARV shall be series no. 401 (Sewage Air/Vacuum Valve-Series 401) as manufactured by APCO/Valve and Primer Corporation, or equal as approved by the OWNER.

2.5 BUTTERFLY VALVES

A. Shall be High Performance Butterfly Valve (BHP) as manufactured by DeZURIK, or equal as approved by the OWNER. Size shall be as shown on the drawings with lever type actuator.

PART 3 - EXECUTION

3.1 GENERAL VALVE INSTALLATION

A. Valves shall be installed at locations indicated on the drawings and in general accordance with the requirements of Section 15200, Pipe and Pipe Fittings.

B. Vertical and horizontal valve stems shall be plumb and level, respectively.

C. Settings of valve actuator stops shall be checked/adjusted in accordance with valve MANUFACTURER's instructions.

D. Trench excavation shall be performed in accordance with Section 02225, Trenching, with bottom of trench hand trimmed such that valve flanges do not rest on subgrade.

3.2 AIR/VACUUM AND AIR RELEASE VALVE INSTALLATION

A. AVV and ARV shall be installed vertically and in accordance with the MANUFACTURER's directions.

END OF SECTION

SECTION 15350
PIPE SUPPORT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pipe support and anchor systems.
   2. Design of Pipe Support Systems as specified.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 05500 - Miscellaneous Metals

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B31.1, Power Piping.
      b. B31.3, Process Piping.
   2. ANVIL International (ANVIL).
   3. ASTM International (ASTM):
      a. A36, Standard Specification for Carbon Structural Steel.
      b. A276, Standard Specification for Stainless Steel Bars and Shapes.
      c. A575, Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades.
      d. A576, Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality.
      e. A917, Standard Specification for Steel Sheet, Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface (General Requirements).
      f. A918, Standard Specification for Steel Sheet, Zinc-Nickel Alloy Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface.
      g. B633, Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
   4. American Welding Society (AWS):
      a. D1.1, Structural Welding Code - Steel.
      b. D1.6, Structural Welding Code - Stainless Steel.
   5. Manufacturers Standardization Society of the Valve and Fittings Industry Inc. (MSS):
      a. SP-58, Pipe Hangers and Supports - Materials, Design and Manufacture.
      b. SP-69, Pipe Hangers and Supports - Selection and Application.

B. Responsibility:
   1. Design complete support systems for piping 12 IN and smaller where supports are not shown on the Drawings.
   2. Provide all labor, materials, equipment and incidentals as shown, specified and required to design, furnish and install the system of hangers, supports, guidance, anchorage and appurtenances.
   3. General piping support details may be indicated on the Drawings in certain locations for pipe 12 IN DIA and smaller.

4. Incorporate those details with requirements of this Specification Section to provide the piping support system.

C. Each type of pipe hanger or support shall be the product of one MANUFACTURER.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. MANUFACTURER's installation instructions.
      c. Itemized list of wall sleeves, anchors, support devices and all other items related to pipe support system.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. General:
   1. All components associated with pipe support system shall be construction with stainless steel 304 or 316.

B. Vertical Pipe Supports:
   1. At base of riser.

C. Expanding Pipe Supports:
   1. Spring hanger type.
   2. MSS SP-58.

D. Pipe Support Saddle:
   1. For pipe located 3 FT or less from floor elevation, except as otherwise indicated on Drawings.

E. Pipe Support Risers:
   1. Schedule 40 pipe.
   2. Stainless steel.
   3. Size: Φ 2 IN minimum or as recommended by saddle MANUFACTURER.

F. Pipe Support Base Plate (except as otherwise indicated on Drawings):
   1. Square cut threaded end.

G. Pipe Anchors:
   1. 1/4 IN stainless steel plate construction.
   2. Designed to prevent movement of pipe at point of attachment.

2.2 DESIGN REQUIREMENTS

A. Supports capable of supporting the pipe for all service and testing conditions.
   1. Provide 5 to 1 safety factor.

B. Allow free expansion and contraction of the piping to prevent excessive stress resulting from service and testing conditions or from weight transferred from the piping or attached equipment.

C. Design supports and hangers to allow for proper pitch of pipes.

D. For chemical and waste piping, design, materials of construction and installation of pipe hangers, supports, guides, restraints, and anchors:

1. ASME B31.3.
2. MSS SP-58 and MSS SP-69.
3. Except where modified by this Specification.

E. Check all physical clearances between piping, support system and structure.
   1. Provide for vertical adjustment after erection.

F. Support vertical pipe runs in pipe chases at base of riser.
   1. Support pipes for lateral movement with clamps or brackets.

G. Provide 20 GA stainless steel pipe saddle for fiberglass and plastic support points to ensure minimum contact width of 4 IN.

H. Pipe Support Spacing:
   1. General:
      a. Factor loads by specific weight of liquid conveyed if specific weight is greater than water.
      b. Locate pipe supports at maximum spacing scheduled unless indicated otherwise on the Drawings.
      c. Provide at least one support for each length of pipe at each change of direction and at each valve.
   2. Steel, stainless steel, cast-iron pipe support schedule:

Table 15350-1 Cast Iron Maximum Span Requirements

PIPE SIZES - IN	MAXIMUM SPAN - FT
1-1/2 and less	5
2 thru 4	10
5 thru 8	15

   3. PVC/HDPE pipe support schedule:

Table 15350-2 PVC/HDPE Maximum Span Requirements

PIPE SIZES - IN	MAXIMUM SPAN - FT
1-1/4 and less	3
1-1/2 thru 3	4
4 and greater	5

* Maximum fluid temperature of 120 DEGF.

   4. Support each length and every fitting:
      a. Bell and spigot piping:
         1) At least one hanger.
         2) Applied at bell.
      b. Mechanical coupling joints:
         1) Place hanger within 2 FT of each side of fittings to keep pipes in alignment.
   5. Space supports for soil and waste pipe and other piping systems not included above every 5 FT.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide piping systems exhibiting pulsation, vibration, swaying, or impact with suitable constraints to correct the condition.
   1. Included in this requirement are movements from:
      a. Trap discharge.
      b. Water hammer.
      c. Similar internal forces.

B. Weld Supports:
   1. AWS D1.1.
   2. Weld anchors to pipe in accordance with ASME B31.3.
   3. AWS D1.6 for stainless steel supports.

C. Locate piping and pipe supports as to not interfere with open accesses, walkways, platforms, and with maintenance or disassembly of equipment.

D. Inspect hangers for:
   1. Design offset.
   2. Adequacy of clearance for piping and supports in the hot and cold positions.
   3. Guides to permit movement without binding.
   4. Adequacy of anchors.

E. Inspect hangers after erection of piping systems and prior to pipe testing and flushing.

F. Anchorage to Concrete.
   1. ½ IN DIA stainless steel expansion anchor bolts.

G. Welding:
   1. Welding rods: ASTM and AWS standards.
   2. Integral attachments:
      a. Include welded-on ears, shoes, plates and angle clips.
      b. Ensure material for integral attachments is of good weldable quality.
   3. Preheating, welding and post heat treating: ASME B31.3, Chapter V.

END OF SECTION

SECTION 16010
ELECTRICAL: BASIC REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Basic requirements for electrical systems.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Division 16 - Electrical.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Aluminum Association (AA).
   2. American Iron and Steel Institute (AISI).
   3. ASTM International (ASTM):
      a. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
      b. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   4. ETL Testing Laboratories (ETL).
   5. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. C2, National Electrical Safety Code (NESC).
   6. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. ICS 6, Industrial Control and Systems Enclosures.
   7. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   8. Underwriters Laboratories, Inc. (UL).

B. Where UL test procedures have been established for the product type, use UL or ETL approved electrical equipment and provide with the UL or ETL label.

1.3 DEFINITIONS

A. For the purposes of providing materials and installing electrical work the following definitions shall be used.
   1. Outdoor area: Exterior locations where the equipment is normally exposed to the weather and including below grade structures, such as vaults, manholes, handholes and in-ground pump stations.
   2. Architecturally finished interior area: Offices, laboratories, conference rooms, restrooms, corridors and other similar occupied spaces.
   3. Non-architecturally finished interior area: Pump, chemical, mechanical, electrical rooms and other similar process type rooms.
   4. Highly corrosive and corrosive area: Areas identified on the Drawings where there is a varying degree of spillage or splashing of corrosive materials such as water,

wastewater or chemical solutions; or chronic exposure to corrosive, caustic or acidic agents, chemicals, chemical fumes or chemical mixtures.

5. Hazardous areas: Class I, II or III areas as defined in NFPA 70.
6. Shop fabricated: Manufactured or assembled equipment for which a UL test procedure has not been established.
7. Maintain Pump Station Operation:
   a. Coordinate with the Owner's operations and maintenance staffs to verify they have equipment operational and construction can proceed.
   b. Coordinate installation of the service transformer and metering with the serving utility.
   c. The serving utility for this Project is LCEC.
   d. The Contractor shall provide all secondary conduits and feeders from the point of demarcation as coordinated with the utility company.
   e. The utility will furnish the transformer, primary service conduit and wire, metering CT's to be mounted as indicated on the drawings, meter and meter socket, and make all connections at the transformer, CT's and meter socket, and furnish the telephone cable.
   f. Execution of this Contract will involve providing new equipment.
   g. Temporary equipment and wiring, installed in accordance with the NFPA70, may be used if necessary to maintain operation or to limit downtime.
   h. Under no circumstances shall equipment be taken out of service without the Owner's permission.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01350 for requirements for the mechanics and administration of submittal process.
   2. General requirements:
      a. Provide manufacturer's technical information on products to be used, including product descriptive bulletin.
      b. Include data sheets that include manufacturer's name and product model number.
         1) Clearly identify all optional accessories.
      c. Acknowledgement that products are UL or ETL listed or are constructed utilizing UL or ETL recognized components.
      d. Manufacturer's delivery, storage, handling and installation instructions.
      e. Product installation details.
      f. See individual specification sections for any additional requirements.
      g. Provide submittal data for the following items specified on the Drawings:
         1) Grounding and Bonding
         2) Wire and Cable: 600 Volt and Below
         3) Raceway and Boxes
         4) Exterior Underground
         5) Wiring Devices
         6) Safety Switches
         7) Panelboards
         8) Overcurrent and short circuit protective devices
         9) Low Voltage Surge Protection Devices
         10) Lighting
      h. Fabrication and/or layout drawings:

1) Provide a conductor identification schedule for all power, control, communication and protective circuits.
2) Schedule to include the following information:
   a) Conductor identification number.
   b) Conductor size.
   c) Number of conductors.
   d) Type of conductor.
   e) Size of conductor.
   f) Size of conductor usage descriptions.
   g) Conductor run (to and from).
   h) Conduit size and type.

B. When a Specification Section includes products specified in another Specification Section, each Specification Section shall have the required Shop Drawing transmittal form per Specification Section 01350 and all Specification Sections shall be submitted simultaneously.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect nameplates on electrical equipment to prevent defacing.

1.6 AREA DESIGNATIONS

A. Designation of an area will determine the NEMA rating of the electrical equipment enclosures, types of conduits and installation methods to be used in that area.
   1. Outdoor areas:
      a. Wet.
      b. Also, corrosive and/or hazardous when specifically designated on the Drawings or in the Specifications.
   2. Indoor areas:
      a. Dry.
      b. Also, wet, corrosive and/or hazardous when specifically designated on the Drawings or in the Specifications.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, refer to specific Division 16 Specification Sections and specific material paragraphs below for acceptable manufacturers.

B. Provide all components of a similar type by one (1) manufacturer.

2.2 MATERIALS

A. Electrical Equipment Support Pedestals and/or Racks:
   1. Approved manufacturers:
      a. Modular strut:
         1) Unistrut Building Systems.
         2) Eaton B-Line.
         3) Globe Strut.
         4) Thomas & Betts Superstrut.
   2. Material requirements:
      a. Modular strut:
         1) Galvanized steel: ASTM A123/123M or ASTM A153/A153M.

2) Stainless steel: AISI Type 316.
3) PVC coated galvanized steel: ASTM A123/A123M or ASTM A153/A153M and 20 mil PVC coating.
4) Aluminum: AA Type 6063-T6.
5) Mounting plates:
a) Galvanized steel: ASTM A123/A123M.
b) Aluminum: AA Type 6063-T6.

b. Mounting hardware:
1) Galvanized steel.
2) Stainless steel.

B. Field touch-up of galvanized surfaces.
1. Zinc-rich primer.
a. One (1) coat, 3.0 mils, ZRC by ZRC Products.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install and wire all equipment, including prepurchased equipment, and perform all tests necessary to assure conformance to the Drawings and Specification Sections and ensure that equipment is ready and safe for energization.

B. Install equipment in accordance with the requirements of:
1. NFPA 70.
2. IEEE C2.
3. The manufacturer's instructions.

C. In general, conduit routing is not shown on the Drawings.
1. The Contractor is responsible for routing all conduits including those shown on one-line and control block diagrams and home runs shown on floor plans.
2. Conduit routings and stub-up locations that are shown are approximate; exact routing to be as required for equipment furnished and field conditions.

D. When complete branch circuiting is not shown on the Drawings:
1. A homerun indicating panelboard name and circuit number will be shown and the circuit number will be shown adjacent to the additional devices (e.g., light fixture and receptacles) on the same circuit.
2. The Contractor is to furnish and install all conduit and conductors required for proper operation of the circuit.
3. The indicated home run conduit and conductor size shall be used for the entire branch circuit.
4. See Specification Section 16120 for combining multiple branch circuits in a common conduit.

E. Do not use equipment that exceed dimensions or reduce clearances indicated on the Drawings or as required by the NFPA 70.

F. Install equipment plumb, square and true with construction features and securely fastened.

G. Install electrical equipment, including pull and junction boxes, minimum of 6 IN from process, gas, air and water piping and equipment.

H. Install equipment so it is readily accessible for operation and maintenance, is not blocked or concealed and does not interfere with normal operation and maintenance requirements of other equipment.

I. Device Mounting Schedule:
   1. Unless indicated otherwise on the Drawings, mounting heights are as indicated below:
      a. Light switch (to center): 48 IN.
      b. Receptacle in architecturally finished areas (to center): 18 IN.
      c. Receptacle on exterior wall of building (to center): 18 IN.
      d. Receptacle in non-architecturally finished areas (to center): 48 IN.
      e. Telephone outlet in architecturally finished areas (to center): 18 IN.
      f. Telephone outlet for wall-mounted phone (to center): 54 IN.
      g. Safety switch (to center of operating handle): 54 IN.
      h. Separately mounted motor starter (to center of operating handle): 54 IN.
      i. Pushbutton or selector switch control station (to center): 48 IN.
      j. Panelboard (to top): 72 IN.

J. Avoid interference of electrical equipment operation and maintenance with structural members, building features and equipment of other trades.
   1. When it is necessary to adjust the intended location of electrical equipment, unless specifically dimensioned or detailed, the Contractor may make adjustments in equipment locations in accordance with the following without obtaining the Engineer's approval:
      a. 3 IN at grade, floor and roof level in any direction in the horizontal plane.
      b. 1 FT for equipment other than lighting at ceiling level in any direction in the horizontal plane.
      c. 1 FT for lighting fixtures at ceiling level in any direction in the horizontal plane.
      d. 1 FT on walls in a horizontal direction within the vertical plane.
      e. Changes in equipment location exceeding those defined above require the Engineer's approval.

K. Provide electrical equipment support system per the following area designations:
   1. Wet areas:
      a. Galvanized system consisting of galvanized steel channels and fittings, nuts and hardware.
      b. Field touch-up cut ends and scratches of galvanized components with the specified primer during the installation before rust appears.
   2. Corrosive areas:
      a. Stainless steel system consisting of stainless steel channels and fittings, nuts and hardware.
   3. Highly corrosive areas:
      a. PVC coated steel system consisting of PVC coated steel channels and fittings with stainless steel nuts and hardware.

L. Provide all necessary anchoring devices and supports rated for the equipment load based on dimensions and weights verified from approved submittals, or as recommended by the manufacturer.
   1. Do not cut, or weld to, building structural members.
   2. Do not mount safety switches or other equipment to equipment enclosures, unless enclosure mounting surface is properly braced to accept mounting of external equipment.

M. Provide corrosion resistant spacers to maintain 1/4 IN separation between metallic equipment and/or metallic equipment supports and mounting surface in wet areas, on below grade walls and on walls of liquid containment or processing areas such as Basins, Clarifiers, Digesters, Reservoirs, etc.

N. Do not place equipment fabricated from aluminum in direct contact with earth or concrete.

O. Screen or seal all openings into equipment mounted outdoors to prevent the entrance of rodents and insects.

P. Do not use materials that may cause the walls or roof of a building to discolor or rust.

3.2 FIELD QUALITY CONTROL

A. Verify exact rough-in location and dimensions for connection to electrified equipment, provided by others.

B. Replace equipment and systems found inoperative or defective and re-test.

C. The protective coating integrity of support structures and equipment enclosures shall be maintained.
   1. Repair galvanized components utilizing a zinc rich paint.
   2. Repair painted components utilizing touch up paint provided by or approved by the manufacturer.
   3. Repair PVC coated components utilizing a patching compound, of the same material as the coating, provided by the manufacturer of the component.
   4. Repair surfaces which will be inaccessible after installation prior to installation.
   5. See Specification Section 16130 for requirements for conduits and associated accessories.

D. Replace nameplates damaged during installation.

3.3 DEMONSTRATION

A. Demonstrate equipment to County staff and in accordance with local utility requirements.

END OF SECTION

SECTION 16060
GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes material and installation requirements for grounding and bonding system(s).

1.2 RELATED SECTIONS

A. Section 16010 - Electrical - Basic Requirements.

B. Section 16080 - Acceptance Testing.

C. Section 16120 - Wire and Cable - 600 Volt and Below.

D. Section 16130 - Raceways and Boxes.

1.3 SUBMITTALS

A. CONTRACTOR shall provide product technical data and provide submittal data for all products specified in Part 2 of this Section except grounding clamps, terminals, and connects, and exothermic welding system. See Specification Section 16010 for additional requirements.

1.4 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
   2. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   3. Underwriters Laboratories, Inc. (UL):
      a. 467, Grounding and Bonding Equipment.

B. CONTRACTOR shall assure ground continuity is continuous throughout the entire Project.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable for ground rods and bars and grounding clamps, connectors, and terminals:
   1. ERICO by Pentair.
   2. Harger Lightning & Grounding.
   3. Heary Bros. Lightning Protection Co. Inc.
   4. Burndy by Hubbell.
   5. Robbins Lightning, Inc.
   6. Blackburn by Thomas & Betts.
   7. Thompson Lightning Protection, Inc.

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable for exothermic weld connections:
   1. ERICO by Pentair - Cadweld.
   2. Harger Lightning & Grounding - Ultraweld.
   3. Burndy by Hubbell - Thermoweld.
   4. FurseWELD by Thomas & Betts.

2.2 COMPONENTS

A. Wire and Cable:
   1. Bare conductors: Soft drawn stranded copper meeting ASTM B8.
   2. Insulated conductors: Color coded green, per Specification Section 16120.

B. Conduit: As specified in Specification Section 16130.

C. Ground Rods:
   1. 3/4 IN x 10 FT
   2. Copper-clad:
      a. 10 MIL minimum uniform coating of electrolytic copper molecularly bonded to a rigid steel core.
      b. Corrosion resistant bond between the copper and steel.
      c. Hard drawn for a scar-resistant surface.

D. Grounding Clamps, Connectors and Terminals:
   1. Mechanical type:
      a. Standards: UL 467.
      b. High copper alloy content.
   2. Compression type for interior locations:
      a. Standards: UL 467.
      b. High copper alloy content.
      c. Non-reversible.
      d. Terminals for connection to bus bars shall have two bolt holes.
   3. Compression type suitable for direct burial in earth or concrete.
      a. Standards: UL 467, IEEE 837.
      b. High copper alloy content.
      c. Non-reversible.
      d. Factory filled with oxide inhibiting compound.
   4. Exothermic Weld Connections:
      a. Copper oxide reduction by aluminum process.
      b. Molds properly sized for each application.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:
   1. Install products in accordance with manufacturer's instructions.
   2. Size grounding conductors and bonding jumpers in accordance with NFPA 70, Article 250, except where larger sizes are indicated on the Drawings.
   3. Remove paint, rust, or other non-conducting material from contact surfaces before making ground connections. After connection, apply manufacturers approved touch-up paint to protect metallic surface from corrosion.
   4. Do not splice grounding electrode conductors except at ground rods.

5. Install ground rods and grounding electrode conductors in undisturbed, firm soil.
   a. Provide excavation required for installation of ground rods and conductors.
   b. Use driving studs or other suitable means to prevent damage to threaded ends of sectional rods.
   c. Unless otherwise specified, connect conductors to ground rods with compression type connectors or exothermic weld.
   d. Provide sufficient slack in conductor to prevent conductor breakage during backfill or due to ground movement.
   e. Backfill excavation completely, thoroughly tamping to provide good contact between backfill materials and ground rods and conductors.
6. Do not use exothermic welding if it will damage the structure the grounding conductor is being welded to.

B. Grounding Electrode System:
   1. Provide a grounding electrode system in accordance with NFPA 70, Article 250 and as indicated on the Drawings.
      a. All grounding electrode conductors terminate on a main ground bar located adjacent to the service entrance equipment.
   2. Grounding electrode conductor terminations:
      a. Ground bars mounted on wall: Use a two-hole compression type conductor terminal and bolt it to the ground bar with two bolts.
      b. Ground bars in electrical equipment: Use compression type conductor terminal and bolt it to the ground bar or manufacture's provided mechanical type termination device.
      c. Piping systems: Use mechanical type connections.
      d. Building steel, below grade and encased in concrete: Use compression type connector or exothermic weld.
      e. Building steel, above grade: Use a two-hole compression type conductor terminal and bolt to the steel with two bolts or exothermic weld.
      f. Ground rod: Compression type or exothermic weld, unless otherwise specified.
   3. Triad grounding system:
      a. Triad consists of three ground rods arranged in a triangle separated by 10 FT and a conductor interconnecting each ground rod.
         1) Place first ground rod a minimum of 10 FT from the structure foundation and 2 FT 6 IN below grade.
   4. Grounding conductor: Bare conductor, size as indicated on the Drawings.
      a. Ground rod test stations:
         1) Provided where indicated on the Drawings.
         2) Grounding conductors connected to ground rod with removable ground clamps.

C. Supplemental Grounding Electrode:
   1. Provide the following grounding in addition to the equipment ground conductor supplied with the feeder conductors whether or not shown on the Drawings.
      a. See Grounding Electrode System paragraph for conductor termination requirements.
   2. Metal light poles:
      a. Connect metal pole and pole base reinforcing steel to a ground rod.
      b. Grounding conductor: Bare #6 AWG minimum.
   3. Equipment support rack and pedestals mounted outdoors:
      a. Connect metallic structure to a ground rod.
      b. Grounding conductor: #6 AWG minimum.

D. Transformer Separately Derived Grounding System:
   1. Install the System Bonding Jumper at the transformer. At the first disconnect, ensure the neutral is isolated from ground.
      a. Install the System Bonding Jumper at the first disconnect means.

E. Raceway Bonding/Grounding:
   1. Install all metallic raceway so that it is electrically continuous.
   2. Provide an equipment grounding conductor in all raceways with insulation identical to the phase conductors, unless otherwise indicated on the Drawings.
   3. NFPA 70 required grounding bushings shall be of the insulating type.
   4. Provide double locknuts at all panels.
   5. Bond all conduits, at entrance and exit of equipment, to the equipment ground bus or lug.
   6. Provide bonding jumpers if conduits are installed in concentric knockouts.
   7. Make all metallic raceway fittings and grounding clamps tight to ensure equipment grounding system will operate continuously at ground potential to provide low impedance current path for proper operation of overcurrent devices during possible ground fault conditions.

F. Equipment Grounding:
   1. Ground all utilization equipment with an equipment grounding conductor.

G. Manhole and Handhole Grounding:
   1. Provide a ground rod and ground bar, when indicated or as needed, in each manhole and handhole with exposed metal parts.
      a. Expose a minimum of 4 IN of the rod above the floor for field connections to the rod.
   2. Connect all exposed metal parts (e.g., conduits and cable racks) to the ground rod.

3.2 FIELD QUALITY CONTROL

A. Leave grounding system uncovered until observed by Owner.

B. Acceptance Testing:
   1. See Specification Section 16080.

END OF SECTION

SECTION 16080
ACCEPTANCE TESTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Basic requirements for acceptance testing.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 16010 – Electrical: Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. InterNational Electrical Testing Association (NETA):
      a. ATS, Standard for Acceptance Testing Specifications for Electric Power Equipment and Systems.
   2. Nationally Recognized Testing Laboratory (NRTL).
   3. Telecommunications Industry Association/Electronic Industries Alliance/American National Standards Institute (TIA/EIA/ANSI):
      a. 455-78-B, Optical Fibres - Part 1-40: Measurement Methods and Test Procedures - Attenuation.

B. Qualifications:
   1. Field personnel:
      a. Supervising technician may be certified by the equipment manufacturer.
   2. Analysis personnel:
      a. Supervising technician may be certified by the equipment manufacturer.

C. Phasing Diagram:
   1. Coordinate with Utility Company for phase rotations and Phase A, B and C markings.
      a. Create a phasing diagram showing the coordinated phase rotations with generators and motors through the transformers.

1.3 SUBMITTALS

A. Informational Submittals:
   1. Prior to energizing equipment:
      a. Coordinated phasing diagram.
      b. Photocopies of continuity tests.
   2. Within two weeks after successful completion of Demonstration Period (Commissioning Period):
      a. Single report containing information including:
         1) Summary of Project.
         2) Information from pre-energization testing.

PART 2 - PRODUCTS

2.1 FACTORY QUALITY CONTROL

A. Provide Electrical equipment with all factory tests required by the applicable industry standards or NRTL.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. General:
   1. Complete electrical testing in three phases:
      a. Pre-energization testing phase.
      b. Equipment energized with no load.
      c. Equipment energized under load.
   2. Perform testing in accordance with this Specification Section and NETA ATS.

B. Electrical Equipment and Connections Testing Program:
   1. See individual Division 26 Specification Sections for equipment specific testing requirements.
   2. Test all electrical equipment.
      a. Perform all required NETA testing.
      b. Perform all required NETA testing plus the optional testing identified with each specific type of equipment in Part 3.2 of this Specification Section.

3.2 SPECIFIC EQUIPMENT TESTING REQUIREMENTS

A. Cable - Low Voltage:
   1. Perform inspections and tests per NETA ATS 7.3.2.

B. Low Voltage Molded Case Circuit Breakers:
   1. Perform inspections and tests per NETA ATS 7.6.1.1.
   2. Components:
      a. Test all components per applicable paragraphs of this Specification Section and NETA ATS.
      b. Thermal magnetic breakers: Visual and mechanical inspection per NETA ATS only.
      c. Solid state trip type: Visual and mechanical inspection and electrical tests per NETA ATS.
   3. Record as-left settings.

C. Metering:
   1. Perform inspections and tests per NETA ATS 7.11.
   2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.

D. Grounding:
   1. Perform inspections and tests per NETA ATS 7.13.
   2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.

E. Motors:
   1. Perform inspections and tests per NETA ATS 7.15.

F. Motor Controllers:
   1. Perform inspections and tests per NETA ATS 7.16.

2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.

END OF SECTION

This page intentionally left blank.

SECTION 16120
WIRE AND CABLE: 600 VOLT AND BELOW

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Building wire.
      b. Power cable.
      c. Control cable.
      d. Instrumentation cable.
      e. Wire connectors.
      f. Insulating tape.
      g. Pulling lubricant.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 16010 - Electrical: Basic Requirements.
   3. Section 16080 - Acceptance Testing.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. 1202, Standard for Flame-Propagation Testing of Wire and Cable.
   2. Insulated Cable Engineers Association (ICEA):
      a. S-58-679, Standard for Control Cable Conductor Identification.
   3. National Electrical Manufacturers Association (NEMA):
      a. ICS 4, Industrial Control and Systems: Terminal Blocks.
   4. National Electrical Manufacturers Association/Insulated Cable Engineers Association (NEMA/ICEA):
      a. WC 57/S-73-532, Standard for Control Cables.
      b. WC 70/S-95-658, Non-Shielded Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.
   5. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
      b. 262, Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.
   6. Telecommunications Industry Association/Electronic Industries Alliance/American National Standards Institute (TIA/EIA/ANSI):
      a. 568, Commercial Building Telecommunications Cabling Standard.
   7. Underwriters Laboratories, Inc. (UL):
      a. 44, Standard for Safety Thermoset-Insulated Wires and Cables.
      b. 83, Standard for Safety Thermoplastic-Insulated Wires and Cables.
      c. 467, Standard for Safety Grounding and Bonding Equipment.
      d. 486A, Standard for Safety Wire Connectors and Soldering Lugs for use with Copper Conductors.
      e. 486C, Standard for Safety Splicing Wire Connections.

f. 510, Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape.
g. 1277, Standard for Safety Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.
h. 1581, Standard for Safety Reference Standard for Electrical Wires, Cables, and Flexible Cords.
i. 2250, Standard for Safety Instrumentation Tray Cable.

1.3 DEFINITIONS

A. Cable: Multi-conductor, insulated, with outer sheath containing either building wire or instrumentation wire.

B. Instrumentation Cable:
1. Multiple conductor, insulated, twisted or untwisted, with outer sheath.
2. The following are specific types of instrumentation cables:
a. Analog signal cable:
1) Used for the transmission of low current (e.g., 4-20mA DC) or low voltage (e.g., 0-10 Vdc) signals, using No. 16 AWG and smaller conductors.
2) Commonly used types are defined in the following:
a) TSP: Twisted shielded pair.
b) TST: Twisted shielded triad.
b. Digital signal cable: Used for the transmission of digital signals between computers, PLC's, RTU's, etc.

C. Power Cable: Multi-conductor, insulated, with outer sheath containing building wire, No. 8 AWG and larger.

D. Shielded VFD Cable: Multi-conductor, insulated, with shield, drain wire and building wires, No. 12 and larger.

E. Control Cable: Multi-conductor, insulated, with outer sheath containing building wires, No. 14, No. 12 or No. 10 AWG.

1.4 SUBMITTALS

A. Shop Drawings:
1. See Specification Section 01350 for requirements for the mechanics and administration of the submittal process.
2. Product technical data:
a. Provide submittal data for all products specified in Part 2 of this Specification Section except:
1) Wire connectors.
2) Insulating tape.
3) Cable lubricant.
b. See Specification Section 16010 for additional requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

A. See Specification Section 16010.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Building wire, power and control cable and multiplex cable:
   a. Aetna Insulated Wire.
   b. Alphawire.
   c. Cerrowire.
   d. Encore Wire Corporation.
   e. General Cable.
   f. Okonite Company.
   g. Southwire Company.
2. Instrumentation cable:
   a. Analog cable:
      1) Alphawire.
      2) Belden Inc.
      3) General Cable.
3. Wire connectors:
   a. Burndy Corporation.
   b. Buchanan.
   c. Ideal.
   d. Ilsco.
   e. 3M Co.
   f. Teledyne Penn Union.
   g. Thomas and Betts.
   h. Phoenix Contact.
4. Insulating and color coding tape:
   a. 3M Co.
   b. Plymouth Bishop Tapes.
   c. Red Seal Electric Co.

2.2 MANUFACTURED UNITS

A. Building Wire:
   1. Conductor shall be copper with 600 V rated insulation.
   2. Conductors shall be stranded, except for conductors used in lighting and receptacle circuits which may be stranded or solid.
   3. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
   4. Conform to NEMA/ICEA WC 70/S-95-658 and UL 83 for type THHN/THWN and THHN/THWN-2 insulation.
   5. Conform to NEMA/ICEA WC 70/S-95-658 and UL 44 for type XHHW-2 insulation.

B. Power Cable:
   1. Conductor shall be copper with 600 V rated insulation.
   2. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
   3. Conform to NEMA/ICEA WC 70/S-95-658 and UL 83 and UL 1277 for type THHN/THWN insulation with an overall PVC jacket.
   4. Conform to NEMA/ICEA WC 70/S-95-658 and UL 44 and UL 1277 for type XHHW-2 insulation with an overall PVC jacket.
   5. Number of conductors as required, including a bare ground conductor.
   6. Individual conductor color coding:
      a. ICEA S-58-679, Method 4.
      b. See PART 3 of this Specification Section for additional requirements.
   7. Conform to NFPA 70 Type TC.

C. Control Cable:
   1. Conductor shall be copper with 600 V rated insulation.
   2. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
   3. Conform to NEMA/ICEA WC 57/S-73-532 and UL 83 and UL 1277 for type THHN/THWN insulation with an overall PVC jacket.
   4. Number of conductors as required, provided with or without bare ground conductor of the same AWG size.
      a. When a bare ground conductor is not provided, an additional insulated conductor shall be provided and used as the ground conductor (e.g., 6/c No. 14 w/g and 7/c No. 14 are equal).
   5. Individual conductor color coding:
      a. ICEA S-58-679, Method 1, Table E-2.
      b. See PART 3 of this Specification Section for additional requirements.
   6. Conform to NFPA 70 Type TC.

D. Electrical Equipment Control Wire:
   1. Conductor shall be copper with 600 V rated insulation.
   2. Conductors shall be stranded.
   3. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
   4. Conform to UL 44 for Type SIS insulation.
   5. Conform to UL 83 for Type MTW insulation.

E. Instrumentation Cable:
   1. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
   2. Analog cable:
      a. Tinned copper conductors.
      b. 300 V or 600 V PVC insulation with PVC jacket.
      c. Twisted with 100 percent foil shield coverage with drain wire.
      d. Six (6) twists per foot minimum.
      e. Individual conductor color coding: ICEA S-58-679, Method 1, Table E-2.
      f. Conform to UL 2250, UL 1581 and NFPA 70 Type ITC.
   3. Digital cable:
      a. As recommended by equipment (e.g., PLC, RTU) manufacturer.
      b. Horizontal voice and data cable:
         1) Category 6 per TIA/EIA/ANSI 568.
         2) Cable shall be label-verified.
         3) Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level.
         4) Conductors: No. 24 AWG solid untinned copper.
         5) Rated CMP per NFPA 70.
      c. Conform to NFPA 262 and NFPA 70 Type ITC.

F. Wire Connectors:
   1. Twist/screw on type:
      a. Insulated pressure or spring type solderless connector.
      b. 600 V rated.
      c. Ground conductors: Conform to UL 486C and/or UL 467 when required by local codes.
      d. Phase and neutral conductors: Conform to UL 486C.

2. Compression and mechanical screw type:
   a. 600 V rated.
   b. Ground conductors: Conform to UL 467.
   c. Phase and neutral conductors: Conform to UL 486A.
3. Terminal block type:
   a. High density, screw-post barrier-type with white center marker strip.
   b. 600 V and ampere rating as required, for power circuits.
   c. 600 V, 20 ampere rated for control circuits.
   d. 300 V, 15 ampere rated for instrumentation circuits.
   e. Conform to NEMA ICS 4 and UL 486A.

G. Insulating and Color Coding Tape:
1. Pressure sensitive vinyl.
2. Premium grade.
3. Heat, cold, moisture, and sunlight resistant.
4. Thickness, depending on use conditions: 7, 8.5, or 10 mil.
5. For cold weather or outdoor location, tape must also be all-weather.
6. Color:
   a. Insulating tape: Black.
   b. Color coding tape: Fade-resistant color as specified herein.
7. Comply with UL 510.

H. Pulling Lubricant: Cable manufacturer's standard containing no petroleum or other products which will deteriorate insulation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The Drawings are based on copper conductors, if aluminum is used, the conductor shall be resized to meet the required conductor ampacities.

B. Permitted Usage of Insulation Types:
1. Type XHHW-2:
   a. Building wire and power and control cable in conduit below grade.
2. Type THHN/THWN and THHN/THWN-2:
   a. Building wire and power and control cable No. 8 AWG and smaller in architectural and non-architectural finished areas.

C. Conductor Size Limitations:
1. Feeder and branch power conductors shall not be smaller than No. 12 AWG unless otherwise indicated on the Drawings.
2. Control conductors shall not be smaller than No. 14 AWG unless otherwise indicated on the Drawings.
3. Instrumentation conductors shall not be smaller than No. 18 AWG unless otherwise indicated on the Drawings.

D. Color Code All Wiring as Follows:
1. Building wire:

Table 16120-1 Wiring Color Codes

	240 V, 208 V, 240/120 V, 208/120 V	480 V, 480/277 V
Phase 1	Black	Brown
Phase 2	Red *	Orange
Phase 3	Blue	Yellow
Neutral	White	White or Gray
Ground	Green	Green

* Orange when it is a high leg of a 120/240 V Delta system.

a. Conductors No. 6 AWG and smaller: Insulated phase, neutral and ground conductors shall be identified by a continuous colored outer finish along its entire length.
b. Conductors larger than No. 6 AWG:
   1) Insulated phase and neutral conductors shall be identified by one (1) of the following methods:
      a) Continuous colored outer finish along its entire length.
      b) 3 IN of colored tape applied at the termination.
   2) Insulated grounding conductor shall be identified by one (1) of the following methods:
      a) Continuous green outer finish along its entire length.
      b) Stripping the insulation from the entire exposed length.
      c) Using green tape to cover the entire exposed length.
   3) The color coding shall be applied at all accessible locations, including but not limited to: Junction and pull boxes, wireways, manholes and handholes.

2. Power cables ICEA S-58-679, Method 4 with:
   a. Phase and neutral conductors identified with 3 IN of colored tape, per the Table herein, applied at the terminations.
   b. Ground conductor: Bare.
3. Control cables ICEA S-58-679, Method 1, Table E-2:
   a. When a bare ground is not provided, one (1) of the colored insulated conductors shall be re-identified by stripping the insulation from the entire exposed length or using green tape to cover the entire exposed length.
   b. When used in power applications the colored insulated conductors used as phase and neutral conductors may have to be re-identified with 3 IN of colored tape, per the Table herein, applied at the terminations.

E. Install all wiring in raceway unless otherwise indicated on the Drawings.

F. Feeder, branch, control and instrumentation circuits shall not be combined in a raceway, cable tray, junction or pull box, except as permitted in the following:
   1. Where specifically indicated on the Drawings.
   2. Where field conditions dictate and written permission is obtained from the Engineer.
   3. Control circuits shall be isolated from feeder and branch power and instrumentation circuits but combining of control circuits is permitted.
      a. The combinations shall comply with the following:
         1) 12 Vdc, 24 Vdc and 48 Vdc may be combined.
         2) 125 Vdc shall be isolated from all other AC and DC circuits.
         3) AC control circuits shall be isolated from all DC circuits.

4. Instrumentation circuits shall be isolated from feeder and branch power and control circuits but combining of instrumentation circuits is permitted.
   a. The combinations shall comply with the following:
      1) Analog signal circuits may be combined.
      2) Digital signal circuits may be combined but isolated from analog signal circuits.
5. Multiple branch circuits for lighting, receptacle and other 120 Vac circuits are allowed to be combined into a common raceway.
   a. Contractor is responsible for making the required adjustments in conductor and raceway size, in accordance with all requirements of the NFPA 70, including but not limited to:
      1) Up sizing conductor size for required ampacity de-ratings for the number of current carrying conductors in the raceway.
      2) The neutral conductor may be shared on sequential circuits (e.g., circuit numbers 1,3,5) if multiple circuit breakers are provided.
      3) Up sizing raceway size for the size and quantity of conductors.

G. Ground the drain wire of shielded instrumentation cables at one (1) end only.
   1. The preferred grounding location is at the load (e.g., control panel), not at the source (e.g., field mounted instrument).

H. Splices and terminations for the following circuit types shall be made in the indicated enclosure type using the indicated method.
   1. Feeder and branch power circuits:
      a. Device outlet boxes:
         1) Twist/screw on type connectors.
      b. Junction and pull boxes and wireways:
         1) Twist/screw on type connectors for use on No. 8 and smaller wire.
         2) Compression, mechanical screw or terminal block or terminal strip type connectors for use on No. 6 AWG and larger wire.
      c. Motor terminal boxes:
         1) Twist/screw on type connectors for use on No. 10 AWG and smaller wire.
         2) Insulated mechanical screw type connectors for use on No. 8 AWG and larger wire.
      d. Manholes or handholes:
         1) Twist/screw on type connectors pre-filled with epoxy for use on No. 8 AWG and smaller wire.
         2) Watertight compression or mechanical screw type connectors for use on No. 6 AWG and larger wire.
   2. Control circuits:
      a. Junction and pull boxes: Terminal block type connector.
      b. Manholes or handholes: Twist/screw on type connectors pre-filled with epoxy.
      c. Control panels and motor control centers: Terminal block or strips provided within the equipment or field installed within the equipment by the Contractor.
   3. Instrumentation circuits can be spliced where field conditions dictate and written permission is obtained from the Engineer.
      a. Maintain electrical continuity of the shield when splicing twisted shielded conductors.
      b. Junction and pull boxes: Terminal block type connector.
      c. Control panels and motor control centers: Terminal block or strip provided within the equipment or field installed within the equipment by the Contractor.

4. Non-insulated compression and mechanical screw type connectors shall be insulated with tape or hot or cold shrink type insulation to the insulation level of the conductors.

I. Insulating Tape Usage:
   1. For insulating connections of No. 8 AWG wire and smaller: 7 mil vinyl tape.
   2. For insulating splices and taps of No. 6 AWG wire or larger: 10 mil vinyl tape.
   3. For insulating connections made in cold weather or in outdoor locations: 8.5 mil, all weather vinyl tape.

J. Color Coding Tape Usage: For color coding of conductors.

3.2 FIELD QUALITY CONTROL

A. Acceptance Testing:
   1. See Specification Section 16080.

END OF SECTION

SECTION 16130
RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Conduits.
      b. Conduit fittings.
      c. Conduit supports.
      d. Wireways.
      e. Outlet boxes.
      f. Pull and junction boxes.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 16010 - Electrical: Basic Requirements.
   3. Section 16120 - Wire and Cable - 600 Volt and Below.
   4. Section 16135 - Electrical: Exterior Underground.
   5. Section 16140 - Wiring Devices.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Iron and Steel Institute (AISI).
   2. ASTM International (ASTM):
      a. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
      b. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
      c. D2564, Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
   3. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. RN 1, Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit (IMC).
      c. TC 2, Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
      d. TC 3, Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
   4. National Electrical Manufacturers Association/American National Standards Institute (NEMA/ANSI):
      a. C80.1, Electric Rigid Steel Conduit (ERSC).
      b. C80.3, Steel Electrical Metallic Tubing (EMT).
      c. OS 1, Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
   5. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   6. Underwriters Laboratories, Inc. (UL):
      a. 1, Standard for Flexible Metal Conduit.
      b. 6, Standard for Electrical Rigid Metal Conduit - Steel.
      c. 50, Enclosures for Electrical Equipment, Non-Environmental Considerations.

d. 360, Standard for Liquid-Tight Flexible Steel Conduit.
e. 467, Grounding and Bonding Equipment.
f. 514A, Metallic Outlet Boxes.
g. 514B, Conduit, Tubing, and Cable Fittings.
h. 651, Standard for Schedule 40 and 80 Rigid PVC Conduit and Fittings.
i. 797, Electrical Metallic Tubing - Steel.
j. 870, Standard for Wireways, Auxiliary Gutters, and Associated Fittings.
k. 886, Standard for Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations.

1.3 SUBMITTALS

A. Shop Drawings:
1. Product technical data:
a. Provide submittal data for all products specified in Part 2 of this Specification Section except:
1) Conduit fittings.
2) Support systems.
b. See Specification Section 16010 for additional requirements.
2. Fabrication and/or layout drawings:
a. Identify dimensional size of pull and junction boxes to be used.

1.4 DELIVERY, STORAGE, AND HANDLING

A. See Specification Section 16010.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Rigid metallic conduits:
a. Allied Tube and Conduit Corporation.
b. Triangle PWC Inc.
c. Western Tube and Conduit Corporation.
d. Wheatland Tube Company.
e. LTV Steel Company.
2. PVC coated rigid metallic conduits:
a. Thomas & Betts Ocal.
b. Rob-Roy Ind.
3. Rigid nonmetallic conduit:
a. Prime Conduit (Carlon).
b. Cantex.
c. Osburn Associates.
4. Flexible conduit:
a. AFC Cable Systems.
b. Anamet, Inc.
c. Electri-Flex.
d. Flexible Metal Hose Company.
e. International Metal Hose Company.
f. Triangle PWC Inc.
g. LTV Steel Company.

5. Wireway:
   a. Hoffman Engineering Company.
   b. Wiegmann.
   c. Square D.
6. Conduit fittings and accessories:
   a. Appleton Electric Co.
   b. Carlon.
   c. Cantex.
   d. Crouse-Hinds.
   e. Killark.
   f. Osburn Associates.
   g. OZ Gedney Company.
   h. RACO.
   i. Steel City.
   j. Thomas & Betts.
7. Support systems:
   a. Unistrut Building Systems.
   b. Eaton B-Line.
   c. Kindorf.
   d. Minerallac Fastening Systems.
   e. Caddy.
   f. Thomas & Betts Superstrut.
8. Outlet, pull and junction boxes:
   a. Appleton Electric Co.
   b. Eaton Crouse-Hinds.
   c. Killark.
   d. O-Z/Gedney.
   e. Thomas & Betts Steel City.
   f. Raco.
   g. Bell.
   h. Hoffman Engineering Co.
   i. Wiegmann.
   j. Eaton B-Line.
   k. Adalet.
   l. Rittal.
   m. Stahlin.

2.2 RIGID METALLIC CONDUITS

A. Rigid Galvanized Steel Conduit (RGS):
   1. Mild steel with continuous welded seam.
   2. Metallic zinc applied by hot-dip galvanizing or electro-galvanizing.
   3. Threads galvanized after cutting.
   4. Internal coating: Baked lacquer, varnish or enamel for a smooth surface.
   5. Standards: NEMA/ANSI C80.1, UL 6.

B. PVC-Coated Rigid Steel Conduit (PVC-RGS):
   1. Nominal 40 mil Polyvinyl Chloride Exterior Coating:
      a. Coating: Bonded to hot-dipped galvanized rigid steel conduit conforming to NEMA/ANSI C80.1.
      b. The bond between the PVC coating and the conduit surface: Greater than the tensile strength of the coating.

2. Nominal 2 mil, minimum, urethane interior coating.
3. Urethane coating on threads.
4. Conduit: Epoxy prime coated prior to application of PVC and urethane coatings.
5. Female Ends:
   a. Have a plastic sleeve extending a minimum of 1 pipe diameter or 2 IN, whichever is less beyond the opening.
   b. The inside diameter of the sleeve shall be the same as the outside diameter of the conduit to be used with it.
6. Standards: NEMA/ANSI C80.1, UL 6, NEMA RN 1.

C. Electrical Metallic Tubing (EMT):
1. Mild steel with continuous welded seam.
2. Metallic zinc applied by hot-dip galvanizing or electro-galvanizing.
3. Internal coating: Baked lacquer, varnish, or enamel for a smooth surface.
4. Standards: NEMA/ANSI C80.3, UL 797.

2.3 RIGID NONMETALLIC CONDUIT

A. Schedules 40 (PVC-40) and 80 (PVC-80):
1. Polyvinyl-chloride (PVC) plastic compound which includes inert modifiers to improve weatherability and heat distribution.
2. Rated for direct sunlight exposure.
3. Fire retardant and low smoke emission.
4. Shall be suitable for use with 90 DegC wire and shall be marked "maximum 90 DegC".
5. Standards: NEMA TC 2, UL 651.

2.4 FLEXIBLE CONDUIT

A. Flexible Galvanized Steel Conduit (FLEX):
1. Formed of continuous, spiral wound, hot-dip galvanized steel strip with successive convolutions securely interlocked.
2. Standard: UL 1.

B. PVC-Coated Flexible Galvanized Steel (liquid-tight) Conduit (FLEX-LT):
1. Core formed of continuous, spiral wound, hot-dip galvanized steel strip with successive convolutions securely interlocked.
2. Extruded PVC outer jacket positively locked to the steel core.
3. Liquid and vaportight.
4. Standard: UL 360.

2.5 WIREWAY

A. General:
1. Suitable for lay-in conductors.
2. Designed for continuous grounding.
3. Covers:
   a. Hinged or removable in accessible areas.
   b. Non-removable when passing through partitions.
4. Finish: Rust inhibiting primer and manufacturers standard paint inside and out except for stainless steel type.
5. Standards: UL 870, NEMA 250.

B. General Purpose (NEMA 1 rated) Wireway:
1. 14 or 16 gage steel without knockouts.

2. Cover: Solid, non-gasketed and held in place by captive screws.

C. Raintight (NEMA 3R) Wiring Trough:
1. 14 or 16 GA galvanized steel without knockouts.
2. Cover: Non-gasketed and held in place by captive screws.

D. Watertight (NEMA 4X rated) Wireway:
1. 14 GA Type 304 or 316 stainless steel bodies and covers without knockouts and 10 GA stainless steel flanges.
2. Cover: Fully gasketed and held in place with captive clamp type latches.
3. Flanges: Fully gasketed and bolted.

E. Dusttight (NEMA 12 rated) Wireway:
1. 14 GA steel bodies and covers without knockouts and 10 GA steel flanges.
2. Cover: Fully gasketed and held in place with captive clamp type latches.
3. Flanges: Fully gasketed and bolted.

2.6 CONDUIT FITTINGS AND ACCESSORIES

A. Fittings for Use with RGS:
1. General:
   a. In hazardous locations listed for use in Class I, Groups C and D locations.
2. Locknuts:
   a. Threaded steel or malleable iron.
   b. Gasketed or non-gasketed.
   c. Grounding or non-grounding type.
3. Bushings:
   a. Threaded, insulated metallic.
   b. Grounding or non-grounding type.
4. Hubs: Threaded, insulated and gasketed metallic for raintight connection.
5. Couplings:
   a. Threaded straight type: Same material and finish as the conduit with which they are used on.
   b. Threadless type: Gland compression or self-threading type, concrete tight.
6. Unions: Threaded galvanized steel or zinc plated malleable iron.
7. Conduit bodies (ells and tees):
   a. Body: Zinc plated cast iron or cast copper free aluminum with threaded hubs.
   b. Standard and mogul size.
   c. Cover:
      1) Clip-on type with stainless steel screws.
      2) Gasketed or non-gasketed galvanized steel, zinc plated cast iron or cast copper free aluminum.
8. Conduit bodies (round):
   a. Body: Zinc plated cast iron or cast copper free aluminum with threaded hubs.
   b. Cover: Threaded screw on type, gasketed, galvanized steel, zinc plated cast iron or cast copper free aluminum.
9. Sealing fittings:
   a. Body: Zinc plated cast iron or cast copper free aluminum with threaded hubs.
   b. Standard and mogul size.
   c. With or without drain and breather.
   d. Fiber and sealing compound: UL listed for use with the sealing fitting.
10. Hazardous location flexible coupling (HAZ-FLEX):
   a. Liquid tight and arc resistant.

b. Electrically conductive so no bonding jumper is required.
c. Dry and wet areas:
1) Bronze braided covering over flexible brass core.
2) Bronze end fittings.
3) Zinc-plated steel or malleable iron unions and nipples.
d. Corrosive areas:
1) Stainless steel braided covering over flexible stainless steel core.
2) Stainless steel end fittings.
3) Aluminum unions and nipples.

11. Service entrance head:
a. Malleable iron, galvanized steel or copper free aluminum.
b. Insulated knockout cover for use with a variety of sizes and number of conductors.

12. Standards: UL 467, UL 514B, UL 886.

B. Fittings for Use with PVC-RGS:
1. The same material and construction as those fittings listed under paragraph "Fittings for Use with RGS" and coated as defined under paragraph "PVC Coated Rigid Steel Conduit (PVC-RGS)."

C. Fittings for Use with EMT:
1. Connectors:
a. Straight, angle and offset types furnished with locknuts.
b. Zinc plated steel.
c. Insulated gland compression type.
d. Concrete and raintight.
2. Couplings:
a. Zinc plated steel.
b. Gland compression type.
c. Concrete and raintight.
3. Conduit bodies (ells and tees):
a. Body: Copper free aluminum with threaded hubs.
b. Standard and mogul size.
c. Cover:
1) Screw down type with steel screws.
2) Gasketed or non-gasketed galvanized steel or copper free aluminum.
4. Standard: UL 514B.

D. Fittings for Use with FLEX:
1. Connector:
a. Zinc plated malleable iron.
b. Squeeze or clamp-type.
2. Standard: UL 514B.

E. Fittings for Use with FLEX-LT:
1. Connector:
a. Straight or angle type.
b. Metal construction, insulated and gasketed.
c. Composed of locknut, grounding ferrule and gland compression nut.
d. Liquid tight.
2. Standards: UL 467, UL 514B.

F. Fittings for Use with Rigid Nonmetallic PVC Conduit:

1. Coupling, adapters and conduit bodies:
   a. Same material, thickness, and construction as the conduits with which they are used.
   b. Homogeneous plastic free from visible cracks, holes or foreign inclusions.
   c. Bore smooth and free of blisters, nicks or other imperfections which could damage the conductor.
2. Solvent cement for welding fittings shall be supplied by the same manufacturer as the conduit and fittings.
3. Standards: ASTM D2564, NEMA TC 3, UL 651, UL 514B.

G. Weather and Corrosion Protection Tape:
1. PVC based tape, 10 mils thick.
2. Protection against moisture, acids, alkalis, salts and sewage and suitable for direct bury.
3. Used with appropriate pipe primer.

2.7 ALL RACEWAY AND FITTINGS

A. Mark Products:
1. Identify the nominal trade size on the product.
2. Stamp with the name or trademark of the manufacturer.

2.8 OUTLET BOXES

A. Metallic Outlet Boxes:
1. Hot-dip galvanized steel.
2. Conduit knockouts and grounding pigtail.
3. Styles:
   a. 2 IN x 3 IN rectangle.
   b. 4 IN square.
   c. 4 IN octagon.
   d. Masonry/tile.
4. Accessories:
   a. Flat blank cover plates.
   b. Barriers.
   c. Extension, plaster or tile rings.
   d. Box supporting brackets in stud walls.
   e. Adjustable bar hangers.
5. Standards: NEMA/ANSI OS 1, UL 514A.

B. Cast Outlet Boxes:
1. Zinc plated cast iron or die-cast copper free aluminum with manufacturers standard finish.
2. Threaded hubs and grounding screw.
3. Styles:
   a. "FS" or "FD".
   b. "Bell".
   c. Single or multiple gang and tandem.
   d. "EDS" or "EFS" for hazardous locations.
4. Accessories: 40 mil PVC exterior coating and 2 mil urethane interior coating.
5. Standards: UL 514A, UL 886.

C. See Specification Section 16140 for wiring devices, wallplates and coverplates.

2.9 PULL AND JUNCTION BOXES

A. NEMA 1 Rated:
   1. Body and cover: 14 GA minimum, galvanized steel or 14 GA minimum, steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
   2. With or without concentric knockouts on four (4) sides.
   3. Flat cover fastened with screws.

B. NEMA 4 Rated:
   1. Body and cover: 14 GA steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
   2. Seams continuously welded and ground smooth.
   3. No knockouts.
   4. External mounting flanges.
   5. Hinged or non-hinged cover held closed with stainless steel screws and clamps.
   6. Cover with oil resistant gasket.

C. NEMA 4X Rated (metallic):
   1. Body and cover: 14 GA Type 304 or 316 stainless steel.
   2. Seams continuously welded and ground smooth.
   3. No knockouts.
   4. External mounting flanges.
   5. Hinged door and stainless steel screws and clamps.
   6. Door with oil-resistant gasket.

D. NEMA 4X Rated (Nonmetallic):
   1. Body and cover: Ultraviolet light protected fiberglass-reinforced polyester boxes.
   2. No knockouts.
   3. External mounting flanges.
   4. Hinged door with quick release latches and padlocking hasp.
   5. Door with oil resistant gasket.

E. NEMA 7 and NEMA 9 Rated:
   1. Cast gray iron alloy or copper-free aluminum with manufacturers standard finish.
   2. Drilled and tapped openings or tapered threaded hub.
   3. Cover bolted-down with stainless steel bolts or threaded cover with neoprene gasket.
   4. External mounting flanges.
   5. Grounding lug.
   6. Accessories: 40 mil PVC exterior coating and 2 mil urethane interior coating.

F. NEMA 12 Rated:
   1. Body and cover:
      a. 14 GA steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
      b. Type 5052 H-32 aluminum, unpainted.
   2. Seams continuously welded and ground smooth.
   3. No knockouts.
   4. External mounting flanges.
   5. Non-hinged cover held closed with captivated cover screws threaded into sealed wells or hinged cover held closed with stainless steel screws and clamps.
   6. Flat door with oil resistant gasket.

G. Miscellaneous Accessories:
   1. Rigid handles for covers larger than 9 SF or heavier than 25 LBS.
   2. Split covers when heavier than 25 LBS.
   3. Weldnuts for mounting optional panels and terminal kits.
   4. Terminal blocks: Screw-post barrier-type, rated 600 volt and 20 ampere minimum.
   5. Standards: NEMA 250, UL 50.

2.10 SUPPORT SYSTEMS

A. Multi-conduit Surface or Trapeze Type Support and Pull or Junction Box Supports:
   1. Material requirements.
      a. Galvanized steel: ASTM A123/A123M or ASTM A153/A153M.
      b. Stainless steel: AISI Type 316.
      c. PVC coat galvanized steel: ASTM A123/A123M or ASTM A153/A153M and 20 mil PVC coating.

B. Single Conduit and Outlet Box Support Fasteners:
   1. Material requirements:
      a. Zinc plated steel.
      b. Stainless steel.
      c. Malleable iron.
      d. PVC coat malleable iron or steel: 20 mil PVC coating.
      e. Steel protected with zinc phosphate and oil finish.

PART 3 - EXECUTION

3.1 RACEWAY INSTALLATION - GENERAL

A. Shall be in accordance with the requirements of:
   1. NFPA 70.
   2. Manufacturer instructions.

B. Size of Raceways:
   1. Raceway sizes are shown on the Drawings, if not shown on the Drawings, then size in accordance with NFPA 70.
   2. Unless specifically indicated otherwise, the minimum raceway size shall be:
      a. Conduit: 3/4 IN.
      b. Wireway: 2-1/2 IN x 2-1/2 IN.

C. Field Bending and Cutting of Conduits:
   1. Utilize tools and equipment recommended by the manufacturer of the conduit, designed for the purpose and the conduit material to make all field bends and cuts.
   2. Do not reduce the internal diameter of the conduit when making conduit bends.
   3. Prepare tools and equipment to prevent damage to the PVC coating.
   4. Degrease threads after threading and apply a zinc rich paint.
   5. Debur interior and exterior after cutting.

D. Male threads of conduit systems shall be coated with an electrically conductive anti-seize compound.

E. The protective coating integrity of conduits, fittings, outlet, pull and junction boxes and accessories shall be maintained.
   1. Repair galvanized components utilizing a zinc rich paint.
   2. Repair painted components utilizing touch up paint provided by or approved by the manufacturer.

3. Repair PVC coated components utilizing a patching compound, of the same material as the coating, provided by the manufacturer of the conduit; or a self-adhesive, highly conformable, cross-linked silicone composition strip, followed by a protective coating of vinyl tape.
   a. Total nominal thickness: 40 mil.
4. Repair surfaces which will be inaccessible after installation prior to installation.

F. Remove moisture and debris from conduit before wire is pulled into place.
1. Pull mandrel with diameter nominally 1/4 IN smaller than the interior of the conduit, to remove obstructions.
2. Swab conduit by pulling a clean, tight-fitting rag through the conduit.
3. Tightly plug ends of conduit with tapered wood plugs or plastic inserts until wire is pulled.

G. Only nylon or polyethylene rope shall be used to pull wire and cable in conduit systems.

H. Where portions of a raceway are subject to different temperatures and where condensation is known to be a problem, as in cold storage areas of buildings or where passing from the interior to the exterior of a building, the raceway shall be sealed to prevent circulation of warm air to colder section of the raceway.

I. Fill openings in walls, floors, and ceilings and finish flush with surface.
1. See Specification Section 01800.

3.2 RACEWAY ROUTING

A. Raceways shall be routed in the field unless otherwise indicated.
1. Conduit and fittings shall be installed, as required, for a complete system that has a neat appearance and is in compliance with all applicable codes.
2. Run in straight lines parallel to or at right angles to building lines.
3. Do not route conduits:
   a. Through areas of high ambient temperature or radiant heat.
   b. In suspended concrete slabs.
4. Conduit shall not interfere with, or prevent access to, piping, valves, ductwork, or other equipment for operation, maintenance and repair.
5. Provide pull boxes or conduit bodies as needed so that there is a maximum of 360 degrees of bends in the conduit run or in long straight runs to limit pulling tensions.

B. All rigid conduits within a structure shall be installed exposed except as follows:
1. As indicated on the Drawings.
2. Concealed above gypsum wall board or acoustical tile suspended ceilings.
3. Concealed within stud frame, poured concrete, concrete block and brick walls of an architecturally finished area.

C. Maintain minimum spacing between parallel conduit and piping runs in accordance with the following when the runs are greater than 30 FT:
1. Between instrumentation and telecommunication: 1 IN.
2. Between instrumentation and 125 V, 48 V and 24 Vdc, 2 IN.
3. Between instrumentation and 600 V and less AC power or control: 6 IN.
4. Between instrumentation and greater than 600 Vac power: 12 IN.
5. Between telecommunication and 125 V, 48 V and 24 Vdc, 2 IN.
6. Between telecommunication and 600 V and less AC power or control: 6 IN.
7. Between telecommunication and greater than 600 Vac power: 12 IN.
8. Between 125 V, 48 V and 24 Vdc and 600 V and less AC power or control: 2 IN.

9. Between 125 V, 48 V and 24 Vdc and greater than 600 Vac power: 2 IN.
10. Between 600 V and less AC and greater than 600 Vac: 2 IN.
11. Between process, gas, air and water pipes: 6 IN.

D. Conduits shall be installed to eliminate moisture pockets.
   1. Where water cannot drain to openings, provide drain fittings in the low spots of the conduit run.

E. Conduit shall not be routed on the exterior of structures except as specifically indicated on the Drawings.

F. Where sufficient room exists within the housing of roof-mounted equipment, the conduit shall be stubbed up inside the housing.

3.3 RACEWAY APPLICATIONS

A. Permitted Raceway Types Per Wire or Cable Types:
   1. Power wire or cables: All raceway types.
   2. Control wire or cables: All raceway types.
   3. Instrumentation cables: Metallic raceway except nonmetallic may be used underground.
   4. Motor leads from a VFD: RGS, RAC or shielded VFD cables in all other raceways.
   5. Telecommunication cables: All raceway types.

B. Permitted Raceway Types Per Area Designations:
   1. Dry areas:
      a. RGS.
      b. RAC.
   2. Wet areas:
      a. RGS.
      b. RAC.
   3. Corrosive areas:
      a. PVC-RGS.
      b. RAC.
      c. Fiberglass.
   4. Highly corrosive areas:
      a. PVC-RGS.
      b. PVC-80.
      c. Fiberglass.
   5. NFPA 70 hazardous areas:
      a. RGS.
      b. RAC when required by other area designations.

C. Permitted Raceway Types Per Routing Locations:
   1. In concrete block or brick walls:
      a. PVC-80.
   2. Embedded in poured concrete walls and floors:
      a. PVC-40.
      b. PVC-RGS when emerging from concrete into areas designated as wet, corrosive or highly corrosive.
   3. Beneath floor slab-on-grade:
      a. PVC-40.
   4. Direct buried conduits and ductbanks:
      a. PVC-80.

b. Fiberglass.
c. 90 degree elbows for transitions to above grade:
1) PVC-RGS.
d. Long sweeping bends greater than 15 degrees:
1) PVC-RGS.

5. Concrete encased ductbanks:
a. PVC-40.
b. PVC-EB.
c. Fiberglass.
d. 90 degree elbows for transitions to above grade:
1) PVC-RGS.
2) Fiberglass.
e. Long sweeping bends greater than 15 degrees:
1) RGS for sizes 2 IN and larger.
2) Fiberglass.

D. FLEX conduits shall be installed for connections to light fixtures, HVAC equipment and other similar devices above the ceilings.
1. The maximum length shall not exceed:
a. 6 FT to light fixtures.
b. 3 FT to all other equipment.

E. FLEX-LT conduits shall be install as the final conduit connection to light fixtures, dry type transformers, motors, electrically operated valves, instrumentation primary elements, and other electrical equipment that is liable to vibrate.
1. The maximum length shall not exceed:
a. 6 FT to light fixtures.
b. 3 FT to motors.
c. 2 FT to all other equipment.

F. HAZ-FLEX coupling shall be installed as the final conduit to motors, electrically operated valves, instrumentation primary elements and electrical equipment that is liable to vibrate.
1. The maximum length shall not exceed:
a. 3 FT to motors.
b. 2 FT to all other equipment.

G. NEMA 1 Rated Wireway:
1. Surface mounted in electrical rooms.
2. Surface mounted above removable ceilings tiles of an architecturally finished area.

H. NEMA 3R Wiring Trough:
1. Surface mounted in exterior locations.

I. NEMA 4X Rated Wireway:
1. Surface mounted in areas designated as wet and or corrosive.

J. NEMA 12 Rated Wireway:
1. Surface mounted in areas designated as dry in architecturally and non-architecturally finished areas.

K. Underground Conduit: See Specification Section 16135.

3.4 CONDUIT FITTINGS AND ACCESSORIES

A. Conduit Seals:

1. Installed in conduit systems located in hazardous areas as required by the NFPA 70.
2. Filler plug and drain shall be accessible.
3. Pour the conduit seals in a two-step process.
   a. Pour the seal and leave cover off.
   b. After seal is dry, inspect for proper sealng, install cover and mark (for example, paint or permanent marker) as complete.

B. Rigid nonmetallic conduit and fittings shall be joined utilizing solvent cement.
   1. Immediately after installation of conduit and fitting, the fitting or conduit shall be rotated 1/4 turn to provide uniform contact.

C. Install Expansion Fittings:
   1. Where conduits are exposed to the sun and conduit run is greater than 200 FT.
   2. Elsewhere as identified on the Drawings.

D. Install Expansion/Deflection Fittings:
   1. Where conduits enter a structure.
      a. Except electrical manholes and handholes.
      b. Except where the ductbank is tied to the structure with rebar.
   2. Where conduits span structural expansions joints.
   3. Elsewhere as identified on the Drawings.

E. Threaded connections shall be made wrench-tight.

F. Conduit joints shall be watertight:
   1. Where subjected to possible submersion.
   2. In areas classified as wet.
   3. Underground.

G. Terminate Conduits:
   1. In metallic outlet boxes:
      a. RGS:
         1) Conduit hub and locknut.
         2) Insulated bushing and two (2) locknuts.
         3) Use grounding type locknut or bushing when required by NFPA 70.
      b. EMT: Compression type connector and locknut.
   2. In NEMA 1 rated enclosures:
      a. RGS:
         1) Conduit hub and locknut.
         2) Insulated bushing and two (2) locknuts.
         3) Use grounding type locknut or bushing when required by NFPA 70.
      b. EMT: Compression type connector and locknut.
   3. In NEMA 12 rated enclosures:
      a. Watertight, insulated and gasketed hub and locknut.
      b. Use grounding type locknut or bushing when required by NFPA 70.
   4. In NEMA 4 and NEMA 4X rated enclosures:
      a. Watertight, insulated and gasketed hub and locknut.
   5. In NEMA 7 and NEMA 9 rated enclosures:
      a. Into an integral threaded hub.
   6. When stubbed up through the floor into floor mount equipment:
      a. With an insulated grounding bushing on metallic conduits.
      b. With end bells on nonmetallic conduits.

H. Threadless couplings shall only be used to join new conduit to existing conduit when the existing conduit end is not threaded and it is not practical or possible to cut threads on the existing conduit with a pipe threader.

3.5 CONDUIT SUPPORT

A. Permitted multi-conduit surface or trapeze type support system per area designations and conduit types:
   1. Dry or wet and/or hazardous areas:
      a. Galvanized system consisting of: Galvanized steel channels and fittings, nuts and hardware and conduit clamps.
      b. Aluminum system consisting of: Aluminum channels, fittings and conduit clamps with stainless steel nuts and hardware.
   2. Corrosive areas:
      a. Stainless steel system consisting of: Stainless steel channels and fittings, nuts and hardware and conduit clamps.
      b. PVC coated steel system consisting of: PVC coated galvanized steel channels and fittings and conduit clamps with stainless steel nuts and hardware.
   3. Highly corrosive areas:
      a. PVC coated steel system consisting of: PVC coated galvanized steel channels and fittings and conduit clamps with stainless steel nuts and hardware.
      b. Fiberglass system consisting of: Fiberglass channels and fittings, nuts and hardware and conduit clamps.
   4. Conduit type shall be compatible with the support system material.
      a. Galvanized steel system may be used with RGS.
      b. Stainless steel system may be used with RGS.
      c. PVC coated galvanized steel system may be used with PVC-RGS.
      d. Aluminum system may be used with RAC.
      e. Fiberglass system may be used with PVC-40 and PVC-80.

B. Permitted single conduit support fasteners per area designations and conduit types:
   1. Architecturally finished areas:
      a. Material: Zinc plated steel, or steel protected with zinc phosphate and oil finish.
      b. Types of fasteners: Spring type hangers and clips, straps, hangers with bolts, clamps with bolts and bolt on beam clamps.
      c. Provide anti-rattle conduit supports when conduits are routed through metal studs.
   2. Dry or wet and/or hazardous areas:
      a. Material: Zinc plated steel, stainless steel and malleable iron.
      b. Types of fasteners: Straps, hangers with bolts, clamps with bolts and bolt on beam clamps.
   3. Corrosive areas:
      a. Material: Stainless steel and PVC coat malleable iron or steel.
      b. Types of fasteners: Straps, hangers with bolts, clamps with bolts and bolt on beam clamps.
   4. Highly corrosive areas:
      a. Material: PVC coat malleable iron or steel.
      b. Types of fasteners: Straps, hangers with bolts, clamps with bolts and bolt on beam clamps.
   5. Conduit type shall be compatible with the support fastener material.

a. Zinc plated steel, steel protected with zinc phosphate and oil finish and malleable iron fasteners may be used with RGS.
b. Stainless steel system may be used with RGSand RAC.
c. PVC coated fasteners may be used with PVC-RGS.
d. Nonmetallic fasteners may be used with PVC-40, PVC-80 and fiberglass.

C. Conduit Support General Requirements:
1. Maximum spacing between conduit supports per NFPA 70.
2. Support conduit from the building structure.
3. Do not support conduit from process, gas, air or water piping; or from other conduits.
4. Provide hangers and brackets to limit the maximum uniform load on a single support to 25 LBS or to the maximum uniform load recommended by the manufacturer if the support is rated less than 25 LBS.
a. Do not exceed maximum concentrated load recommended by the manufacturer on any support.
b. Conduit hangers:
1) Continuous threaded rods combined with struts or conduit clamps: Do not use perforated strap hangers and iron bailing wire.
c. Do not use suspended ceiling support systems to support raceways.
d. Hangers in metal roof decks:
1) Utilize fender washers.
2) Not extend above top of ribs.
3) Not interfere with vapor barrier, insulation, or roofing.
5. Conduit support system fasteners:
a. Use sleeve-type expansion anchors as fasteners in masonry wall construction.
b. Do not use concrete nails and powder-driven fasteners.

3.6 OUTLET, PULL AND JUNCTION BOX INSTALLATION

A. General:
1. Install products in accordance with manufacturer's instructions.
2. See Specification Section 16010 and the Drawings for area classifications.
3. Fill unused punched-out, tapped, or threaded hub openings with insert plugs.
4. Size boxes to accommodate quantity of conductors enclosed and quantity of conduits connected to the box.

B. Outlet Boxes:
1. Permitted uses of metallic outlet boxes:
a. Housing of wiring devices:
1) Recessed in all stud framed walls and ceilings.
2) Recessed in poured concrete, concrete block and brick walls of architecturally finished areas and exterior building walls.
b. Pull or junction box:
1) Above gypsum wall board or acoustical tile ceilings.
2. Permitted uses of cast outlet boxes:
a. Housing of wiring devices surface mounted in non-architecturally finished dry, wet, corrosive, highly corrosive and hazardous areas.
b. Pull and junction box surface mounted in non-architecturally finished dry, wet, corrosive and highly corrosive areas.
3. Mount device outlet boxes where indicated on the Drawings and at heights as scheduled in Specification Section 16010.
4. Set device outlet boxes plumb and vertical to the floor.

5. Outlet boxes recessed in walls:
   a. Install with appropriate stud wall support brackets or adjustable bar hangers so that they are flush with the face of the wall.
   b. Locate in ungrouted cell of concrete block with bottom edge of box flush with bottom edge of block and flush with the face of the block.
6. Place barriers between switches in boxes with 277 V switches on opposite phases.
7. Back-to-back are not permitted.
8. When an outlet box is connected to a PVC coated conduit, the box shall also be PVC coated.

C. Pull and Junction Boxes:
1. Install pull or junction boxes in conduit runs where indicated or required to facilitate pulling of wires or making connections.
   a. Make covers of boxes accessible.
2. Permitted uses of NEMA 1 enclosure:
   a. Pull or junction box surface mounted above removable ceiling tiles of an architecturally finished area.
3. Permitted uses of NEMA 4 enclosure:
   a. Pull or junction box surface mounted in areas designated as wet.
4. Permitted uses of NEMA 4X metallic enclosure:
   a. Pull or junction box surface mounted in areas designated as wet and/or corrosive.
5. Permitted uses of NEMA 7 enclosure:
   a. Pull or junction box surface mounted in areas designated as Class I hazardous.
      1) Provide PVC coating in corrosive and highly corrosive areas when PVC coated conduit is used.
6. Permitted uses of NEMA 12 enclosure:
   a. Pull or junction box surface mounted in areas designated as dry.

END OF SECTION

SECTION 16135
ELECTRICAL: EXTERIOR UNDERGROUND

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Manholes.
      b. Handhole.
      c. Underground conduits and ductbanks.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Division 02 – Site Construction
   3. Division 03 - Concrete.
   4. Section 16060 - Grounding and Bonding.
   5. Section 16130 - Raceways and Boxes.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Association of State Highway and Transportation Officials (AASHTO):
      a. HB, Standard Specifications for Highway Bridges.
   2. ASTM International (ASTM):
      a. A536, Standard Specification for Ductile Iron Castings.
   3. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   4. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   5. Society of Cable Telecommunications Engineers (SCTE):
      a. 77, Specification for Underground Enclosure Integrity.

1.3 DEFINITIONS

A. Direct-buried conduit(s):
   1. Individual (single) underground conduit.
   2. Multiple underground conduits, arranged in one or more planes, in a common trench.

B. Concrete encased ductbank: An individual (single) or multiple conduit(s), arranged in one or more planes, encased in a common concrete envelope.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01350 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products specified in Part 2 of this Specification Section.
   3. Fabrication and/or layout drawings:

a. Provide dimensional drawings of each manhole indicating all specified accessories and conduit entry locations.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Prefabricated composite handholes:
      a. Quazite Composolite.
      b. Armorcast Products Company.
      c. Synertech.
   2. Precast manholes and handholes:
      a. Utility Vault Co.
      b. Oldcastle Precast, Inc.
      c. Lister Industries.
   3. Manhole and handhole and ductbank accessories:
      a. Neenah.
      b. Unistrut.
      c. Condux International, Inc.
      d. Underground Devices, Inc.

2.2 MANHOLES AND HANDHOLES

A. Prefabricated Composite Material Handholes:
   1. Handhole body and cover: Fiberglass reinforced polymer concrete conforming to all test provisions of SCTE 77.
   2. Minimum load ratings: SCTE 77 Tier 5.
   3. Stackable design as required for specified depth.
   4. Cover:
      a. Engraved legend of “ELECTRIC" or "COMMUNICATIONS".
      b. Non-gasketed bolt down with stainless steel penta head bolts.
      c. Lay-in non-bolt down, when cover is over 100 LBS.
      d. One or multiple sections so the maximum weight of a section is 125 LBS.
   5. Cover lifting hook: 24 IN minimum in length.

B. Precast Manholes and Handholes:
   1. Fiberglass reinforced polymer concrete or steel reinforced cement concrete structures:
   2. AASHTO live load rating: H-20 for full deliberate vehicle traffic.
   3. Mating edges: Tongue and groove type.
   4. Cable pulling eyes opposite all conduit entrances.
      a. Coordinate exact location with installation contractor.

2.3 CONCRETE MANHOLE AND HANDHOLE ACCESSORIES

A. Cover and Frame:
   1. Cast ductile iron: ASTM A536.
   2. AASHTO live load rating: H-20.
   3. Diameter: 30 IN.
   4. Cast the legend "ELECTRICAL" or "COMMUNICATIONS" into manhole and handhole covers.

B. Cable Racks and Hooks:

1. Material: Heavy-duty nonmetallic (glass reinforced nylon).
2. Hook loading capacity: 400 LBS minimum.
3. Rack loading capacity: Four (4) hooks maximum.
4. Hook deflection: 0.25 IN maximum.
5. Hooks: Length, as required, with positive locking device to prevent upward movement.
6. Mounding hardware: Stainless steel.

C. Cable Pulling Irons:
1. 7/8 IN DIA hot-dipped galvanized steel.
2. 6000 LB minimum pulling load.

D. Ground Rods and Grounding Equipment: See Specification Section 16060.

2.4 UNDERGROUND CONDUIT AND ACCESSORIES

A. Concrete: Comply with Division 03 Specifications Section 03300.

B. Conduit: See Specification Section 16130.

C. Duct Spacers/Supports:
1. High density polyethylene or high impact polystyrene.
2. Interlocking.
3. Provide 2 IN minimum spacing between conduits.
4. Accessories, as required:
   a. Hold down bars.
   b. Ductbank strapping.

PART 3 - EXECUTION

3.1 GENERAL

A. Drawings indicate the intended location of manholes and handholes and routing of ductbanks and direct buried conduit.
1. Field conditions may affect actual routing.

B. Manhole and Handhole Locations:
1. Approximately where shown on the Drawings.
2. As required for pulling distances.
3. As required to keep pulling tensions under allowable cable tensions.
4. As required for number of bends in ductbank routing.
5. Shall not be installed in a swale or ditch.
6. Determine the exact locations after careful consideration has been given to the location of other utilities, grading, and paving.
7. Locations are to be approved by the Engineer prior to excavation and placement or construction of manholes and handholes.

C. Install products in accordance with manufacturer's instructions.

D. Install manholes and handholes in conduit runs where indicated or as required to facilitate pulling of wires or making connections.

E. Comply with Specification Section 02225 for trenching, backfilling and compacting.

3.2 MANHOLES AND HANDHOLES

A. Prefabricated Composite Material Handholes:
1. For use in areas subjected to occasional non-deliberate vehicular traffic.

2. Place handhole on a foundation of compacted 1/4 to 1/2 IN crushed rock or gravel a minimum of 8 IN thick and 6 IN larger than handholes footprint on all sides.
3. Provide concrete encasement ring around handhole per manufacturers installation instructions (minimum of 10 IN wide x 12 IN deep).
4. Install so that the surrounding grade is 1 IN lower than the top of the handhole.
5. Size: As indicated on the Drawings or as required for the number and size of conduits.
6. Provide cable rails and pulling eyes as needed.

B. Precast Manholes and Handholes:
1. For use in vehicular and non-vehicular traffic areas.
2. Construction:
a. Grout or seal all joints, per manufacturer's instructions.
b. Support cables on walls by cable racks:
1) Provide a minimum of two (2) racks, install symmetrically on each wall of manholes and handholes.
a) Provide additional cable racks, as required, so that both ends of cable splices will be supported horizontally.
2) Equip cable racks with adjustable hooks: Quantity of cable hooks as required by the number of conductors to be supported.
c. In each manhole and handhole, drive 3/4 IN x 10 FT long copper clad ground rod into the earth with approximately 6 IN exposed above finished floor.
1) Drill opening in floor for ground rod.
2) Connect all metallic components to ground rod by means of #8 AWG minimum copper wire and approved grounding clamps.
3) Utilize a ground bar in the manhole or handhole if the quantity of ground wires exceeds three (3).
a) Connect ground bar to ground rod with a #2/0 AWG minimum copper wire.
3. Place manhole or handhole on a foundation of compacted 1/4 to 1/2 IN crushed rock or gravel a minimum of 8 IN thick and 6 IN larger than manholes or handholes footprint on all sides.
4. Install so that the top of cover is 1 IN above finished grade.
a. Where existing grades are higher than finished grades, install sufficient number of courses of curved segmented concrete block between top of handhole and manhole frame to temporarily elevate manhole cover to existing grade level.
5. After installation is complete, backfill and compact soil around manholes and handholes.
6. Handhole size:
a. As indicated on the Drawings or as required for the number and size of conduits entering or as indicated on the Drawings.
b. Minimum floor dimension of 4 FT x 4 FT and minimum depth of 4 FT.
7. Manhole size:
a. As indicated on the Drawings or as required for the number and size of conduits entering or as indicated on the Drawings.
b. Minimum floor dimension of 6 FT x 6 FT and a minimum depth of 6 FT.

3.3 UNDERGROUND CONDUITS

A. General Installation Requirements:
1. Ductbank types per location:
a. Reinforced concrete ductbank:

1) Under aircraft pavement.
2) Under railroads.
3) As indicated in the Ductbank Schedule.

b. Concrete encased ductbank:
1) Under roads.
2) Conduits containing medium voltage cables.
3) Pad mounted transformer secondaries.
4) Plant process equipment feeders and controls.
5) As indicated in the Ductbank Schedule.

c. Direct-buried conduit(s):
1) Area/Roadway lighting.
2) As indicated in the Ductbank Schedule

2. Do not place concrete or soil until conduits have been observed by the Engineer.
3. Ductbanks shall be sloped a minimum of 4 IN per 100 FT or as detailed on the Drawings.
a. Low points shall be at manholes or handholes.
4. During construction and after conduit installation is complete, plug the ends of all conduits.
5. Provide conduit supports and spacers.
a. Place supports and spacers for rigid nonmetallic conduit on maximum centers as indicated for the following trade sizes:
1) 1 IN and less: 3 FT.
2) 1-1/4 to 3 IN: 5 FT.
3) 3-1/2 to 6 IN: 7 FT.

b. Place supports and spacers for rigid steel conduit on maximum centers as indicated for the following trade sizes:
1) 1 IN and less: 10 FT.
2) 1-1/4 to 2-1/2 IN: 14 FT.
3) 3 IN and larger: 20 FT.

c. Securely anchor conduits to supports and spacers to prevent movement during placement of concrete or soil.
6. Stagger conduit joints at intervals of 6 IN vertically.
7. Make conduit joints watertight and in accordance with manufacturer's recommendations.
8. Accomplish changes in direction of runs exceeding a total of 15 degrees by long sweep bends having a minimum radius of 25 FT.
a. Sweep bends may be made up of one or more curved or straight sections or combinations thereof.
9. Furnish manufactured bends at end of runs.
a. Minimum radius of 18 IN for conduits less than 3 IN trade size and 36 IN for conduits 3 IN trade size and larger.
10. Field cuts requiring tapers shall be made with the proper tools and shall match factory tapers.
11. After the conduit run has been completed:
a. Prove joint integrity and test for out-of-round duct by pulling a test mandrel through each conduit.
1) Test mandrel:
a) Length: Not less than 12 IN
b) Diameter: Approximately 1/4 IN less than the inside diameter of the conduit.

b. Clean the conduit by pulling a heavy duty wire brush mandrel followed by a rubber duct swab through each conduit.

12. Pneumatic rodding may be used to draw in lead wire.
    a. Install a heavy nylon cord free of kinks and splices in all unused new ducts.
    b. Extend cord 3 FT beyond ends of conduit.
13. Transition from rigid nonmetallic conduit to rigid metallic conduit, per Specification Section 16130, prior to entering a structure or going above ground.
    a. Except rigid nonmetallic conduit may be extended directly to manholes, handholes, pad mounted transformer boxes and other exterior pad mounted electrical equipment where the conduit is concealed within the enclosure.
    b. Terminate rigid PVC conduits with end bells.
    c. Terminate steel conduits with insulated bushings.
14. Place warning tape in trench directly over ductbanks, direct-buried conduit, and direct-buried wire and cable.
15. Placement of conduits stubbing into handholes and manholes shall be located to allow for proper bending radiuses of the cables.

B. Concrete Encased Ductbank:
    1. Ductbank system consists of conduits completely encased in minimum 2 IN of concrete and with separations between different cabling types as required in Specification Section 16130 or as detailed on the Drawings.
    2. Install so that top of concrete encased duct, at any point:
        a. Is not less than 24 IN below grade.
        b. Is below pavement sub-grading.
    3. Where identified and for a distance 10 FT either side of the area, the concrete shall be reinforced.
        a. The reinforcement shall consist of #4 bars and #4 ties placed 12 IN on center, in accordance with Division 03 Specification Sections or as detailed on the Drawings.
    4. Conduit supports shall provide a uniform minimum clearance of 2 IN between the bottom of the trench and the bottom row of conduit.
    5. Conduit separators shall provide a uniform minimum clearance of 2 IN between conduits or as required in Specification Section 16130 for different cabling types.

C. Direct-Buried Conduit(s):
    1. Install so that the top of the uppermost conduit, at any point:
        a. Is not less than 30 IN below grade.
        b. Is below pavement sub-grading.
    2. Provide a uniform minimum clearance of 2 IN between conduits or as required in Specification Section 16130 for different cabling types.
        a. Maintain the separation of multiple planes of conduits by one of the following methods:
            1) Install multilevel conduits with the use of conduit supports and separators to maintain the required separations and backfill with flowable fill (100 PSI) or concrete per Specification Section 02225.
            2) Install the multilevel conduits one level at a time.
                a) Each level is backfilled with the appropriate amount of soil and compaction, per Specification Section 02225, to maintain the required separations.

END OF SECTION

SECTION 16140
WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Light switches.
      b. Receptacles.
      c. Device wallplates and coverplates.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 16010 - Electrical: Basic Requirements.
   3. Section 16130 - Raceways and Boxes.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. WD 1, General Color Requirements for Wiring Devices.
      c. WD 6, Wiring Devices - Dimensional Requirements.
   2. Underwriters Laboratories, Inc. (UL):
      a. 20, General-Use Snap Switches.
      b. 498, Standard for Attachment Plugs and Receptacles.
      c. 514A, Metallic Outlet Boxes.
      d. 894, Standard for Switches for Use in Hazardous (Classified) Locations.
      e. 943, Ground-Fault Circuit-Interrupters.
      f. 1010, Standard for Receptacle-Plug Combinations for Use in Hazardous (Classified) Locations.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01350 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products specified in Part 2 of this Specification Section.
      b. See Specification Section 16010 for additional requirements.

PART 2 - PRODUCTS

2.1 RECEPTACLES

A. General requirements unless modified in specific requirements paragraph of receptacles per designated areas:
   1. Straight blade, Industrial Specification Grade.
   2. Brass triple wipe line contacts.

3. One-piece grounding system with double wipe brass grounding contacts and self grounding strap.
4. Back and side wired.
5. Rated 20 A, 125 Vac.
6. High impact nylon body.
7. Receptacle body color:
   a. Normal power: brown.
   b. Generator or UPS power: Red.
8. Types as indicated on the Drawings:
   a. Normal: Self grounding with grounding terminal.
   b. Ground fault circuit interrupter: Feed-through type with test and reset buttons.
9. Duplex or simplex as indicated on the Drawings.
10. Configuration: NEMA 5-20R.
11. Standards: UL 498, UL 514A, UL 943, NEMA WD 1, NEMA WD 6.

B. Dry Non-architecturally Finished Areas:
   1. Coverplate:
      a. Zinc plated malleable iron or galvanized steel.
      b. Single or multiple gang as required.

C. Wet Non-architecturally Finished Areas:
   1. Coverplate: Weatherproof (NEMA 3R) while in use, gasketed, copper-free aluminum, 2.5 IN minimum cover depth.

D. Exterior Locations:
   1. Coverplate: Weatherproof (NEMA 3R) while in use, gasketed, copper-free aluminum, 2.5 IN minimum cover depth.

E. Corrosive Areas:
   1. Corrosion resistant nickel plated metal parts.
   2. Receptacle body color: Yellow.
   3. Coverplate:
      a. Zinc plated malleable iron or galvanized steel.
      b. Single or multiple gang as required.

F. Highly Corrosive Areas:
   1. Corrosion resistant nickel plated metal parts.
   2. Receptacle body color: Yellow.
   3. Coverplate:
      a. PVC-RGS conduit system:
         1) PVC coated zinc plated malleable iron or copper free aluminum.
         2) Single or multiple gang as required.
      b. PVC conduit system:
         1) Gray colored high impact thermoplastic.
         2) Single or multiple gang as required.

G. Hazardous Areas:
   1. Rated for Class I, Division 1 and 2, Groups B, C, and D; and Class II, Division 1 and 2 areas, Groups F and G.
   2. Factory-sealed receptacle/switch/coverplate.
      a. Zinc plated malleable iron or copper free aluminum with stainless steel screws and gasketed spring-loaded cover.
   3. "Dead-front" construction requiring plug to be inserted and rotated to activate receptacle.

a. Ordinary nonhazardous plug shall not activate the receptacle.

4. Standard: UL 1010.

H. Special Purpose Receptacles:
1. NEMA configuration as indicated on the Drawings.
2. Coverplate: See requirements per area designations herein.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with MANUFACTURER's instructions.

B. Mount devices where indicated on the Drawings and as scheduled in Specification Section 16010.

C. See Specification Section 16130 for device outlet box requirements.

D. Where more than one (1) receptacle is installed in a room, they shall be symmetrically arranged.

E. Provide blank plates for empty outlets.

END OF SECTION

This page intentionally left blank.

SECTION 16410
SAFETY SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Safety switches.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 16010 - Electrical: Basic Requirements.
   3. Section 16490 - Overcurrent and Short Circuit Protective Devices.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. KS 1, Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
   2. Underwriters Laboratories, Inc. (UL):
      a. 98, Enclosed and Dead-Front Switches.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01350 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products specified in Part 2 of this Specification Section.
      b. Provide a table that associates safety switch model number with connected equipment tag number.
      c. See Specification Section 16010 for additional requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following safety switch manufacturers are acceptable:
   1. Eaton
   2. General Electric Company.
   3. Square D Company.
   4. Siemens.
   5. Appleton Electric Company.
   6. Crouse-Hinds.
   7. Killark.

2.2 SAFETY SWITCHES

A. General:
   1. Non-fusible or fusible as indicated on the Drawings.
   2. Suitable for service entrance when required.
   3. NEMA Type HD heavy-duty construction.
   4. Switch blades will be fully visible in the OFF position with the enclosure door open.
   5. Quick-make/quick-break operating mechanism.
   6. Deionizating arc chutes.
   7. Manufacture double-break rotary action shaft and switchblade as one (1) common component.
   8. Clear line shields to prevent accidental contact with line terminals.
   9. Operating handle (except NEMA 7 and NEMA 9 rated enclosures):
      a. Red and easily recognizable.
      b. Padlockable in the OFF position
      c. Interlocked to prevent door from opening when the switch is in the ON position with a defeater mechanism.

B. Ratings:
   1. Horsepower rated of connected motor.
   2. Voltage and amperage: As indicated on the Drawings.
   3. Short circuit withstand:
      a. Non-fused: 10,000A.
      b. Fused: 200,000A.

C. Accessories, when indicated in PART 3 of this Specification Section or on the Drawings:
   1. Neutral kits.
   2. Ground lug kits.
   3. Auxiliary contact kits with 1 N.O. and 1 N.C. contact.

D. Enclosures:
   1. NEMA 1 rated:
      a. Body and cover: Sheet steel finished with rust inhibiting primer and MANUFACTURER’s standard paint inside and out.
      b. With or without knockouts, hinged and lockable door.
   2. NEMA 3R rated:
      a. Body and cover: Sheet steel finished with rust inhibiting primer and MANUFACTURER’s standard paint inside and out.
      b. With or without knockouts, hinged and lockable door.
   3. NEMA 4 rated:
      a. Body and cover: Sheet steel finished with rust inhibiting primer and MANUFACTURER’s standard paint inside and out.
      b. No knockouts, external mounting flanges, hinged, gasketed and lockable door.
   4. NEMA 4X rated (metallic):
      a. Body and cover: Type 304 or 316 stainless steel.
      b. No knockouts, external mounting flanges, hinged and gasketed door.
   5. NEMA 4X rated (nonmetallic):
      a. Body and cover: Ultraviolet light protected fiberglass-reinforced polyester boxes.
      b. No knockouts, external mounting flanges, hinged, gasketed and lockable door.
   6. NEMA 7 and NEMA 9 rated:

a. Cast gray iron alloy or copper-free aluminum with MANUFACTURER's standard finish.
b. Drilled and tapped openings or tapered threaded hub.
c. Gasketed cover bolted-down with stainless steel bolts.
d. External mounting flanges.
e. Operating handle padlockable in the OFF position.

7. NEMA 12 rated:
a. Body and cover: Sheet steel finished with rust inhibiting primer and MANUFACTURER's standard paint inside and out.
b. No knockouts, external mounting flanges, hinged and gasketed door.

E. Overcurrent and short circuit protective devices:
1. Fuses.
2. See Specification Section 16490 for overcurrent and short circuit protective device requirements.

F. Standards: NEMA KS 1, UL 98.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install as indicated and in accordance with MANUFACTURER's instructions and recommendations.

B. Install switches adjacent to the equipment they are intended to serve unless otherwise indicated on the Drawings.

C. Provide auxiliary contact kit on local safety switches for motors being controlled by a variable frequency drive.
1. The VFD is to be disabled with the switch is in the open position.

D. Permitted uses of NEMA 1 enclosure:
1. Surface or flush mounted in areas designated dry in architecturally finished areas.

E. Permitted uses of NEMA 3R enclosure:
1. Surface mounted in exterior location for HVAC equipment only.

F. Permitted uses of NEMA 4 enclosure:
1. Surface mounted in areas designated as wet.

G. Permitted uses of NEMA 4X metallic enclosure:
1. Surface mounted in areas designated as wet and/or corrosive.

H. Permitted uses of NEMA 4X nonmetallic enclosure:
1. Surface mounted in areas designated as corrosive.
2. Surface mounted in areas designated as highly corrosive.

I. Permitted uses of NEMA 7 enclosure:
1. Surface mounted in areas designated as Class I hazardous.
2. Provide PVC coating in corrosive and highly corrosive areas when PVC coated conduit is used.

J. Permitted uses of NEMA 9 enclosure:
1. Surface mounted in areas designated as Class II hazardous.
2. Provide PVC coating in corrosive and highly corrosive areas when PVC coated conduit is used.

K. Permitted uses of NEMA 12 enclosure:
   1. Surface mounted in areas designated as dry in non-architecturally finished areas.

END OF SECTION

SECTION 16441
PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes branch circuit panelboards.

1.2 RELATED SECTIONS

A. Section 16010 – Electrical - Basic Requirements.

B. Section 16490 – Overcurrent and Short Circuit Protective Devices.

1.3 SUBMITTALS

A. CONTRACTOR shall provide product technical data and provide submittal data for all products in Part 2 of this Specification Section. See Specification 16010 for additional requirements.

B. CONTRACTOR shall provide fabrication and/or layout drawings including panelboard layout with alphanumeric designation, branch circuit breakers size and type, as indicated in the panelboard schedules.

C. CONTRACTOR shall provide contract closeout information including operation and maintenance data and panelboard schedules with as-built conditions. See Specification Section 01342 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

D. CONTRACTOR shall provide information submittals including service equipment marking and documentation.

1.4 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts maximum).
      b. PB 1, Panelboards.
   2. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   3. Underwriters Laboratories, Inc. (UL):
      a. 50, Enclosures for Electrical Equipment, Non-Environmental Considerations.
      b. 67, Standard for Panelboards.

1.5 DEFINITIONS

A. Branch Circuit Panelboard: Bus rating of 400A and less or where labeled as Branch Circuit Panelboard on the Drawings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Eaton.
   2. GE by ABB.
   3. Square D by Schneider Electric.
   4. Siemens Corporation.

2.2 MANUFACTURED UNITS

A. Standards: NEMA PB 1, NFPA 70, UL 50, UL 67.

B. Ratings:
   1. Current, voltage, number of phases, number of wires as indicated on the Drawings.
   2. Short Circuit Current Rating (SCCR) and/or Ampere Interrupting Current (AIC) ratings equal to or greater than the interrupting rating indicated on the Drawings or in the schedule.
      a. Series rating is not acceptable.
      b. When fault current or minimum interrupting rating is not indicated, use rating of upstream equipment or infinite bus calculation of transformer secondary.
         1) Service Entrance Equipment rated when indicated on the Drawings or when shown to be fed from a utility source.

C. Construction:
   1. Interiors factory assembled and designed such that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors.
   2. Multi-section panelboards: Feed-through or sub-feed lugs.
   3. Main lugs: Solderless type approved for copper and aluminum wire.

D. Bus Bars:
   1. Main bus bars:
      a. Tin plated aluminum or tin plated copper sized to limit temperature rise to a maximum of 65 DEGC above an ambient of 40 DEGC.
      b. Drilled and tapped and arranged for sequence phasing of the branch circuit devices.
   2. Ground bus and isolated ground bus, when indicated on the Drawings: Solderless mechanical type connectors.
   3. Neutral bus bars: Insulated 100% rated or 200% rated, when indicated on the Drawings and with solderless mechanical type connectors.

E. Overcurrent and Short Circuit Protective Devices:
   1. Main overcurrent protective device:
      a. Molded case circuit breaker.
   2. Branch overcurrent protective devices:
      a. Molded case circuit breaker.
   3. See Specification Section 16490 for overcurrent and short circuit protective device requirements.
   4. Factory installed.

F. Integral surge protective device:
   1. Provide for panelboards where indicated on the Drawings

2. See Specification Section 16491.

G. Enclosure:
   1. Boxes: Code gage galvanized steel, furnish without knockouts.
   2. Trim assembly: Code gage steel finished with rust inhibited primer and MANUFACTURER's standard paint inside and out.
   3. Branch circuit panelboard:
      a. Trims supplied with hinged door-in-door construction.
         1) Outer door:
            a) Allows access to the interior of the enclosure.
            b) Hinged to the enclosure.
            c) Opened by removal of screws or by operating a mechanical latch located behind the inner door.
         2) Inner door:
            a) Allows access to breakers (non-live parts).
            b) Hinged to outer door.
            c) Opened by operation of a keyed corrosion resistant chrome-plated combination lock and catch. Locks for all branch circuit panelboards keyed alike.
      b. Trims for surface mounted panelboards, same size as box.
      c. Trims for flush mounted panelboards, overlap the box by 3/4 IN on all sides.
      d. Nominal 20 IN wide and 5-3/4 IN deep with gutter space in accordance with NFPA 70.
      e. Clear plastic cover for directory card mounted on the inside of each door.
      f. Where NEMA 3R or NEMA 12 rating is indicated: Door gasketed.
      g. Where NEMA 4X is indicated: Stainless Steel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install as indicated on the Drawings, in accordance with the NFPA 70, and in accordance with MANUFACTURER's instructions.

B. Support panelboard enclosures from wall studs or modular channels support structure, per Specification Section 16010.

C. Provide NEMA rated enclosure as indicated on the Drawings. Where enclosure type is not indicated, provide enclosure rating suitable for the atmosphere where equipment is installed.

D. Equipment Marking and Documentation:
   1. Provide labeling per NFPA 70 and other applicable codes.
   2. Service equipment:
      a. Arc-flash hazard warning label. (Ref. NFPA 70 Article 110.16(A) and (B))
      b. Available fault current label and documentation of the calculations made for compliance with marking requirements. (Ref. NFPA 70 Article 110.24)
   3. Other than service equipment:
      a. Arc-flash hazard warning label. (Ref. NFPA 70 Article 110.16(A))
      b. Available fault current label. (Ref. NFPA 70 Article 408.6)
   4. Identify (tag) all equipment and equipment components.
   5. Available fault current and other required label data from Coordinated Power System Study as required by the contract documents

E. Provide each panelboard with a typed directory:
   1. Identify all circuit locations in each panelboard with the load type and location served.
   2. Use OWNER-furnished mechanical equipment designation if different than designation indicated on the Drawings.
   3. Use final building room names and numbers as identified by the OWNER if different than designation indicated on the Drawings.
   4. Identify spare overcurrent devices.

END OF SECTION

SECTION 16490
OVERCURRENT AND SHORT CIRCUIT PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes low voltage circuit breakers.

1.2 RELATED SECTIONS

A. Section 16010 - Electrical: Basic Requirements.

B. Section 16080 - Acceptance Testing.

1.3 SUBMITTALS

A. CONTRACTOR shall provide product technical data including submittal data for all products specified in Part 2 of this Specification Section. See Specification Section 16010 for additional requirements.

B. CONTRACTOR shall provide contract closeout information including operation and maintenance data.

C. CONTRACTOR shall provide information submittals including reports of as-left conditions of all circuit breakers that have adjustable settings.

1.4 QUALITY ASSURANCE

A. Reference Standards:
   1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. C37.13, Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures.
      b. C37.16, Low-Voltage Power Circuit Breakers and AC Power Circuit Protectors - Preferred Ratings, Related Requirements, and Application Recommendations.
         1) C37.17, Trip Devices for AC and General Purpose DC Low Voltage Power Circuit Breakers.
      c. National Fire Protection Association (NFPA):
         1) 70, National Electrical Code (NEC).
      d. Underwriters Laboratories, Inc. (UL):
         1) 489, Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
         2) 943, Standard for Safety for Ground-Fault Circuit-Interrupters.
         3) 1066, Standard for Low-Voltage AC and DC Power Circuit Breakers Used in Enclosures.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Circuit breakers:

a. Eaton.
b. GE by ABB.
c. Square D Company.
d. Siemens.

2.2 CIRCUIT BREAKERS

A. Molded Case Type:
1. General:
a. Standards: UL 489.
b. Unit construction.
c. Over-center, toggle handle operated.
d. Quick-make, quick-break, independent of toggle handle operation.
e. Manual and automatic operation.
f. All poles open and close simultaneously.
g. Three position handle: On, off and tripped.
h. Molded-in ON and OFF markings on breaker cover.
i. One-, two- or three-pole as indicated on the Drawings.
j. Current and interrupting ratings as indicated on the Drawings.
2. Thermal magnetic type:
a. Inverse time overload and instantaneous short circuit protection by means of a thermal magnetic element.
b. Frame size 150 amp and below:
1) Non-interchangeable, non-adjustable thermal magnetic trip units.
c. Frame sizes 225 to 400 amp (trip settings less than 400A):
1) Interchangeable and adjustable instantaneous thermal magnetic trip units.
d. Ground Fault Circuit Interrupter (GFCI) Listed:
1) Standard: UL 943.
2) One- or two-pole as indicated on the Drawings.
3) Class A ground fault circuit.
4) Trip on 5 mA ground fault (4-6 mA range).
3. Solid state trip type:
a. Inverse time overload, instantaneous short circuit and ground fault protection by means of a solid-state trip element, associated current monitors and flux shunt trip mechanism.
b. Frame size 400 amp to 1200 amp (trip settings between 400 and 1200A):
1) Standard rating.
2) Interchangeable current sensor or rating plug.
3) Adjustable long time pick-up setting.
a) Adjustable from 50 to 100% of the current sensor or rating plug.
4) Adjustable short time pick-up setting.
5) Adjustable instantaneous pick-up.
6) Fixed ground fault pick-up, when indicated on the Drawings.
c. Adjustable arc energy-reducing maintenance system.
1) Frame size 1200A or when indicated on the Drawings for less than 1200A frame size.
2) Activate and deactivate without opening door and exposing operators to energized parts.
3) System status indicator adjacent to activation switch.
d. Frame size 1600 amp and above:
1) 100% rated.
2) Interchangeable current sensor or rating plug.

3) Adjustable long time pick-up setting.
a) Adjustable from 50 to 100% of the current sensor or rating plug.
4) Adjustable long time delay setting.
5) Adjustable short time pick-up setting.
6) Adjustable instantaneous pick-up setting.
7) Adjustable ground fault pick-up setting, when indicated on the Drawings.
8) Adjustable ground fault delay setting, when indicated on the Drawings.

e. Adjustable arc energy-reducing maintenance system.
1) Activate and deactivate without opening door and exposing operators to energized parts.
2) System status indicator adjacent to activation switch.

4. Motor circuit protector:
1) Adjustable instantaneous short circuit protection by means of a magnetic or solid-state trip element.
2) Sized for the connected motor.

B. Insulated Case Type:
1. Inverse time overload, instantaneous short circuit and ground fault protection by means of a solid-state trip element, associated current monitors and two-step stored energy trip mechanism.
2. Standards: UL 489.
3. 100% rated.
4. Manually operated (MO) unless electrically operated (EO) is indicated on the Drawings.
5. Motor driven operator for charging mechanism with open, close and charge push button.
6. Draw out construction:
a. Roll out type operated by removable crank handle and interlocked with the door.
b. Four positions: Connected, test, disconnected and removed.
c. Cell switches to short out ground fault relay when main or tie breaker is drawn out.
7. Current and interrupting ratings as indicated on the Drawings.
8. Selective override circuit on breakers with short time settings and without instantaneous settings that allow selectivity up to the breakers RMS symmetrical short time rating.
a. The selective override circuit shall allow the breaker to ride through a fully offset (asymmetrical) fault equal to its RMS symmetrical short time rating in a system having an X/R ration of 6.6 with a maximum single phase peak current of 2.3 times the RMS symmetrical short time range.
9. Frame size 400 amp and above:
a. Interchangeable current sensor or rating plug:
b. Adjustable long time pick-up setting.
1) Adjustable from 50 to 100% of the current sensor or rating plug.
c. Adjustable long time delay setting.
d. Adjustable short time pick-up setting.
e. Adjustable instantaneous pick-up setting.
f. Adjustable ground fault pick-up setting, when indicated on the Drawings.
g. Adjustable ground fault delay setting, when indicated on the Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Current and interrupting ratings as indicated on the Drawings.

B. Series rated systems not acceptable.

C. Devices shall be ambient temperature compensated.

D. Circuit Breakers:
   1. Molded case circuit breakers shall incorporate the following, unless indicated otherwise on the Drawings:
      a. Frame sizes 400 amp and less with trip setting less than 400A shall be thermal magnetic type.
      b. Frame sizes 400 amp and larger shall be solid state trip type.
      c. Motor circuit protectors sized for the connected motor.
   2. Insulated case circuit breakers shall incorporate the following, unless indicated otherwise on the Drawings:
      a. Set current sensor or rating plugs long time pick-up setting so that the indicated trip level is near the 75% trip point.

3.2 FIELD QUALITY CONTROL

A. CONTRACTOR shall set all circuit breaker adjustable taps as defined on the Drawings, except adjust motor circuit protectors per the motor nameplate and NEPA 70 requirements.

B. CONTRACTOR shall quality control the Ground Fault Protection System.
   1. Single source system:
      a. Main breaker using the residual sensing method system.
      b. Main and feeder breakers: Utilize four individual current sensors; the phase sensors are integral to the circuit breaker and the neutral sensor is external to the circuit breaker.

C. CONTRACTOR shall conduct acceptance testing based on the requirements in Specification Section 16080.

END OF SECTION

SECTION 16491
LOW VOLTAGE SURGE PROTECTION DEVICES (SPD)

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Type 1 SPD - High exposure locations (switchgear, switchboard, panelboard or motor control center), integrally mounted.
   2. Type 2 SPD - High exposure locations (switchgear, switchboard, panelboard or motor control center), externally mounted.
   3. Type 3 SPD - Medium exposure locations (switchboard, panelboard and motor control center), integrally mounted.
   4. Type 4 SPD - Medium exposure location (switchboard, panelboard and motor control center), externally mounted.
   5. Type 5 SPD - Medium or low exposure locations at individual equipment locations, external, parallel connection.

B. Related Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. C62.41, Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
      b. C62.41.1, Guide on the Surge Environment in Low-Voltage (1000V and Less) AC Power Circuits.
      c. C62.41.2, Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits.
      d. C62.45, Recommended Practice on Surge Testing For Equipment Connected to Low-Voltage (1000V and Less) AC Power Circuits.
   2. Military Standard:
      a. MIL-STD-220B, Method of Insertion-Loss Measurement.
   3. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. LS 1, Low Voltage Surge Protective Devices.
   4. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   5. Underwriters Laboratories, Inc. (UL):
      a. 1283, Standard for Electromagnetic Interference Filters.
      b. 1449, Standard for Safety Transient Voltage Surge Suppressors.

B. Qualifications:
   1. Provide devices from a MANUFACTURER who has been regularly engaged in the development, design, testing, listing and manufacturing of SPDs of the types and ratings required for a period of 10 years or more and whose products have been in satisfactory use in similar service.
      a. Upon request, suppliers or MANUFACTURERS shall provide a list of not less than three (3) customer references showing satisfactory operation.

1.3 DEFINITIONS

A. Clamping Voltage:
   1. The applied surge shall be induced at the 90 degree phase angle of the applied system frequency voltage.
   2. The voltage measured at the end of the 6 IN output leads of the SPD and from the zero voltage reference to the peak of the surge.

B. Let-Through Voltage:
   1. The applied surge shall be induced at the 90 degree phase angle of the applied system frequency voltage.
   2. The voltage measured at the end of the 6 IN output leads of the SPD and from the system peak voltage to the peak of the surge.

C. Maximum Continuous Operating Voltage (MCOV): The maximum steady state voltage at which the SPD device can operate and meet its specification within its rated temperature.

D. Maximum Surge Current:
   1. The maximum 8 x 20 microsecond surge current pulse the SPD device is capable of surviving on a single-impulse basis without suffering either performance degradation or more than 10 percent deviation of clamping voltage at a specified surge current.
   2. Listed by mode, since number and type of components in any SPD may very by mode.

E. MCC: Motor Control Center.

F. Protection Modes: This parameter identifies the modes for which the SPD has directly connected protection elements, i.e., line-to-neutral (L-N), line-to-line (L-L), line-to-ground (L-G), neutral-to-ground (N-G).

G. Surge Current per Phase:
   1. The per phase rating is the total surge current capacity connected to a given phase conductor.
      a. For example, a wye system surge current per phase would equal L-N plus L-G; a delta system surge current per phase would equal L-L plus L-G.
      b. The N-G mode is not included in the per phase calculation.

H. System Peak Voltage: The electrical equipment supply voltage sine wave peak (i.e., for a 480/277 V system the L-L peak voltage is 679V and the L-N peak voltage is 392 V).

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01350 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. MANUFACTURER's qualifications.
      b. Standard catalog cut sheet.
      c. Electrical and mechanical drawing showing unit dimensions, weights, mounting provisions, connection details and layout diagram of the unit.
      d. Testing procedures and testing equipment data.

e. Create a Product Data Sheet for each different model number of SPD provided (i.e., Model XYZ with disconnect and Model XYZ without disconnect, each require a Product Data Sheet).
   1) Data in the Product Data Sheet heading:
      a) SPD Type Number per PART 2 of the Specification.
      b) MANUFACTURER's Name.
      c) Product model number.
   2) Data in the Product Data Sheet body:
      a) Column one: Specified value/feature of every paragraph of Part 2 of the Specification.
      b) Column two: MANUFACTURER's certified value confirming the product meets the specified value/feature.
      c) Name of the nationally recognized testing laboratory that preformed the tests.
      d) Warranty information.
   3) Data in the Product Data Sheet closing:
      a) Signature of the MANUFACTURER's official (printed and signed).
      b) Title of the official.
   4) Date of signature.

3. Warranty.

1.5 WARRANTY

A. Minimum of a five (5) year Warranty from date of shipment against failure when installed in compliance with applicable national/local electrical codes and the MANUFACTURER's installation, operation and maintenance instructions.

PART 2 - PRODUCTS

2.1 GENERAL

A. Standards: IEEE C62.41.1, IEEE C62.41.2, IEEE C62.45, NEMA LS 1, MIL-STD 220B, UL 1283, UL 1449.

2.2 TYPE 1 SPD

A. Product:
   1. SPD tag number or electrical equipment tag number SPD is connected to service equipment.
   2. Integrally mounted in switchgear, switchboards or MCCs.
   3. Hybrid solid-state high performance suppression system.
   4. Do not use a suppression system with gas tubes, spark gaps or other components which might short or crowbar the line resulting in interruption of normal power flow to connected loads.
   5. Do not connect multiple SPD modules in series to achieve the specified performance.
   6. Designed for parallel connection.
   7. Field connection: Use mechanical or compression lugs for each phase, neutral and ground that will accept bus bar or #10 through #1/0 conductors.
   8. Device monitor:
      a. Long-life, solid state, externally visible indicators and Form C dry contact(s) that monitors the on-line status of each mode of the units suppression filter system and power loss in any of the phases.

b. A fuse status only monitor system is not acceptable.

B. Operating Voltage: The nominal unit operating voltage and configuration as indicated on Drawings.

C. Modes of Protection: All modes.
1. Three phase (delta): L-L, L-G.
2. Three phase (wye): L-N, L-L, L-G and N-G.
3. Single phase (2 pole): L-L, L-N, L-G and N-G.
4. Single phase: L-N, L-G and N-G.

D. Maximum Continuous Operating Voltage: Less than 130 percent of system peak voltage.

E. Operating Frequency: 45 to 65 Hz.

F. Short Circuit Rating: Equal to or greater than rating of equipment SPD is connected to.

G. Maximum Surge Current: 240,000 A per phase, 120,000 A per mode minimum.

H. Minimum Repetitive Surge Current Capacity: 4000 IEEE C High waveform impulses with no degradation greater than 10 percent deviation of the clamping voltage.

I. SPD Protection:
1. Integral unit level and/or component level overcurrent fuses and sustained overvoltage thermal cutout device.
2. An IEEE C High waveforms shall not cause the fuse to open and render the SPD inoperable.

J. Maximum Clamping Voltages: Dynamic test at the 90 degree phase angle including 6 IN lead length and measured from the zero voltage reference:

Table 16491-1 Type 1 SPD Maximum Clamping Voltages

SYSTEM VOLTAGE	TEST MODE	IEEE C62.41		UL 1449
		C HIGH V & I WAVE	B COMBINATION WAVE	
L-L < 250 V L-N < 150 V	L-L	1470 V	1000 V	800 V
	L-N	850 V	600 V	500 V
	L-G	1150 V	800 V	600 V
	N-G	1150 V	800 V	600 V
L-L > 250 V L-N > 150 V	L-L	2700 V	2000 V	1800 V
	L-N	1500 V	1150 V	1000 V
	L-G	2000 V	1550 V	1200 V
	N-G	2000 V	1550 V	1200 V

K. EMI-RFI Noise Rejection: Attenuation greater than 30 dB for frequencies between 100 kHz and 100 MHz.

2.3 TYPE 2 SPD

A. Product:

1. SPD tag number or electrical equipment tag number SPD is connected to secondary distribution.
2. Externally mounted next to switchgear, switchboards or MCCs.
3. Hybrid solid-state high performance suppression system.
   a. Do not use suppression system with gas tubes, spark gaps or other components which might short or crowbar the line resulting in interruption of normal power flow to connected loads.
4. Do not connect multiple SPD modules in series to achieve the specified performance.
5. Designed for parallel connection.
6. Enclosure:
   a. Metallic NEMA 4 or 12 for interior locations.
   b. Metallic NEMA 4 or 4X for exterior locations.
7. Field connection:
   a. Mechanical or compression lugs for each phase, neutral and ground that will accept #10 through #1/0 conductors.
8. Device monitor:
   a. Long-life, solid state, externally visible indicators and Form C dry contact(s) that monitor the on-line status of each mode of the units suppression filter system or power loss in any of the phase.
   b. A fuse status only monitor system is not acceptable.
9. Accessories (when specifically specified): Unit mounted disconnect switch.

B. Operating Voltage: Nominal unit operating voltage and configuration as indicated on the Drawings.

C. Modes of Protection: All modes.
   1. Three phase (delta): L-L, L-G.
   2. Three phase (wye): L-N, L-L, L-G and N-G.
   3. Single phase (2 pole): L-L, L-N, L-G and N-G.
   4. Single phase: L-N, L-G and N-G.

D. Maximum Continuous Operating Voltage: Less than 130 percent of system peak voltage.

E. Operating Frequency: 45 to 65 Hz.

F. Short Circuit Rating: Equal to or greater than rating of equipment SPD is connected to.

G. Maximum Surge Current: 240,000 A per phase, 120,000 A per mode minimum.

H. Minimum Repetitive Surge Current Capacity: 4000 IEEE C High waveform impulses with no degradation of more than 10 percent deviation of the clamping voltage.

I. SPD Protection:
   1. Integral unit level and/or component level overcurrent fuses and sustained overvoltage thermal cutout device.
   2. An IEEE C High waveforms shall not cause the fuse to open and render the SPD inoperable.

J. Maximum Clamping Voltages: Dynamic test at the 90 degree phase angle including 6 IN lead length and measured from the zero voltage reference:

Table 16491-2 Type 2 SPD Maximum Clamping Voltages

SYSTEM VOLTAGE	TEST MODE	IEEE C62.41		UL 1449
		C HIGH V & I WAVE	B COMBINATION WAVE	
L-L < 250 V L-N < 150 V	L-L	1470 V	1000 V	800 V
	L-N	850 V	600 V	500 V
	L-G	1150 V	800 V	600 V
	N-G	1150 V	800 V	600 V
L-L > 250 V L-N > 150 V	L-L	2700 V	2000 V	1800 V
	L-N	1500 V	1150 V	1000 V
	L-G	2000 V	1550 V	1200 V
	N-G	2000 V	1550 V	1200 V

K. EMI-RFI Noise Rejection: Attenuation greater than 30 dB for frequencies between 100 kHz and 100 MHz.

2.4 TYPE 3 SPD

A. Product:
   1. SPD tag number or electrical equipment tag number SPD is connected to control panels.
   2. Integrally mounted in a switchboard, panelboards or motor control centers.
   3. Hybrid solid state high performance suppression system.
      a. Do not use gas tubes, spark gaps or other components in suppression system which might short or crowbar the line resulting in interruption of normal power flow to connected loads.
   4. Do not connect multiple SPD modules in series to achieve the specified performance.
   5. Designed for parallel connection.
   6. Field connection: Use mechanical or compression lugs for each phase, neutral and ground that will accept bus bar or #10 through #1/0 conductors.
   7. Device monitor:
      a. Long-life, solid state, externally visible indicators and Form C contact(s) that monitor the on-line status of each mode of the units suppression filter system or power loss in any of the phases.
      b. A fuse status only monitor system is not acceptable.

B. Operating Voltage: The nominal unit operating voltage and configuration as indicated on the Drawings.

C. Modes of Protection: All modes.
   1. Three phase (delta): L-L, L-G.
   2. Three phase (wye): L-N, L-L, L-G and N-G.
   3. Single phase (2 pole): L-L, L-N, L-G and N-G.
   4. Single phase: L-N, L-G and N-G.

D. Maximum Continuous Operating Voltage: Less than 130 percent of system peak voltage.

E. Operating Frequency: 45 to 65 Hz.

F. Short Circuit Rating: Equal to or greater than rating of equipment SPD is connected to.

G. Maximum Surge Current: 160,000 A per phase, 80,000 A per mode minimum.

H. Minimum Repetitive Surge Current Capacity: 4000 IEEE C High or B combination waveform impulses with no degradation of more than 10 percent deviation of the clamping voltage.

I. SPD Protection:
   1. Integral unit level and/or component level overcurrent fuses and sustained overvoltage thermal cutout device.
   2. An IEEE B combination wave shall not cause the fuse to open and render the SPD inoperable.

J. Maximum Clamping Voltages: Dynamic test at the 90 degree phase angle including 6 IN lead length and measured from the zero voltage reference:

Table 16491-3 Type 3 SPD Maximum Clamping Voltages

SYSTEM VOLTAGE	TEST MODE	IEEE C62.41		UL 1449
		B COMB. WAVE	B3 RING WAVE	
L-L < 250 V L-N < 150 V	L-L	1000 V	700 V	800 V
	L-N	600 V	400 V	500 V
	L-G	800 V	550 V	600 V
	N-G	800 V	550 V	600 V
L-L > 250 V L-N > 150 V	L-L	2000 V	1400 V	1800 V
	L-N	1150 V	800 V	1000 V
	L-G	1550 V	1000 V	1200 V
	N-G	1550 V	1000 V	1200 V

K. EMI-RFI Noise Rejection: Attenuation greater than 30 dB for frequencies between 100 kHz and 100 MHz.

2.5 SOURCE QUALITY CONTROL

A. SPD approvals and ratings shall be obtained by MANUFACTURER from nationally recognized testing laboratories.

B. The SPD are to be tested as a complete SPD system including:
   1. Integral unit level and/or component level fusing.
   2. Neutral and ground shall not be bonded during testing.
   3. 6 IN lead lengths.
   4. Integral disconnect switch when provided.

C. The “as installed” SPD system including the MANUFACTURER’s recommended circuit breaker, the SPD is connected to, will not open when tested with a IEEE C3 combination waveform.

D. Tests to be performed in accordance with IEEE C62.45:
   1. Clamping voltage performance testing using IEEE C62.41 Category waveforms.
   2. Single pulse surge current capacity test.
   3. Repetitive surge current capacity testing.
   4. Spectrum analysis for EMI-RFI noise rejection.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with MANUFACTURER's instructions.

B. Type 1 SPD:
   1. Connected in parallel to the equipment.
   2. Install in dedicated electrical equipment compartment, bucket or panelboard box at the factory before shipment.
   3. Provide leads that are as short and straight as possible.
   4. Maximum lead length: 12 IN.
   5. Minimum lead size: #2 stranded AWG or bus bar.
   6. Connect leads to the equipment to be protected by one (1) of the following means:
      a. Through a circuit breaker or molded case switch mounted in the equipment.
      b. Use MANUFACTURER recommended circuit breaker size.
      c. Circuit breaker or switch to be operable from the equipment exterior or from behind a hinged door.

C. Type 2 SPD:
   1. Mounting options:
   2. Nipple connection directly to the equipment to be protected.
   3. Install leads as short and straight as possible.
   4. Maximum lead length: 5 FT.
   5. Minimum lead size:
      a. Type 2 and 4 SPD: #2 stranded AWG.
      b. Type 5: #10 stranded AWG.
   6. When conduit connection is used, provide a minimum of four (4) twists per foot in the lead conductors and install in NFPA 70 sized conduit.
   7. Connect leads to the equipment to be protected by one (1) of the following means:
      a. Through a circuit breaker or molded case switch mounted in the equipment.
         1) Use MANUFACTURER recommended circuit breaker size.
      b. Directly to the protected equipment bus when SPD has integral disconnect switch.
      c. To the load side of field mounted equipment’s local disconnect switch.
         1) Provide taps or lugs as required to provide a UL and NFPA 70 compliant connection.

END OF SECTION

76 S Laura Street, Suite 1600
Jacksonville, FL 32202-3433
904.598.8900

hdrinc.com