VL-4

New York State Department of Environmental Conservation
Contract #1 for the Volney Landfill, Site #7-38-003 Oswego County Region 7
☒ Approved ☐ Approved As Noted ☐ Resubmit With Revisions ☐ Disapproved
COMMISSIONER OF ENVIRONMENTAL CONSERVATION
Designated Representative
Date 6/12/00

TECHNICAL SPECIFICATIONS

FOR

VOLNEY LANDFILL SITE
REMEDIAL ACTION
TOWN OF VOLNEY
OSWEGO COUNTY, NEW YORK

OSWEGO COUNTY
DEPARTMENT OF PUBLIC WORKS
SOLID WASTE MANAGEMENT SYSTEM

8

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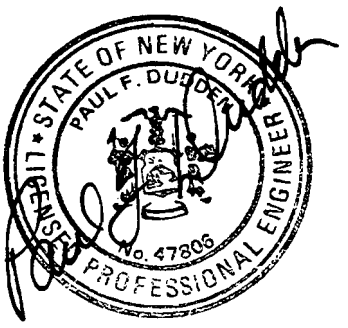

BIDDING & CONTRACT REQUIREMENTS

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GENERAL REQUIREMENTS

SECTION 01580

PROJECT SIGN

01580.01 GENERAL

If directed in the Additional Instructions, the Contractor shall provide and erect a project sign or signs at the project site identifying the project and the applicable funding agencies participating in the project. The project sign(s) shall also indicate the following; the title and description of the project, a statement that the project is being performed by the County of Oswego - Supervising Contractor, under the oversight of the USEPA - Jack O'Dell, Remedial Project Manager, Telephone No. (212) 637-4256. The sign(s) shall be erected within twenty-one (21) days after the construction contract is awarded, and shall be in accordance with the specifications and detailed drawing included in the Additional Instructions.

01580.02 SIGN PANEL

Each sign panel shall be constructed of 3/4" minimum thickness marine plywood rabbetted into a 2" x 4" lumber frame. All fasteners used in the construction of each sign shall be of a rustproof nature.

01580.03 PAINTING

Each sign face shall be painted with the proper paint colors for the background, lettering and emblem as specified in the Additional Instructions. All supports, trim and the back of the sign panel, shall be painted with at least two coats of the same color paint as used for each sign face. All paint used shall be exterior grade paint, suitable for use on wood signs.

01580.04 MISCELLANEOUS

Sign(s) shall be located in a prominent position and aligned as determined by the Engineer. Adequate support for the project sign(s) shall be provided by the Contractor. The bottom edge of each sign shall be a minimum of 3 feet above grade. The project sign(s) shall be maintained in good condition by the Contractor for the duration of construction. The removal of the project sign(s) from the construction site by the Contractor shall be at the completion of construction, when ordered by the Engineer.

END OF SECTION

SPECIFICATIONS

SECTION 02110

CLEARING

PART 1 - GENERAL:

1.1 DESCRIPTION:

1.1.1 Under this Section, the Contractor shall prepare and clear from the site of the work, by removal or destruction, as may be required, the following:

- Debris
- Brush
- Logs
- Trees
- Stumps
- Snow and Ice
- Refuse and Rubbish

1.1.2 The work also includes:

- Removal and replacement, as required, of fencing and supporting of all telephone and power, poles and lines within the work area.

- Any work to be performed specifically to be paid for under the Clearing Item as stated in the Information For Bidders and/or the Additional Instructions.

PART 2 - PRODUCTS

2.1 The Contractor shall furnish and install materials and equipment required.

PART 3 - EXECUTION

3.1 The Contractor shall furnish all labor, material and equipment necessary to properly construct all items under this Section in an acceptable manner.

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3.1.1 No burning or burying of brush, logs, trees, stumps or other debris will be allowed on the site.

3.1.2 The Contractor shall chip all brush, roots, slash and toppings, and dispose with stumps at an approved location on-site.

END OF SECTION

SPECIFICATIONS

SECTION 02220

EXCAVATION

PART 1 - GENERAL

1.1 DESCRIPTION:

1.1.1 Under this Section, the Contractor shall furnish all labor, materials and equipment for Excavation, as shown on the Plans, specified, and/or directed.

1.1.2 Excavation, in open cut, includes the loosening, removing, transporting, storage and disposal of all materials necessary to be removed for the construction and completion of all work under the Contract. Excavations shall be made to the widths and depths shown on the Plans, specified or directed.

1.1.3 Where rock is encountered, the excavations shall be done in accordance with the applicable provisions hereof.

1.2 DEFINITIONS:

1.2.1 The term "excavation" and the term "trenching" where used, shall be deemed and understood to cover the following described work, and the price bid for any and all items including "excavation", or "trenching" shall be deemed to include and cover all of the several following detailed operations:

- The loosening, removing, transporting, storage and rehandling of all materials;
- All sheeting, sheetpiling, bracing and shoring, and the placing, driving, cutting off and removing of the same;
- All diking, ditching, fluming, cofferdamming, pumping, well-pointing, bailing, dewatering and draining or otherwise disposing of water (surface and subsurface);
- The refilling of trenches, excavations and pits, and the furnishing and placing of material over trenches, excavations and pits to the original surface of the ground or to other grades as may be shown or directed;

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- The compacting of all materials used in filling or refilling by rolling, ramming, watering, puddling, etc., as may be required;

- The removing and disposing of all surplus materials from all excavations in the manner specified;

- The maintenance, accommodation and protection of travel;

- The supporting and protecting of all tracks, rails, buildings, curbs, sidewalks, pavements, overhead wires, poles, trees, vines, shrubbery, pipes, sewers, conduits or other structures or property and its appurtenances, in the vicinity of the work, whether over or underground or which appear within the excavations, and the restoration of the same in case of settlement or other injury;

- All temporary bridging and fencing and the removing of same, the temporary paving of highways, roads, driveways, and the permanent repairing or replacing and relaying of pavements, curbs, gutters and sidewalks removed, disturbed, or injured, the removing and clearing away of all construction rubbish, refuse, unused materials, plant and tools from the site;

- The dressing, topsoiling, sodding and/or seeding of all unpaved areas disturbed by the Contractor within and outside the limits of the Contract as may be necessary to leave the surface in as good condition as it was previous to the commencement of the work.

1.2.2 "Earth" includes all materials, such as sand, gravel, clay loam, pavements, ashes, cinders, muck, roots, or pieces of timber, soft or disintegrated rock, not requiring blasting, barring or wedging from their original beds and specifically excludes all ledge or bed rock, and individual boulders or masonry larger than one-half cubic yard in volume.

1.2.3 "Backfill" includes selected materials for the backfilling or refilling of all excavations and trenches up to the original surface of the ground or to other grades as may be shown or directed.

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1.2.4 "Spoil" includes surplus excavated materials not required or not suitable for backfills or embankments.

1.2.5 "Embankments" include fills constructed of selected materials above the original surface of the ground.

1.2.6 "Rock" includes ledge or bedrock requiring blasting, barring or wedging from their original beds and individual boulders or masonry larger than one-half cubic yard in volume.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS: Where used for general site fill, soil material shall be free of debris, roots, wood, scrap material, vegetable matter, refuse, soft unsound particles, frozen, deleterious, or objectionable materials.

2.2 CONTROLLED FILL: Provide where indicted and also within building lines and under concrete slabs and aprons. Fill to be granular fill as specified in Section 02222.

PART 3 - EXECUTION

3.1 ROCK EXCAVATION:

3.1.1 Rock excavation shall include the loosening, removing, transporting, storing and disposal of all materials requiring blasting, barring, or wedging for removal from their original beds. All pieces of ledge or bed rock and boulders or masonry larger than one-half (1/2) cubic yard in volume are included under rock excavation. Rock excavations shall be made to the widths and depths shown on the Plans or as directed by the Engineer. For concrete structures, rock shall be excavated only to the bottom of the structure unless otherwise shown or noted on drawings. All excavated rock which cannot be handled and compacted as earth shall not be mixed with other backfill or embankment materials except as specified herein or as directed.

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3.1.2 Blasting:

3.1.2.1 Blasting shall be done with extreme care. All blasts in open cut shall be properly covered and protected with heavy timber chained together or approved blasting mats.

3.1.2.2 Charges shall be of such size that the excavation will not be unduly large and shall be so arranged and timed that adjacent rock upon or against which structures are to be built will not be shattered. Blasting shall be conducted in accordance with all applicable rules and regulations including, but not limited to, 12 NYCRR 23, 12 NYCRR 39, 12 NYCRR 53 and NYS Labor Law § 28-a. Where blasting occurs in highways under jurisdiction of NYSDOT or under jurisdiction of agencies adhering to the NYSDOT Standard Specification, the Provisions of NYSDOT Standard Specification Sections 107-05 and 203-3.05 shall also be adhered to. Where existing pipelines, conduits or structures have been exposed during excavation, such pipelines, conduits or structures shall be adequately protected from damage before proceeding with the blasting.

3.1.2.3 Any injury or damage to the work or to the existing pipelines, conduits, or structures shall be repaired or rebuilt by the Contractor at his own expense. Whenever the Engineer determines that further blasting may damage adjacent rock, pipelines or structures, blasting shall be discontinued and the rock removed by drilling, barring, wedging or other methods.

3.1.2.4 Danger signals shall be given before firing each blast. Blasting shall be done only by a person experienced in the handling and detonation of explosives, and shall be in conformity with all laws and regulations, imposed by public authorities.

3.1.2.5 Blasting shall not be carried on within three hundred (300) feet of any radio transmitter or radio frequency emission equipment such as high frequency welders, and blasting caps shall be kept in tightly-closed metal cans when in the vicinity of such equipment.

3.1.3 Explosives:

3.1.3.1 At no time shall an excessive amount of explosives be kept at the Site of the work. Such explosives shall be stored, handled and used in conformity with all applicable laws and regulations.

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3.1.3.2 Accurate daily records shall be kept showing the amounts of explosives on hand, both at the Site and at any storage magazine, the quantities received and issued, and the purpose for which issued. Copies of all records shall be furnished to the Engineer.

3.1.3.3 The Contractor shall be responsible for any damage or injury to any persons, property or structures as a result of his blasting operations.

3.2 EXCAVATION FOR STRUCTURES:

3.2.1 Excavation shall be of sufficient size, and only of sufficient size, to give suitable room for the proper construction of structures and appurtenances, including allowances for sheeting, dewatering, and other similar work necessary for completion of the Contract.

3.2.2 Excavations for structures shall be made only to the lines and grades shown on the Plans, specified or directed.

3.2.3 In no case will under cutting excavation faces for extended footings be permitted. Not less than twelve (12) inches clearance shall be provided between excavation faces and brick or block masonry exterior wall surfaces which are to be plastered.

3.2.4 Subgrade for all concrete structures shall be undisturbed original earth, thoroughly compacted where noted on drawings. Where excavation below subgrade is ordered, it shall be a thoroughly compacted and consolidated lining, special lining or special backfill as directed and as specified in Section 02224. It shall be sufficiently stable to remain firm and intact during the surfacing of subgrade, laying reinforcing steel and placing concrete thereon.

3.2.5 Where necessary, a layer of Class "D" concrete of sufficient strength and thickness to withstand subsequent construction operations shall be installed below the specified subgrade elevation and the structural concrete deposited thereon. Subject to the approval of the Engineer, lining or special lining may be used for subsoil reinforcement if satisfactory results can be obtained thereby. Such material shall be applied in thin layers, each layer being entirely embedded in the subsoil by thorough tamping. All excess soil shall be removed to compensate for the displacement of the gravel or crushed stone and the finished elevation of any subsoil reinforced in this manner shall not be above the specified subgrade.

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3.3 BACKFILLING AROUND STRUCTURES:

3.3.1 Backfilling around structures shall not be commenced until all lumber, refuse, rubbish and other similar materials are removed from the excavated area. Backfill around structures may be placed by machine, provided the work shall be done carefully to prevent damage to the structure. In no case shall backfill materials be allowed to fall directly on a structure, until at least twelve (12) inches of hand-placed material has been placed thereon and compacted.

3.3.2 Backfill around structures shall be deposited in horizontal layers not more than eight (8) inches in thickness and shall be thoroughly compacted. Compaction shall be by a vibrating tamper or other approved method and shall be to a minimum dry density of ninety-five (95) percent of the maximum dry weight density in pounds per cubic foot as determined by the AASHTO Standard Density Test or the Modified Proctor Compaction Test (ASTM D1557).

3.3.3 Backfilling shall be done immediately after work has been inspected and approved. No frozen material shall be used, nor shall backfilling be placed on or against frozen earth, debris or other deleterious matter not conducive to proper compaction. Backfill within building lines, under concrete slabs and aprons shall be granular fill as specified in Section 02222.

3.3.4 Backfilling against free standing walls shall be made against both sides at the same time. If backfill is required on one side only, the wall shall be adequately braced on the opposite side until properly cured to full strength.

3.3.5 Contractor shall take every necessary precaution during compaction of fill adjacent to foundations, walls, etc., that such items are not displaced from their proper location or damaged by compacting equipment. In the event damage or displacement occurs during or resulting from compaction of fill as specified above, the Contractor shall be responsible for correcting the same, to approval of the Engineer and at no expense to the Owner.

3.4 TRENCHING:

3.4.1 The alignment, depth and pipe subgrades of all pipe trenches shall be determined by overhead grade lines parallel to the pipe invert, or other grade control devices, installed and maintained by the Contractor.

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3.4.2 Under ordinary conditions, excavation shall be by open cut from the ground surface. Where the depth of trench and soil conditions permit, tunneling may be required beneath crosswalks, curbs, gutters, pavements, concrete driveways, railroad tracks and other surface structures. No additional compensation will be allowed for such tunneling over the price bid for open cut excavation of equivalent depths below the ground surface unless such tunnel excavation is specifically provided for in unit or lump sum price items.

3.4.3 Trenches shall not be opened for more than three hundred (300) feet in advance of the completed pipe or sewer nor left unfilled for more than one hundred (100) feet in the rear thereof without consent of the Engineer. Excavation of the trench shall be fully completed at least twenty (20) feet in advance of the pipe laying or construction of the invert unless specifically permitted otherwise.

3.4.4 Width and Depth of Trenches:

3.4.4.1 The trenches in which pipelines are to be constructed, shall be excavated in all cases in such manner and to such depths and widths as will give suitable room for the pipelines which the trenches are to contain, for sheeting, pumping, dewatering, well-pointing and draining of water, and for removing the material not suitable for pipe subgrade.

3.4.4.2 Trenches for pipes shall be not less than six (6) inches wider than the hubs of the pipe in the clear on each side, measured over the hubs of the pipe. Width of trenches, measured at a point twelve (12) inches above the top of the pipe shall not exceed twelve (12) inches on each side. Width of trenches greater than specified above will be permitted in the vicinity of joints for welded steel pipe where access for the welding of joints is required.

3.4.4.3 Where, as required by loading conditions, the width of the lower portion of the trench, measured at twelve (12) inches above top of pipe, exceeds the maximum for the size of pipe, additional concrete cradle or concrete encasement shall be installed by the Contractor at his own expense.

3.4.4.4 Ledge rock, shale, boulders and large stones shall be removed to provide minimum bottom and side clearances, for the size of pipe being laid in each case, as follows:

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Size of Pipe (Inches)	Minimum Clearance Below Pipe (Inches)	Minimum Clearance At Sides (Inches)
12 or smaller	4	6
15, 18, and 21	5	6
24 to 36	7	6
Over 36	9	7

Where concrete embedment or cradle is to be placed, it shall be placed directly on the rock, and the bottom clearance shall be adjusted as directed by the Engineer.

3.5 EARTH SUBGRADE PREPARATION FOR PIPES:

3.5.1 Unless otherwise permitted by the Engineer, the trench shall have a flat bottom conforming to the grade to which the pipe is to be laid.

3.5.2 Except where concrete cradle or encasement is required below the specified pipe subgrade, mechanical excavation of trenches for pipe shall not extend lower than one (1) inch above the finished pipe subgrade elevation at any point. The remainder of the trench excavation shall be made with hand tools.

3.5.3 Pipe subgrade preparation shall be performed immediately prior to installing the pipe in the trench. The trench bottom shall be accurately graded by means of hand tools in such a manner that a uniform and continuous bearing and support on solid and undisturbed ground is provided for each pipe for its entire length or between bell holes.

3.5.4 All trenches shall be so graded that the spigot end of the pipe will be accurately centered in the adjacent pipe bell when laid, without raising the pipe off the trench bottom. Regrading of a trench bottom which is too high will be permitted. Correction of a subgrade that is too low shall be done only by placing and compacting lining over the entire width of the trench and regrading.

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3.5.5 The trench bottom shall be accurately graded and ready for the installation of the pipe thereon prior to excavating bell holes if and where required.

3.5.6 Each bell hole shall be excavated immediately prior to laying the pipe therefor. Bell holes shall have a length, measured at the elevation of the pipe subgrade, not in excess of nine (9) inches and shall be of sufficient size so that no part of the pipe bell will be in contact with the trench bottom or granular fill thereon.

3.6 EXCAVATION FOR CONCRETE CRADLE OR ENCASEMENT:

3.6.1 Where concrete cradle or encasement is required, the trench subgrade elevation will be determined by the required concrete section in each case. Unless otherwise authorized by the Engineer, concrete cradle or encasement shall extend across the full width of the trench as excavated, and the concrete therein shall be poured directly against vertical trench banks. In the case of concrete cradle or encasement of pipe in a sheeted trench, the concrete may be poured directly against sheeting which is to be left in place in the trench, as specified.

3.7 PIPE EMBEDMENT:

3.7.1 All pipe shall be protected from lateral displacement and possible damage resulting from superimposed backfill loads, impact or unbalanced loading during backfilling operations by being adequately embedded in suitable pipe embedment material. Except where loading or subsoil conditions require the use of concrete cradle or encasement, all pipe embedment shall be placed so as to insure adequate lateral and vertical stability of the installed pipe during pipe jointing and embedment operations. A sufficient amount of the specified pipe embedment material to hold the pipe in rigid alignment shall be uniformly deposited and thoroughly compacted on each side, and back of the bell, of each pipe laid.

3.7.2 Pipe embedment materials placed at any point below an elevation six (6) inches above the top of pipe or sewer, shall be deposited and compacted in layers not to exceed four (4) inches in uncompacted depth, and such deposition and compactions shall be done simultaneously and uniformly on both sides of the pipe. Compaction shall be by vibrating tamper or other approved method and shall be to a minimum dry density of ninety-five (95) percent of the maximum dry weight density in pounds per cubic foot as determined by the Modified Proctor Compaction Test. All such materials shall be placed in the trench with hand tools in such a manner that they will be scattered alongside the pipe and not dropped into the trench in compact masses.

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3.7.3 Concrete cradle and encasement of the class specified shall be installed where and as shown on the Plans or ordered by the Engineer. Before concrete cradle or encasement is placed, the pipe shall be braced in all directions to prevent movement or flotation.

3.8 BACKFILL ABOVE PIPE EMBEDMENT:

3.8.1 The portion of pipe trenches between the top of the pipe embedment (see paragraph 3.7) and the upper limit of backfill shall be refilled with suitable materials.

3.8.2 Where trenches are within the ditch-to-ditch or curb-to-curb limits of any street, road, driveway or other recognized traveled vehicular way, or within other limits that may be specifically shown or specified for this purpose, the backfill materials shall be deposited in the trench in horizontal layers not more than eight (8) inches in thickness, and each layer shall be compacted by vibrating tamper or other approved method and shall be to a minimum dry density of ninety-five (95) percent of the maximum dry weight density in pounds per cubic foot as determined by the Modified Proctor Compaction Test (ASTM D1557).

3.8.3 Where trenches are outside the ditch-to-ditch or curb-to-curb limits of any street, road, driveway or other recognized traveled vehicular way, and outside of other limits that may be specifically shown or specified as areas in which mechanical compaction in layers is to be performed, the backfill material may be deposited in the trench by mechanical means for the full depth of the trench between the top of pipe embedment and ground surface with no special compaction. In such case the backfill materials shall be mounded over the trench to an elevation slightly above desired finished grade to allow for settlement and compaction by natural means, and the Contractor shall return to the area during his clean-up operations to remove any excess materials remaining above finished grade or add sufficient additional backfill to bring the completed work to grade. If a hazard should be created by such excess materials, or by settlement below finished grade, prior to the performance of clean-up operations, the Contractor shall remove such excess, or add additional backfill, at the time the hazard is created or when directed.

3.8.4 Any additional material added during clean-up operations, or at any other time to prevent or remove a hazard, shall be placed in horizontal layers not more than eight (8) inches in thickness, with each layer adequately compacted by mechanical means, by the Contractor at his own expense.

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3.9 REMOVAL OF WATER:

3.9.1 The Contractor shall at all times during construction provide and maintain proper and satisfactory means and devices for the removal of all water entering the excavations, and shall remove all such water as fast as it may collect, in such manner as shall not interfere with the prosecution of the work or the proper placing of pipe, masonry, concrete, structures, or other work.

3.9.2 Removal of water includes the construction and removal of cofferdams, sheeting and bracing, the furnishing of materials, equipment and labor necessary therefore, the excavation and maintenance of ditches and sluice-ways and the furnishing and operation of pumps, wellpoints, and appliances needed to maintain thorough drainage of the work in a satisfactory manner.

3.9.3 Water shall not be allowed to rise over or come in contact with any masonry, concrete or mortar, until at least twenty-four (24) hours after placement, and no stream of water shall be allowed to flow over such work until such time as the Engineer may permit.

3.9.4 Unless otherwise specified, all excavations which extend down to below the ground water elevation at the sites of structures shall be dewatered by lowering and maintaining the ground water beneath such excavations at an elevation not less than that specified herein at all times when work thereon is in progress, during subgrade preparation and the placing of the structures or pipe thereon.

3.9.5 Where an upward pressure or flow of water in combination with a fine-grained subsurface material causes a quick condition, the Contractor shall install wellpoints to stabilize the subgrade. Where wellpoints are used, the ground water table shall be continuously (day and night) maintained to an elevation of not less than twenty-four (24) inches below the excavation and when subgrade is reached the ground water shall be maintained not less than twenty-four (24) inches below the subgrade. Unless otherwise permitted by the Engineer, the ground water shall be maintained not less than twenty-four (24) inches below the subgrade until completion of the backfilling to an elevation at least twelve (12) inches above natural ground water level. Wellpoint headers, points, and other pertinent equipment shall not be placed within the limits of the excavation in such a manner or location as to interfere with the laying of pipe or trenching operations or with the excavation for and construction of other structures.

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3.9.6 In areas where ground water enters the excavation but does not cause a quick condition, the ground water may be removed by any practical method which does not damage the subgrade, cause the same to become unstable or interferes with construction operations.

3.9.7 The ground water control requirements specified for wellpointing operations apply to other dewatering methods.

3.9.8 Suitable stand-by pumping equipment shall be provided to insure the maintenance of the specified lowering of the water table.

3.9.9 Water pumped or drained from excavations, or any sewers, drains, or water courses encountered in the work, shall be disposed of in a suitable and environmental manner without injury to adjacent property, the work under construction, or to pavements, roads, and drives. No water shall be discharged to sanitary sewers. Sanitary sewage shall be pumped to sanitary sewers or shall be disposed of by an approved method.

3.9.10 Any damage caused by improper handling of water shall be repaired by the Contractor at his own expense.

3.10 SHEETING & BRACING:

3.10.1 The Contractor shall furnish, place and maintain such sheeting, bracing and shoring as may be required to support the sides and ends of excavations in such manner as to prevent any movement which could, in any way, injure the pipe, sewers, masonry, or other work; diminish the width necessary; otherwise damage or delay the work; or endanger existing structures, pipes or pavements; cause the excavation limits to exceed the right-of-way limits; or to occasion a hazard to persons engaged on the project or to the general public.

3.10.2 In no case will bracing be permitted against pipes or structures in trenches or other excavations.

3.10.3 The Contractor shall be solely responsible for the safety and adequacy of all sheeting and bracing. He shall make good any damage resulting from failure of supports with no additional cost to Owner.

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3.10.4 Removal of Sheeting & Bracing:

3.10.4.1 In general, all sheeting and bracing, whether of steel, timber or other material, used to support the sides of trenches or other open excavations, shall be withdrawn as the trenches or other open excavations are being refilled. That portion of the sheeting extending below the top of a pipe or sewer shall be withdrawn, unless directed, before more than six (6) inches of earth is placed above the top of the pipe or sewer and before any bracing is removed. The voids left by the sheeting shall be carefully refilled with selected material and rammed tight with tools especially adapted for the purpose, or otherwise as may be approved.

3.10.4.2 The Engineer may order the Contractor to delay the removal of sheeting and bracing, if in his judgement the installed work has not attained the necessary strength to permit placing of backfill.

3.10.5 Sheeting & Bracing Left In Place:

3.10.5.1 If, to serve any purpose of his own, the Contractor files a written request for permission to leave sheeting or bracing in the trench or excavation, the Engineer may grant such permission, in writing, on condition that the cost of such sheeting and bracing be assumed and paid by the Contractor.

3.10.5.2 The Contractor shall leave in place all sheeting, shoring and bracing which are shown on the Drawings or specified to be left in place or which the Engineer may order, in writing, to be left in place. All shoring, sheeting, and bracing shown or ordered to be left in place will be paid for under the appropriate item of the Contract. No payment allowance will be made for wasted ends or for portions above the proposed cut-off level which are driven down instead of cut-off.

3.10.5.3 In case sheeting is left in place, it shall be cut off or driven down as directed so that no portion of the same shall remain within twelve (12) inches of the finished street or ground surface.

3.10.5.4 All timber sheeting and bracing to be left in place and paid for under an item of the Contract shall be new, sound and straight, free from cracks, shakes and large or loose knots, and shall otherwise conform with National Design Specifications for Stress Grade Lumber for lumber of a minimum fiber stress of 1,200 pounds per square inch.

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3.10.5.5 Steel sheeting and bracing left in place and paid for under an item of the Contract shall be new and shall conform with ASTM Des: A7, with a minimum thickness of 3/8-inch.

3.10.5.6 Sheeting and bracing left in place and paid for under an item of the Contract shall be driven as the excavation progresses and in such manner as to maintain pressure against the original ground at all times. The sheeting shall be driven vertical with the edges tight together, and all bracing shall be of such design and strength as to maintain the sheeting in its proper position.

3.11 STORAGE OF MATERIAL:

3.11.1 Any sod cut during excavation shall be removed and stored during construction so as to preserve the grass growth, and shall be replaced in position upon completion of the work.

3.11.2 Topsoil suitable for final grading shall be removed and stored on the Site separately from other excavated material, and shall be replaced in position upon completion of the work.

3.11.3 All excavation materials shall be stored in locations so as not to endanger the work, and so that easy access may be had at all times to all parts of the excavation. Stored materials shall be kept neatly piled and trimmed, so as to cause as little inconvenience as possible to public travel or to adjoining property holders. All stockpiled fill material shall be stored only in those fill areas as approved by the Engineer and the New York State Department of Environmental Conservation.

3.11.4 All excavated materials shall be kept clear of all sidewalks, driveway entrances, street crossings, and any other points that may inconvenience the public. Special precautions must be taken to permit access at all times to fire hydrants, fire alarm boxes, police and fire department driveways, and other points of public convenience.

3.11.5 Where traffic is to be maintained, at least one-half (1/2) of the street width must be kept open at all times. Approved types of bridging across trenches shall be constructed and maintained where necessary. Where conditions do not permit storage of materials, the material excavated from the first one hundred (100) feet of any opening, or from such additional length as may be required, shall be removed from the street by the Contractor, at his own cost and expense, as soon as excavated. The material subsequently excavated shall be used to refill the trench where the facility has been built, provided it be of suitable character.

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3.11.6 If more material is excavated from any trench, excavation, or pit than can be refilled over the completed work or stored on the street, leaving space for traffic as herein provided, or within the limits of the right-of-way, the excess material shall be spoiled at locations selected and obtained by the Contractor. A copy of the signed agreement between the property owner and Contractor granting permission to deposit spoil shall be given to the Engineer prior to placement. When the facility is complete, the Contractor shall, at his own cost and expense, bring back adequate amounts of satisfactory excavated materials as may be required to properly refill the trenches, excavations, or pits. If directed by the Engineer, the Contractor shall refill such trenches, excavations, or pits with special backfill or other suitable materials, and excess excavated materials shall be disposed of as spoil.

3.12 DRAINAGE:

3.12.1 All material deposited in roadway ditches or other water courses crossed by the line of trench or near a structure shall be removed immediately after backfilling is completed and the section grades and contours of such ditches or water course restored to their original condition, in order that surface drainage will be obstructed no longer than necessary.

3.12.2 Backfilling of trenches for pipes installed beneath or across roadways, driveways, walks and other traffic ways adjacent to drainage ditches and water courses shall not be done prior to the completion of backfilling to the original ground surface of the trench on the upstream side of such traffic-way in order to prevent the impounding of water at any point after the pipe has been laid, and all necessary bridges and other temporary structures required to maintain traffic across such unfilled trenches shall be constructed and maintained. All backfilling shall be done in such a manner that water will not accumulate in unfilled or partially filled trenches.

3.12.3 Where trenches are constructed in or across roadway ditches or other water courses, the backfill shall be protected from surface erosion by adequate and environmentally sound means. Where trenches cross such waterways; the backfill surface exposed on the bottom and slopes thereof shall be protected by means of stone or concrete riprap, at no additional cost to the Owner.

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3.13 ADDITIONAL EXCAVATION:

3.13.1 In case the materials encountered at the locations and grades shown on the Plans or specified are not suitable, or in case it is found desirable or necessary to excavate additional materials to secure good support for the structure or pipeline, the excavation shall be carried to such additional limits as the Engineer may direct. The Contractor shall refill such additional excavated space with either lining, special lining, Class "D" or "E" concrete or other material, as the Engineer may direct. Additional excavation, lining, special backfill, concrete or other materials so ordered, will be paid for under the appropriate items of the Contract.

3.14 UNAUTHORIZED EXCAVATION:

3.14.1 Whenever excavations are carried beyond or below the lines and grades shown on the Plans, or as given or directed by the Engineer, all such excavated space shall be refilled with lining, special backfill, concrete or other materials as the Engineer may direct. Beneath structures, all such excavated space shall be refilled with Class "D" concrete. All refilling of unauthorized excavations shall be at the Contractor's own expense.

3.14.2 All material which slides, falls or caves into the established limits of excavations due to any cause whatsoever shall be removed and disposed of at the Contractor's own expense, and no extra compensation will be paid the Contractor for any materials ordered for refilling the void areas left by the slide, fall or cave-in.

3.15 DISPOSAL OF MATERIALS:

3.15.1 All spoil shall be transported and placed on the Site of the work at the locations and to the elevations and grades shown on the Plans, or if spoil areas are not shown, all spoil materials shall be disposed off the Site at appropriate locations selected and obtained by the Contractor and approved by the Engineer and the New York State Department of Environmental Conservation. No environmental sensitive areas shall be used for spoil areas. A copy of the signed agreement between the property owner and the Contractor granting permission to deposit spoil shall be given to the Engineer prior to placement.

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3.15.2 The surface of all spoil placed on the Site shall be graded and dressed, and no unsightly mounds or heaps shall be left on completion of the work.

3.16 UNFINISHED WORK:

3.16.1 When for any reason the work is left unfinished, all trenches and excavations shall be filled and all roadways and sidewalks left unobstructed with their surfaces in a safe and satisfactory condition.

3.17 HAULING MATERIAL ON STREETS:

3.17.1 When it is necessary to haul material over the streets or pavements, the Contractor shall provide suitable tight vehicles so as to prevent deposits on the streets or pavements. In all cases where any materials are dropped from the vehicles, the Contractor shall clean up the same at least daily or as often as directed and keep the crosswalks, streets and pavements clean and free from dirt, mud, stone and other hauled material.

3.18 TEST PITS:

3.18.1 For the purpose of locating underground obstructions, the Contractor shall make such excavations in advance of the work as directed. Payment for the excavations of test pits will be made under an appropriate item of the Contract.

3.19 RESTORATION OF SURFACES:

3.19.1 The various types of street surface, gutters and culverts, disturbed, damaged or destroyed during the performance of the work under the Contractor, shall be restored and maintained as specified herein and as shown and directed.

3.19.2 Restoration of Property:

3.19.2.1 The Contractor shall restore all pavement, driveways, sidewalks, gutters, culverts, trees, shrubs, lawns, landscaped areas and any other public or private property damaged as a result of work under this Contract. The quality of materials and workmanship used in the restoration shall produce a condition equal to or better than the condition before the work began. If conditions are inferior before restoration, they shall be superior after restoration.

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3.19.2.2 Payment for restoration of property shall be included in the applicable excavation items unless specifically provided for in other unit or lump sum price items.

3.19.3 Time of Replacement:

3.19.3.1 In general, permanent restoration of street surfaces will not be permitted until one month's time has elapsed after trenches have been completely backfilled as specified. A greater length of time, but not more than nine (9) months, may be allowed to elapse before permanent restoration of street surfaces is undertaken if, in the opinion of the Engineer such additional time is required for complete shrinkage and settlement of the backfill.

3.19.3.2 If the Contractor is permitted to replace pavement at any time by the Engineer, it shall not relieve the Contractor of responsibility to make repairs to damage caused by settlement for a period of one year or as elsewhere specified.

3.19.4 Schedule of Operations:

3.19.4.1 A schedule of replacement operations shall be worked out by the Contractor, and approval of the Engineer shall be obtained. The program shall be adhered to unless otherwise approved by the Engineer.

3.19.5 Temporary Resurfacing & Repaving:

3.19.5.1 Immediately upon completion of refilling of the trench or excavation, the Contractor shall place a temporary pavement over all disturbed areas of the streets, driveways, alleys and other traveled places where the original surface has been disturbed by his operations. The temporary repavement shall be of a character satisfactory in all respects and safe for public travel.

3.19.5.2 The temporary resurfacing shall consist of a minimum of six inches (6") of well-graded broken stone with such additional depth as is necessary to withstand the traffic to which it is subjected. Where concrete pavements are removed, the broken stone shall be surfaced with "cold patch". The surface of the temporary repaving shall conform to the street grades. Mounding up of the material over the trench and covering the same with loose broken stone will not be considered as compliance with the above requirements.

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3.19.5.3 For dust prevention, the Contractor shall treat all surfaces, not covered with cold patch, as approved by the Engineer. Use of calcium chloride and/or petroleum products for dust control is prohibited.

3.19.5.4 The temporary repavement shall be placed and maintained by the Contractor in a safe and satisfactory condition until such time as the permanent repaving is completed. The Contractor shall immediately remove and restore to a satisfactory condition any and all such resurfacing and repavements as shall become unsatisfactory and not in accordance with the terms and intent of the Specifications.

3.19.6 Preparation for Permanent Replacement:

3.19.6.1 After due notice and within the time specified, the temporary broken stone or gravel pavement shall be prepared as the base to receive the permanent pavement. It shall be brought to the required grade and cross section and thoroughly compacted before placing the permanent pavement. Service boxes, manhole frames and covers, and similar structures, within the area of pavement to be replaced and not conforming to the new work, shall be set to established grade by the Contractor at his expense, unless a specific item is included in the Contract.

3.19.7 Permanent Repaving:

3.19.7.1 The permanent and final repaving of all streets, driveways and similar surfaces where pavement has been removed, disturbed, settled or damaged by or on account of the work of the Contract shall be repaired and replaced by the Contractor, by a new and similar pavement at such time as directed. The top surface shall conform with the grade of existing adjacent pavement, and the entire replacement shall meet the current specifications of the local community for the particular types of pavement.

3.19.7.2 Concrete pavement and concrete base beneath asphalt, brick and other pavement surfacings supported by a concrete base, shall be replaced with Class "B" concrete.

3.19.7.3 Undamaged brick removed from brick pavement laid with sand or a bituminous filler may be reused in the pavement replacement. All broken and otherwise damaged brick, even though such brick were broken prior to removal, and all brick from grout filled pavement, shall be replaced with new brick of equal or better quality by and at the expense of the Contractor.

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3.19.7.4 Where specified or approved by the Engineer, in writing, brick or block surfacing may be replaced by placing Class "B" concrete even with the adjacent wearing surface.

3.19.7.5 All pavement other than brick and concrete, and all gravel, crushed stone, and other types of roadway surfacings shall be replaced with new materials except where, in the opinion of the Engineer, materials salvaged from stone or gravel roadways have been removed, handled, and stored in such a manner that their original quality has been maintained, in which case such salvaged materials may be used to the extent available in the lower portion of the roadway surfacing after proper screening to remove dust and other excess fine material.

3.19.7.6 All such roadway surfacings shall be replaced to their original thickness at all points and such replacement shall in all cases conform in type, kind, and quality to the original when built. Where specifications covering the original construction are available, such specifications will apply to the replacement work. If not, the work shall be done in conformity with the State Department of Transportation Standard which conforms the closest to the type of surfacing being replaced, as determined by the Engineer.

3.19.8 Concrete Walks:

3.19.8.1 Concrete walks removed in connection with, or damaged as a result of, construction operations under the Contract shall be replaced with new construction; such walks shall be constructed of Class "B" concrete on a thoroughly compacted subgrade, shall have a vertical thickness of not less than four (4) inches (or thickness of the replaced walk where greater than four (4) inches), shall be constructed with vertical construction joints spaced not more than twenty-five (25) feet apart, shall be provided with expansion joints spaced not to exceed fifty (50) feet apart, and shall be sloped for drainage at right angles to the longitudinal center line in the amount of approximately 1/8-inch per foot of walk width.

3.19.8.2 Walks shall be float finished, edged with an edging tool, and grooved at construction joints and at intermediate intervals not in excess of the width of the walk. The length of blocks formed by grooving tool and distances between construction and expansion joints shall be uniform throughout the length of the walk in any one location. All walks shall be cured as specified for concrete slabs in the Section headed "Cast-In-Place Concrete".

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3.19.9 Curbs, Gutters & Culverts:

3.19.9.1 The Contractor shall, at his own cost and expense, permanently repair and relay all curbs, gutters, roadway and driveway culverts, where the same have been broken, injured or disturbed by the Contractor, his agents or employees, in executing any of the work covered by the Contract or by or on account of said work. He shall restore the same in a manner, to a condition and with material, either new or old as required, similar and equal to that existing before such excavations were made.

3.19.10 Maintenance & Surfaces:

3.19.10.1 The pavements, sidewalks, curbs, driveways, gutters, culverts, restored lawns, shrubs, trees, landscaped areas and any other public or private property shall be maintained in satisfactory condition during a period of one year from and after completion and acceptance of the Contract.

END OF SECTION

SPECIFICATIONS

SECTION 02222

GRANULAR FILL

PART 1 - GENERAL

1.1 DESCRIPTION:

1.1.1 Under this Section, the Contractor shall furnish all labor, materials and equipment for Granular Fill, as shown on the Plans, as specified, and/or directed.

PART 2 - PRODUCTS

2.1 GRANULAR FILL:

2.1.1 The Granular Fill shall consist of clean, durable, gravel, or stone, well graded from coarse to fine, conforming to New York State Department of Transportation Standard Specifications Items 304.05 (Subbase Course Type 4) as indicated on the Contract Drawings.

2.1.2 The Contractor shall submit to the Engineer a certified sieve analysis by an independent testing laboratory showing that the materials meet the required gradation, at no cost to the Owner.

PART 3 - EXECUTION

3.1 PLACING:

3.1.1 The Items 304.04 Granular Fill shall be spread in horizontal layers so that the maximum thickness of any layer after compaction shall not exceed six (6) inches. Compaction shall be by travelling vibrators or other approved method and shall be to a minimum dry density of ninety-five percent (95%) of the maximum dry density as determined by the Modified Proctor Test, ASTM D1557. Each layer shall be thoroughly compacted before placement of overlying layers.

3.2 COMPACTION TEST:

3.2.1 The Contractor shall employ an approved commercial testing laboratory at his own expense to conduct the compaction tests.

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GRANULAR FILL

3.2.2 Each layer shall be tested and approved by the Engineer before succeeding layers are placed. One field density test shall be made for each fifty (50) cubic yards of material placed and/or as shown or specified in the Drawings.

3.2.3 The Contractor shall provide one optimum moisture-maximum density curve for each type of soil encountered in subgrade and fills or as directed by the Engineer.

3.2.4 The following reports in quadruplicate shall be submitted directly to the Engineer:

a. Report and Certification of Gradation.

b. Field Density Reports.

c. Optimum moisture-maximum density curves.

3.2.5 Based on the reports of the testing laboratory and inspection, if the subgrade or fills which have been placed and compacted are below the specified density, the Engineer will ask for additional compaction and testing at the expense of the Contractor.

END OF SECTION

SPECIFICATIONS

SECTION 02225

SELECT FILL MATERIALS

PART 1 - GENERAL

1.1 DESCRIPTION:

1.1.1 Under this Section, the Contractor shall furnish all labor, materials and equipment for Select Fill Materials as shown on the Plans, as specified, and/or directed.

1.1.2 Work under this Section shall include furnishing, transport, dumping and placement of Select Fill Materials in the areas and to the depths and grades shown on the engineering drawings and/or directed by the Engineer.

PART 2 - PRODUCTS

2.1 MATERIALS:

2.1.1 Select Fill Materials shall be of the types listed below:

Type (A) - Select Fill
Type (B) - Select Fill

2.1.1.2 Type (A) - Select Fill shall consist of clean, washed, sound, medium to coarse sand or fine gravel, less than 1 inch in the maximum dimension, free from organic material and coatings, and possessing a minimum permeability of 1.0×10^{-3} cm/sec at a relative density of 90 percent. In addition, this material must have less than three percent, by weight, pass the No. 200 sieve.

2.1.1.3 Type (B) - Select Fill shall consist of clean, screened, durable, sharp-angled fragments of crushed gravel of uniform quality, conforming to New York State Department of Transportation #3/4 Stone, with the gradation shown below:

SECTION 02225

SELECT FILL MATERIALS

% Passing By Weight	Sieve
100	2"
90 - 100	1-1/2"
0 - 15	1"
0 - 3	#200

In addition, this material must be free of organic material and coatings.

2.1.1.3.1 A crushed particle shall be defined as one in which the total area of face fracture exceeds 25 percent of the maximum cross-sectional area of the particle. When two fractured faces are designated, the total area of each fractured face shall exceed 25 percent of the maximum cross-sectional area of the particle.

2.1.1.3.2 A naturally fractured face shall be acceptable providing that the sharp angular portion of the particle consists of sound material and is free from unsound or injurious coatings.

2.1.2 Special Considerations:

2.1.2.1 Gravels that have not been crushed may be utilized for Type (B) Select Fill.

2.1.3 Submittals:

2.1.3.1 The Contractor shall submit to the Engineer for approval a certified sieve analysis, for each type of Select Fill Material, the minimum permeability, the minimum and maximum relative densities as determined by an independent testing laboratory for the Type (A) Select Fill, at no cost to the Owner. All tests will be performed in accordance with the methods outlined in this Section.

SECTION 02225

SELECT FILL MATERIALS

PART 3 - EXECUTION

3.1 USAGE:

3.1.1 Type (A) - Select Fill Material will be used to construct the drainage layer, or as directed by the Engineer.

3.1.2 Type (B) - Select Fill Material will be used as backfill around the gas vents, collection pipes, or as directed by the Engineer.

3.2 PLACEMENT:

3.2.1 Select fill materials shall be installed in accordance with Specification Section 02220, "Excavation", except as modified herein.

3.2.2 For Type (A) Select Fill Material, the following preparation and inspection shall be conducted prior to placement:

a. Insure all placement procedures do not damage any underlying soil or geosynthetic layers. Equipment must access on approved temporary haul roads.

b. Verify areas to be filled are properly compacted and all geosynthetics are in place.

c. Verify areas to be backfilled are free of debris, snow, ice or water and ground surfaces are not frozen.

d. Identify required lines, levels, contours and datums.

e. Proof roll existing subgrade as directed by the Engineer.

SECTION 02225

SELECT FILL MATERIALS

f. Multiple cover spreading points will not be allowed. One initial spreading location shall be established, and the work shall proceed from this location towards a free end of the geomembrane. Select fill material must be placed using vertical placement techniques. No horizontal pushing of the initial soil lift above the geomembrane will be allowed.

g. Placement of select fill layers shall be from the low end of the cell to the high end and also from the valley to the ridge as much as possible.

h. Place select fill to contours and elevations shown on Contract Drawings. Use unfrozen materials.

i. Spread systematically, with low ground pressure equipment which exerts a ground pressure of no more than 7 pounds per square inch in a manner that will minimize movement of the underlying geotextile and geomembrane materials and potential for puncture of geotextile and geomembranes.

j. Spread select fill in loose lifts up to 12 inches thick and compact using the weight of the dozer and/or a smooth drum roller to a minimum relative density of 50 percent. Hand tamp or vibrate as required in areas not accessible to heavy compaction equipment.

k. Where heavy compaction equipment cannot access, hand tamp or vibrate select fill in 6-inch lifts, and/or as directed by the Engineer.

l. Refer to Section 02595 for placement of select fill over Polyvinyl Chloride (PVC) Lining Material.

3.2.4 For Select Fill Material Type (B), the following specific placement procedures shall be followed:

a. Place uncompacted select fill in gas vents after riser pipes are installed shown on Contract Drawings. Protect pipe from lateral displacement and possible damage during backfilling operations. Place fill uniformly around riser.

SECTION 02225

SELECT FILL MATERIALS

3.3 FIELD TESTING AND QUALITY CONTROL:

3.3.1 In-place density will be visually approved by the Engineer for the Type (A) Select Fill Materials with field density tests performed as requested by the Engineer at the Contractor's expense.

3.3.2 In addition to field density testing, the following laboratory testing will be performed at the Contractor's expense by an independent testing laboratory on samples of the Type (A) Select Fill Materials. All samples of the select fill materials will be taken from material after placement.

a. One grain size (ASTM D422) analysis every 1,000 cubic yards of in-place material, or as directed by the Engineer.

b. One laboratory permeability test in accordance with ASTM D2434 per every 2,500 cubic yards of in-place Type (A) material, or as directed by the Engineer.

c. One minimum/maximum relative density test in accordance with ASTM D4253 and ASTM D4254 for every 5,000 cubic yards of in-place Type A Select Fill and one for each stockpile of Type B Select Fill to be pre-qualified.

3.4 CRITERIA AND TOLERANCES:

3.4.1 Criteria and tolerances of the select fill material are as listed in Paragraph 2.1.

3.5 REMEDIATION OF FAILED TEST RESULTS:

3.5.1 If laboratory test results indicate that the in-place Type (A) Select Fill Material fails to meet the required specifications, additional samples shall be taken in the field and tested in order to isolate the unacceptable area. Once the limits of unacceptable material have been defined, the Contractor shall remove the unacceptable material, replace it and retest the new material, at no additional cost to the Owner.

SECTION 02225

SELECT FILL MATERIALS

3.5.1.1 If unacceptable material is in the initial lift directly above a geomembrane, the unacceptable material will be removed to within 4 inches of the geomembrane and replaced. Testing of the final layer will be performed on a sample representative of the actual completed lift.

END OF SECTION

SPECIFICATIONS

SECTION 02233

GEOTEXTILE

PART 1 - GENERAL

1.1 DESCRIPTION:

1.1.1 Under this Section, the Contractor shall furnish all labor, materials and equipment for Geotextile as shown on the Plans, as specified, and/or directed.

1.2 SUBMITTALS:

1.2.1 Prior to the installation or delivery of a geotextile, the Contractor shall submit to the Engineer, from the geosynthetic manufacturer, a list of guaranteed "minimum average roll values" (MARV) for the geotextile (the minimum average roll value is the minimum value obtained from the average values of the sampled rolls). The Contractor shall provide the Engineer, from the manufacturer, a written certification stating that the geosynthetic material meets or exceeds the guaranteed properties submitted.

1.2.2 In addition to submitting guaranteed physical properties, the Contractor shall submit to the Engineer, from the manufacturer, documentation demonstrating the chemical compatibility of the geosynthetic material with leachate generated from mixed municipal solid waste. Such documentation shall include chemical compatibility testing results.

1.2.3 Prior to delivery of the geotextile, the Contractor shall submit a sample of the warranty to be provided as described in paragraph 3.3.1.

1.3 DELIVERY:

1.3.1 All geotextiles will be inspected on delivery, and materials that do not comply with the Specification will be rejected. The Contractor shall furnish all labor required to handle the geotextiles during inspection and shall remove the rejected material from the site of the work.

SECTION 02233

GEOTEXTILE

1.4 CONFORMANCE TESTING:

1.4.1 Within one week of delivery and at the Engineer's direction, the Contractor shall provide the necessary labor, tools and equipment to obtain samples and send these samples to an independent quality assurance laboratory for testing at the Contractor's expense. As a minimum, the following tests will be performed on all geotextiles:

- mass per unit area - ASTM D5261
- burst strength - ASTM D3786
- grab strength - ASTM D4632
- puncture strength - ASTM D4833
- trapezoidal tear strength - ASTM D4533

1.4.2 Samples will be taken by cutting along the width and 5 feet from the end of a rolled or folded geotextile material. The sampling frequency for the geotextile will be one sample per every 50,000 square feet of respective material delivered.

1.4.3 Any samples which fail the conformance testing will require the failed material to be removed from the site and replaced with new material at the Contractor's expense.

PART 2 - PRODUCTS

2.1 MATERIALS:

2.1.1 Geotextile:

2.1.1.1 The geotextile to be utilized shall be a nonwoven, needle-punched, polymeric geotextile. The fibrous structure of the geotextile must be able to withstand handling, placement and long-term loads associated with the incorporated Specifications.

2.1.1.2 The geotextile shall be protected from ultraviolet light, precipitation, mud, dirt, excessive dust, puncture, cutting and/or other damaging condition prior to and during delivery. The geotextile shall be capable of withstanding 30 days of sunlight without measurable deterioration.

SECTION 02233

GEOTEXTILE

2.1.1.3 Two types of nonwoven geotextiles will be supplied by the Contractor. Both fabrics shall be similar materials except for the weight and the associated physical properties. Type 1 will be nominal eight oz./square yard or heavier, and Type 2 will be a nominal twelve oz./square yard or heavier fabric. An equivalent substitution may be made subject to the approval of the Engineer. Geotextile Specifications are given in Paragraph 2.2.

2.1.1.4 All geotextiles shall be delivered on site in rolls contained within opaque plastic covers. These rolls will be tagged and display the following information.

- Manufacturer's name
- Product identification
- Lot number
- Roll number and dimensions

2.2 MINIMUM SPECIFIED VALUES:

2.2.1 Geotextile Minimum Average Roll Value (MARV) Specifications:

2.2.1.1 The table below lists the MARV specification values for the Type 1 and Type 2 nonwoven geotextiles. In addition, the typical average specification values, as indicated, have been listed. Final approval of the geotextile properties shall be made by the Engineer based upon Contractor's submittals.

Non-Woven Geotextiles

Property	Specification Limit Type 1	Type 2	Test Method
*Mass per Unit Area (oz/yd^2)	8.0	12.0	ASTM D5261
*Thickness (mils)	90	120	ASTM D5199
**Apparent Opening Size (micron)	70-120	100-140	CW-02215 or ASTM D4751

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GEOTEXTILE

Property	Specification Limit Type 1	Type 2	Test Method
*Burst Strength (psi)	380	450	ASTM D3786
*Grab Strength (lbs)	210	290	ASTM D4632
*Grab Elongation (%)	50	50	ASTM 04632
*Puncture Strength (lbs)	100	135	ASTM D4833
*Trapezoidal Tear Strength (lbs)	80	105	ASTM D4533
**Wide-Width Strength (lbs/in)	90	130	ASTM D4595
*Permittivity (sec^{-1})	1.2	0.8	ASTM D4491
*Water Flow Rate (gpm/ft^2)	90	65	ASTM D4491

*MARV Values Taken Along Weakest Principal Direction.
**Typical Average Values

PART 3 - EXECUTION

3.1 GEOTEXTILE INSTALLATION

3.1.1 The following procedures and requirements will be followed during the installation of geotextile.

SECTION 02233

GEOTEXTILE

3.1.2 Placement:

3.1.2.1 The placement of the geotextile shall not be conducted during adverse weather conditions. The geotextile will be kept dry during storage and up to the time of deployment. During windy conditions, all geotextiles will be secured with sandbags or an equivalent approved anchoring system. Removal of the sandbags or equal will only occur upon placement of an overlying soil layer.

3.1.2.2 Proper cutting tools shall be used to cut and size the geotextile materials. Extreme care will be taken while cutting in-place geotextiles.

3.1.2.3 During the placement of geotextiles, all dirt, dust, sand or mud shall be kept off to prevent clogging. If excessive contaminant materials are present on the geotextile, it shall be cleaned or replaced as directed by the Engineer.

3.1.2.4 No equipment used will damage the geotextiles by handling, trafficking or other means. Equipment, including ATVs, will not be allowed to travel directly on the geotextiles during the installation of overlying soils or geosynthetic layers unless otherwise determined by the Engineer.

3.1.3 Seaming or Joining:

3.1.3.1 Geotextiles:

3.1.3.1.1 Geotextiles shall be seamed using either an eighteen inch overlap, by sewing or by leister (heat) seaming. The specific conditions requiring a sewn or leistered seam or simply an overlap are as follows:

a. In all cases, seams on side slopes will be parallel to the line of slope and sewn or leistered 5 feet from the toe-of-slope upward over the length of the slope and into the anchor trench. No horizontal seams will be allowed on side slopes, except for patching.

b. Geotextiles placed on the subgrade, or between two soil layers at less than 10 percent slope may utilize an 18-inch overlap seam.

c. Where the slope is greater than 10 percent, and directly above a geomembrane, these seams shall be sewn or leistered as stated above.

3.1.3.1.2 Sewing will be done using a polymeric thread with chemical compatibility resistance equal to or exceeding the geotextile being sewn. Thread and the sewing device shall be approved by the Engineer prior to its use in the field.

3.1.3.1.3 The leistering device shall be approved by the Engineer prior to its use in the field. If required by the Engineer, sample seams will be constructed using scrap material to verify the integrity of the seam.

3.1.3.1.4 Repair of tears or holes in the geotextile will require the following procedures:

a. On slopes: A patch made from the same geotextile will be double seamed into place; with each seam 1/4-inch to 3/4-inch apart and no closer than 1-inch from any edge. Should any tear exceed 10% of the width of the roll, that roll will be removed from the slope and replaced.

b. Flat slopes: A patch made from the same geotextile will be spot-seamed in place with a minimum of 24-inch overlap in all directions.

3.2 POST-CONSTRUCTION:

3.2.1 Upon completion of the installation, the Contractor shall submit to the Engineer:

a. All quality control documentation.

b. The warranty obtained from the Manufacturer/Fabricator.

3.3 WARRANTY:

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GEOTEXTILE

3.3.1 The Contractor shall obtain and submit to the Owner from the manufacturer a standard warranty provided for the geotextiles. The warranty shall guarantee that the geotextile shall remain free from defects for a minimum of one (1) year from the date of substantial completion of the project. The Engineer will review the warranty for completeness prior to the Owner accepting its provisions.

END OF SECTION

SPECIFICATIONS

SECTION 02255

COMMON FILL MATERIAL

PART 1 - GENERAL

1.1 DESCRIPTION:

1.1.1 Under this Section, the Contractor shall furnish all labor, materials and equipment for Common Fill Material, as shown on the Plans, as specified, and/or directed.

1.1.2 Work under this Section shall include, but not necessarily be limited to excavating, transporting, dumping, spreading and compacting common fill material in the locations and to the depths and grades shown on the Contract Drawings or as directed by the Engineer.

PART 2 - PRODUCTS

2.1 MATERIALS:

2.1.1 Common Fill Material shall be natural soil, free from excessive moisture, frost, stumps, trees, roots, sod, muck, marl, vegetable matter or other unsuitable materials. The soil must also be free from chemical contamination.

2.1.2 Acceptable on-site borrow shall be well graded from fine to coarse with a maximum particle size of six (6) inches and a maximum 50 percent passing by weight the No. 200 sieve. All materials shall be suitable for compaction in layers not exceeding eight (8) inches in loose thickness and shall remain stable when wet.

PART 3 - EXECUTION

3.1 PLACEMENT:

3.1.1 The entire surface to be covered with common fill shall be stripped of all grass, vegetation, top soil, rubbish, or other unsuitable materials before backfilling.

SECTION 02255

COMMON FILL MATERIAL

3.1.2 In general, common fill shall be placed in horizontal layers not exceeding eight (8) inches in loose thickness and shall be compacted according to the criteria and tolerances of Paragraph 3.3. Stones, if any, shall not exceed six (6) inches in greatest dimension and shall be well distributed throughout the mass. Subgrade for common fill shall be approved by the Engineer. Where common fill is to be constructed across ground which will not support the weight of the construction equipment, the fill shall be constructed by placing Type 2 geotextile on the subgrade or the soft soils excavated and replaced with suitable backfill as approved by the Engineer.

3.1.3 Each layer of common fill material shall be thoroughly tamped or rolled to the required degree of compaction by sheepsfoot, mechanical tampers, or vibrators. Successive layers shall not be placed until the layer under construction has been thoroughly compacted.

3.1.4 Sheepsfoot rollers shall be used wherever possible to compact common fill soil and shall have a weight on each row of feet of not less than two hundred (200) nor more than five hundred (500) pounds per square inch of foot surface.

3.1.5 Trucks or other heavy equipment shall not be operated over pipelines until a minimum of twenty-four (24) inches of backfill above the crown of the trenched pipe has been placed and properly compacted by tampers or other approved method.

3.1.6 Where required, the Contractor shall, at his own expense, moisture condition the fill to meet the compaction requirements of the specification. If, due to rain or other causes, the material is too wet for satisfactory compaction, it shall be allowed to dry or be removed as required, before compaction.

3.2 FIELD TESTING AND QUALITY CONTROL:

3.2.1 Common fill shall be compacted to a minimum dry density of ninety (90) percent of the maximum dry weight density in pounds per cubic foot as determined by the Modified Proctor Compaction Test, ASTM D1557 unless otherwise noted on the Contract Drawings or Specifications. Modified Proctor, Grain Size Analyses (ASTM D422 and 2217) and Atterberg Limits (ASTM D4318) shall be performed for each 5,000 cubic yard of fill placed by an independent testing laboratory at the Contractor's expense.

SECTION 02255

COMMON FILL MATERIAL

3.2.2 Compaction curves shall be developed for use in the construction of access roads, berms and subgrades. The development of the curves from the Modified Proctor Compaction Test shall be done by an approved testing laboratory at the Contractor's expense.

3.2.3 Field control samples shall be taken as directed by the Engineer during the construction to verify that the Proctor density limits and grain size distribution are consistent and that the common fill is uniform. Such samples shall be taken and tested by the soils quality assurance laboratory at the Contractor's expense. In-place density testing according to ASTM D2922, D2167 or D1556 procedures will be conducted at the frequencies given below:

- in-place testing will be performed at a frequency of one per 5,000 square feet per lift of common fill.

3.2.4 All in-place density tests will be located according to an approved testing grid system. Elevations will be established from known existing benchmarks by Contractor. Contractor shall establish the grid system in the field such that work areas can be easily located by the Engineer.

3.2.5 Common fill shall be constructed to such heights as to make allowance for after-construction settlement and any settlements which occur before final acceptance of the Contract shall be corrected to make the backfill conform with the established lines and grades.

3.3 CRITERIA AND TOLERANCES:

3.3.1 Criteria and tolerances of common fill are as follows:

- Compaction - a minimum of 90 percent of the maximum dry density as determined by the Modified Proctor Method unless otherwise specified or directed.

END OF SECTION

SPECIFICATIONS

SECTION 02271

RIPRAP

PART 1 - GENERAL

1.1 DESCRIPTION:

1.1.1 Under this Section, the Contractor shall furnish all labor, materials and equipment for Riprap as shown on the Plans, as specified and/or directed.

1.1.2 The work shall be done in accordance with these specifications and in conformity with the lines and grades shown on the Plans or established by the Engineer. The type of Riprap to be used shall be as indicated on the Contract Drawings.

PART 2 - PRODUCTS

2.1 MATERIALS:

2.1.1 Stone used for Riprap shall be hard, durable, angular in shape, resistant to weathering and to water action, free from overburden, spoil, shale and organic material, and shall meet the gradation requirements for the type specified. Neither breadth nor thickness of a single stone should be less than one-third its length. Rounded stone or boulders will not be accepted unless authorized by the Engineer. Broken concrete may be substituted for stone when authorized by the Engineer. Shale and stone with shale seams are not acceptable. The minimum unit weight of the stone shall be 155 pounds per cubic foot as computed by multiplying the specific gravity (bulk-saturated-surface-dry basis, AASHTO Test T85) times 62.4 pounds per cubic foot.

2.1.1.1 The sources from which the stone will be obtained shall be selected for approval by the Engineer well in advance of the time when the stone will be required in the work. The acceptability of the stone will be determined by service records and/or by suitable tests, as required by the Engineer. If testing is required, suitable samples of stone shall be taken in the presence of the Engineer at least 25 days in advance of the time when the placing of Riprap is expected to begin. The approval of some rock fragments from a particular quarry site shall not be construed as constituting the approval of all rock fragments taken from that quarry.

SECTION 02271

RIPRAP

2.1.2 The quality of all material used for Riprap shall be determined by the Magnesium Sulfate Soundness Test, if so elected by the Engineer. A maximum 10 percent loss at ten (10) cycles, by weight, shall be acceptable.

2.1.3 The types of Riprap to be provided shall conform to the following gradation requirements:

Item	% Passing	Stone Size
Type I	90-100	Smaller than 8 inches
	50-100	Larger than 3 inches
	0-10	Smaller than No. 10 Sieve
Type II	90-100	Lighter than 100 lbs.
	50-100	Larger than 6 inches
	0-10	Smaller than 1/2 inch
Type III	50-100	Heavier than 100 lbs.
	0-10	Smaller than 4 inches
Type IV	50-100	Heavier than 600 lbs.
	0-10	Smaller than 6 inches

2.1.3.1 Each load of Riprap shall be reasonably well graded from the smallest to the maximum size specified. Stones smaller than the specified 10 percent size and spalls will not be permitted in an amount exceeding 10 percent by weight of each load.

2.1.3.2 Control of gradation will be by visual inspection. If requested by the Engineer, the Contractor shall provide two samples of rock of at least 5 tons each, meeting the gradation for the type specified. The sample at the construction site may be a part of the finished Riprap covering. The other sample shall be provided at the quarry. These samples shall be used as a frequent reference for judging the gradation of the Riprap supplied. Any difference of opinion between the Engineer and the Contractor shall be resolved by dumping and checking the gradation of two random truck loads of stone. Mechanical equipment, a sorting site, and labor needed to assist in checking gradation shall be provided by the Contractor at no additional cost to the Owner.

SECTION 02271

RIPRAP

2.1.3.3 In addition to meeting the gradation requirements set forth in this section for the type of Riprap indicated, Riprap shall consist of stones shaped as nearly as practicable in the form of right rectangular prisms. One dimension of the majority of the stones furnished shall be at least equal to the thickness as shown on the Plans.

PART 3 - EXECUTION:

3.1 RIPRAP PLACEMENT:

3.1.1 Slopes to be protected by Riprap shall be free of brush, topsoil, trees, stumps, and other objectionable material and shall be dressed to a smooth surface. All soft or spongy material shall be removed to the depth shown on the Plans or as directed by the Engineer and replaced with approved material. Filled areas will be compacted as specified. If shown on the Plans, a toe trench shall be dug and maintained until the Riprap is placed.

3.1.2 Protection for structure foundations shall be provided as early as the foundation construction permits. The area to be protected shall be cleaned of waste materials and the surfaces to be protected prepared as shown on the Plans. The type of Riprap specified will be placed in accordance with these Specifications.

3.1.3 When shown on the Plans, a bedding material blanket shall be placed on the prepared slope or area to be provided with Riprap as specified in Article 2.1.5 before the stone is placed.

3.1.4 Stone for Riprap shall be placed on the prepared slope or area in a manner which will produce a reasonably well-graded mass of stone with the minimum practicable percentage of voids. The entire mass of stone shall be placed so as to be in conformance with the lines, grades, and thicknesses shown on the Plans. Riprap shall be placed to its full course thickness in one operation and in such a manner as to avoid displacing the underlying material. Placing of Riprap in layers, or by dumping into chutes, or by similar methods likely to cause segregation will not be permitted.

3.1.5 The larger stones shall be well distributed, and the entire mass of stone shall conform to the gradation specified in Article 2.1.3. All material going into Riprap protection shall be so placed and distributed that there will be no large accumulations of either the larger or smaller sizes of stone.

SECTION 02271

RIPRAP

3.1.6 It is the intent of these Specifications to produce a fairly compact Riprap protection in which all sizes of material are placed in their proper proportions. Hand placing or rearranging of individual stones by mechanical equipment may be required to the extent necessary to secure the results specified.

3.1.6.1 Unless otherwise authorized by the Engineer, the Riprap protection shall be placed in continuous progression with the construction of the embankment. The Contractor shall maintain the Riprap protection until accepted, and any material displaced by any cause shall be replaced to the lines and grades shown on the Plans at no additional cost to the Owner.

3.1.7 When Riprap and bedding material are placed under water, thickness of the layers shall be increased as shown on the Plans; and methods shall be used that will minimize segregation.

3.1.8 Riprap shall be placed so that the dimension approximately equal to the layer thickness is perpendicular to the slope surface and that the weight of the stone is carried by the underlying material and not by the adjacent stones. On slopes, the largest stones shall be placed at the bottom of the slope. The Riprap shall be properly aligned and placed so as to minimize void spaces between adjacent stones. The spaces between the stones shall be filled with spalls of suitable size.

END OF SECTION

SPECIFICATIONS

SECTION 02436

POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

PART 1 - GENERAL

1.1 DESCRIPTION:

1.1.1 Under this Section, the Contractor shall furnish all referenced materials for Polyvinyl Chloride (PVC) Pipe And Fittings, as shown on the Plans, as specified, and/or directed.

1.2 SUBMITTALS:

1.2.1 The Contractor shall submit six (6) copies of the Manufacturer's material Specifications for each item to be supplied under this Section.

1.3 QUALITY ASSURANCE:

1.3.1 All pipe, fittings, and specials will be inspected on delivery, and materials that do not comply with the Specification will be rejected. The Contractor shall furnish all labor required to handle the pipe and related materials during inspection and shall remove the rejected materials from the site of work.

PART 2 - PRODUCTS

2.1 PVC PLASTIC SOLVENT WELD PIPE AND FITTINGS:

2.1.1 PVC material for the pipe and fittings shall meet the requirements of ASTM D1784 for Rigid Poly (Vinyl Chloride) Compounds and Chlorinated Poly (Vinyl Chloride) Compounds, Class 12454-B, or Class 12454-C.

2.1.2 The PVC pipe and fittings shall be extruded or molded in such a manner that all cross sections shall be dense, homogeneous, and free from porosity or other imperfections. The molded or extruded pipe and fittings shall conform to ASTM D1785 for Polyvinyl Chloride (PVC) Plastic Pipe, and ASTM D2466 and ASTM D2467 for Polyvinyl Chloride (PVC) Plastic Pipe Fittings.

SECTION 02436

POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

2.1.3 All PVC pipe and fittings shall be Schedule 80 (unless otherwise noted).

2.1.3.1 Interior flange fittings shall be 150 pound, Schedule 80 PVC conforming to ASTM D178, unless otherwise specified or indicated.

2.1.3.2 All fasteners, bolts, nuts and washers shall be ASTM A276 (Condition B, Cold-Worked) 304 Stainless Steel with a minimum 100,000 psi yield strength.

2.1.4 Standard length of all pipe shall be 10 or 20 feet. Provide couplings as necessary. All pipe and fittings shall be of the solvent weld type unless otherwise indicated. Provide adequate solvent cement for the number of couplings and fittings provided.

2.1.4.1 The solvent cement shall be a solution of unplasticized PVC, tetrahydrofuran and cyclohexanone. The solvent cement shall meet the requirements of ASTM D2564 for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.

PART 3 - EXECUTION

3.1 INSTALLATION:

3.1.1 Installation of all pipe, fittings, specials, adapters and appurtenances shall conform to the manufacturer's recommendations and the following summary of installation recommendations. Where Specifications and recommendations conflict, the strictest shall apply.

3.1.2 Proper implements, tools and facilities satisfactory to the Engineer shall be provided and used by the Contractor for the safe and convenient execution of the work.

3.1.3 The interior surface of all pipe shall be clean when installed, and shall be kept clean until final acceptance. Removable end caps shall be placed on all open ends of pipe lines when pipe laying is not actively in progress. The bulkheads shall be designed to prevent the entrance of dirt, debris or small animals, and shall not be removed until pipe laying is resumed.

SECTION 02436

POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

3.2 FIELD QUALITY CONTROL:

3.2.1 Field Tests and Inspections: The Engineer will conduct field inspections and witness field tests specified in this Section. The Contractor shall perform field tests on the gas main prior to connecting gas vents. The Contractor shall provide all labor, equipment, and incidentals required for testing. Be able to produce evidence, when required, that each item of work has been constructed in accordance with the drawings and Specifications.

3.2.1.1 Leakage Tests: Test lines for leakage by low-pressure air tests. Prior to testing for leakage, backfill trench up to at least lower half of pipe. When necessary to prevent pipeline movement during testing, place additional backfill around pipe sufficient to prevent movement, but leaving joints uncovered to permit inspection. When leakage or pressure drop exceeds the allowable amount specified, make satisfactory correction and retest pipeline section in the same manner. Correct visible leaks regardless of leakage test results.

a. Low-pressure Air Tests: Perform tests as follows:

(1) PVC Plastic Pipelines: Test in accordance with UNI B-6. Allowable pressure drop shall be as given in UNI B-6. Make calculations in accordance with the Appendix to UNI B-67.

END OF SECTION

SPECIFICATIONS

SECTION 02444

FENCE, CHAIN LINK

PART 1 - GENERAL

1.1 DESCRIPTION:

1.1.1 Under this Section, the Contractor shall furnish all labor, materials and equipment for Fence, Chain Link, including accessory items of work herein described, as shown on the Plans, as specified and/or directed.

1.2 REFERENCES: The publications listed below and their latest revisions form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1.2.1 American Society for Testing and Materials (ASTM) Publications:

A121	Standard Specification for Zinc-Coated (Galvanized) Steel Barbed Wire
A123	Standard Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated From Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip
A153	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
A392	Standard Specification for Zinc-Coated Chain-Link Fence Fabric
F567	Standard Practice for Installation of Chain-Link Fence
F1083-9	Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures

SECTION 02444

FENCE, CHAIN LINK

1.3 SUBMITTALS:

1.3.1 Shop Drawings and Catalog Cuts Show all fencing components, details of fencing and accessories. Drawing shall also show fence height and concrete footing details.

1.3.2 Manufacturer's Certificate of Conformance: Certify that materials and coatings furnished have been tested and conform to the referenced ASTM Specification.

a. Posts
b. Braces
c. Framing
d. Rails
e. Tension Wire
f. Fabric

1.4 DELIVERY, STORAGE, AND PROTECTION: Deliver materials to the site in an undamaged condition. Store materials off the ground to provide protection against oxidation caused by ground contact.

PART 2 - PRODUCTS

2.1 POSTS, RAILS, BRACES AND GATE FRAMES: All posts, rails, gate frames, and post braces shall be hot-dip galvanized Schedule 40 standard steel pipe.

2.1.1 Minimum pipe diameters shall be as follows:

End, corner and pull posts	2-7/8" OD, 5.79 lb per foot
Line posts	2-3/8" OD, 3.65 lb per foot
Top rail	1-5/8" OD, 2.27 lb per foot
Horizontal post braces	1-5/8" OD, 2.27 lb per foot

SECTION 02444

FENCE, CHAIN LINK

2.1.2 All posts shall be equipped with pressed steel combination tops with barbed wire supporting arms. Tops shall be provided with a hole to permit through passage of the top rail.

2.2 FENCE FABRIC:

2.2.1 Wire for chain link fence fabric shall be No. 9 coated wire gauge carbon steel produced in accordance with ASTM A392, Class 2 with a 2-inch mesh; twisted selvage at top, knuckled selvage at bottom. The fabric shall be stretched taut and anchored so that a pull of 150 pounds at the middle of a panel will not lift the bottom of the fabric more than 6 inches.

2.2.2 Coated fence fabric shall be produced from helically wound and interwoven steel wire forming a continuous 2-inch mesh.

2.2.3 Ties or clips of adequate strength shall be provided in sufficient number for attachment of the fabric to line posts at intervals not exceeding 16 inches and to the top rail and bottom tension wire at a maximum 24-inch spacing.

2.3 TENSION BARS: Tension bars shall be minimum 3/16-inch by 3/4-inch flat steel plates and no more than 2 inches shorter than the fabric height. Bars shall be hot-dip galvanized.

2.4 TERMINAL POST BANDS: Bands or clips of adequate strength shall be provided in sufficient number for attachment of the fabric and stretcher bars to all terminal posts at intervals not exceeding 15 inches. Tension bands shall be formed from No. 12 gauge flat or beveled steel and attached with 3/8-inch diameter carriage bolts hot-dip galvanized.

2.5 FENCING ACCESSORIES: All accessories shall have zinc coatings.

2.6 TENSION WIRE: Bottom tension wire shall be 7 gauge galvanized coil spring wire.

2.7 BARBED WIRE: Barbed wire shall consist of two (2) strands of twisted 12-1/2 gauge steel wire with 4 point 14 gauge barbs on 4-inch spacing; wire shall be zinc coated.

SECTION 02444

FENCE, CHAIN LINK

2.8 FOOTINGS:

2.8.1 Where posts are set in earth, concrete foundations 36 inches deep shall be provided. If bedrock is encountered, post excavation shall be continued to the 36-inch depth or 18 inches into the rock, whichever is less. Concrete foundations shall be circular in horizontal section, not less than 18 inches in diameter. Foundations shall extend above the ground surface and shall be crowned approximately 1 inch.

2.8.2 Concrete for footings shall conform to the requirements of Specification 03300, "Cast-In-Place Concrete".

2.8.3 Placement:

2.8.3.1 Before placing concrete, all debris, water, snow and ice shall be removed from the footing excavation.

2.8.3.2 Do not suspend or interrupt placing of concrete once a pour has started for each footing.

2.8.3.3 All concrete shall be protected against injury by sun, rain, freezing, premature drying or other damage. Maintain concrete above 50°F in a moist or wet condition for at least the first 7 days. Cover footing with wet burlap, wet sand, curing paper or insulating blankets.

2.8.3.4 Cold weather protection shall conform to ACI 306R-88. Hot weather protection shall conform to ACI 305R-89.

PART 3 - EXECUTION

3.1 INSTALLATION: Install fence in accordance with the fence manufacturer's written installation instructions except as modified herein. Fencing shall consist of galvanized steel framework and steel fabric with a height of 7 feet. The fence shall have a top rail, bottom tension wire, and three strands of barbed wire mounted on 45 degrees extension areas. The upper strand shall be approximately 12 inches out from the fence and 12 inches above the top of the fabric.

SECTION 02444

FENCE, CHAIN LINK

3.1.1 Grading: Establish a graded fence line prior to fencing installation. Clear the fence line of all obstacles that will interfere with the fencing.

3.1.2 Bracing: Brace end and corner posts to the nearest adjoining line post at mid height with a horizontal standard steel pipe used as a compression member and a diagonal truss rod and truss tightener used as a tension member. Diagonal tension bracing provided from end, corner, or gate posts to line posts shall consist of 3/8-inch minimum diameter steel truss rods with turnbuckles or equivalent provision for adjustment.

3.1.3 One tension bar shall be provided for each end and gate post, and two (2) for each corner and pull post.

3.1.4 Bottom Tension Wires: Install bottom tension wires before installing chain-link fabric, and pull wires taut. Bottom tension wires shall be within 8 inches and the respective fabric edge. Fabric shall be attached to wires at 24 inches on center.

3.1.5 Post Caps: Design post caps to accommodate the top rail. Install post caps as recommended by the manufacturer.

3.2 CLEANUP: Remove waste fencing materials and other debris from the fencing site.

END OF SECTION

SPECIFICATIONS

SECTION 02484

TOPSOIL

PART 1 - GENERAL

1.1 DESCRIPTION:

1.1.1 Under this Section, the Contractor shall furnish all labor, materials and equipment for Topsoil as shown on the Plans, as specified, and/or directed.

PART 2 - PRODUCTS

2.1 MATERIAL:

2.1.1 Topsoil for such depth as directed shall be removed from areas of the Site where excavations are to be made or embankments placed. The soil so removed shall be transported and stored in piles at convenient locations designated or approved and shall be kept separate from all other classes of excavated material. Should the Contractor fail to keep separate from other material any soil removed, he shall procure and furnish at his own expense an equivalent quantity of satisfactory topsoil.

2.1.2 In the event the topsoil removed from areas of the Site is unsatisfactory, or the quantity available is inadequate, the Contractor shall furnish topsoil from an approved source or sources off the Site. The off-site material shall contain no admixture of refuse or any material toxic to plant growth and shall be free from subsoil, stumps, roots, brush, stones, clay lumps or similar objects larger than two inches in greatest dimension. Topsoil shall not be delivered or placed in a frozen or muddy condition.

PART 3 - EXECUTION

3.1 PLACING:

3.1.1 Topsoil shall include fine grading the surface of the ground upon which topsoil is to be placed and the furnishing and placing of topsoil in the areas to be seeded or planted.

SECTION 02484

TOPSOIL

3.1.2 Depth of topsoil shall be minimum 6 inches unless otherwise shown or directed.

3.1.3 After approval by the Engineer of the fine grading of the subgrade, the topsoil shall be spread and compacted with a light roller to the lines, grades and elevations shown on the drawings, or directed by the Engineer, without unsightly variations, ridges or other depressions which will hold water. Any stone, litter or objectionable material shall be removed from the topsoil and the surface raked to true lines. Any uneven spots shall be leveled. The work shall not be performed during unsuitable weather.

END OF SECTION

SPECIFICATIONS

SECTION 02485

SEEDING

PART 1 - GENERAL

1.1 DESCRIPTION:

1.1.1 Under this Section, the Contractor shall furnish all labor, materials and equipment for Seeding as shown on the Plans, as specified, and/or directed.

1.1.2 The Contractor shall seed new areas and disturbed areas where shown on the Drawings, specified or directed by the Engineer. Contractor shall prepare the seed bed by scarifying or otherwise loosening soil to a depth of 2 inches, applying fertilizer, lime, seed and mulch at the rates specified.

PART 2 - PRODUCTS

2.1 MATERIALS:

2.1.1 Fertilizer:

2.1.1.1 Commercial fertilizer (19-19-19) shall contain not less than nineteen percent nitrogen, nineteen percent available phosphoric acid and nineteen percent water soluble potash. The fertilizer shall be inorganic or a combination of inorganic and organic substances.

2.1.1.2 If, as an alternative, the Contractor wishes to substitute another fertilizer, such as 10-20-10 to 6-12-6, he may do so with the approval of the Engineer, and the rate of fertilizer to be used shall be whatever amount is required to furnish the same amount of nitrogen as would be supplied by the 19-19-19.

2.1.1.3 Commercial fertilizer shall be delivered in original bags of the manufacturer, showing weight, analysis and the name of the manufacturer.

2.1.1.4 If the commercial fertilizer is not used immediately after delivery, the Contractor shall store it in such a manner that its effectiveness will not be impaired.

SECTION 02485

SEEDING

2.2 SEED:

2.2.1 Grass seed shall be a mixture of the species and/or varieties specified, mixed in the proportions specified.

2.2.2 The seed shall be fresh, recleaned and of the latest crop year. It shall conform to Federal and State Standards. Each type of grass in the mixture shall meet or exceed the minimum percentage purity and germination listed for that type of grass.

2.2.3 The following seed mixture shall be utilized:

SPECIES	POUNDS PER ACRE
White clover (Trifolium repens)	5
Lancer perennial pea (Lathyrus latifolius)	20
Perennial ryegrass (Lolium perenne)	10
Timothy grass (Phleum pratense)	5
Orchard grass (Dactylis glomerata)	5
Smooth bromegrass (Bromus inermis)	5

2.2.4 The balance of material in an acceptable seed mixture, other than specified pure live seed shall, for the most part, consist of non-viable seed, chaff, hulls, live seeds of crop plants and harmless inert matter. The percentage of weed seed shall not exceed one percent by weight for the mixture.

2.2.5 All seed mixtures furnished under this Section shall be mixed by the vendor and shall be delivered in standard sized bags of the vendor, showing the weight, analysis and vendor's name.

PART 3 - EXECUTION

3.1 INSTALLATION:

3.1.1 Time For Seeding:

SECTION 02485

SEEDING

3.1.1.1 Grass seed shall be sown from March 15th to May 15th or from August 15th to October 1st, unless in a favorable season, and upon written permission of the Engineer, the seeding period is extended. All seeding shall be done in a dry or moderately dry soil and at times when the wind does not exceed a velocity of five miles per hour.

3.1.2 Preparation of Seed Bed:

3.1.2.1 After the finished grading is completed and just before seeding, the areas to be seeded shall be loosened to a depth of two inches and free from depressions which will hold water. All sticks, stones, clods, roots or other objectionable material which might interfere with the formation of a fine seed bed shall be removed from the soil.

3.1.2.2 Commercial fertilizer shall be evenly applied at the rate of 600 pounds per acre.

3.1.3 Seeding:

3.1.3.1 Grass seed mixture shall be sown at the rate of 200 pounds per acre.

3.1.3.2 The seed shall be sown by hand or by an approved machine, in such a manner that a uniform stand will result.

3.1.3.3 After sowing, seeded areas shall be rolled with a light lawn roller weighing not more than one hundred pounds per foot of width.

3.1.4 Mulching:

3.1.4.1 Within three days after the seed is sown, the seeded areas shall be covered with a uniform blanket of straw mulch at the rate of 1,000 pounds per acre of seeded area or as required to provide 90% coverage (i.e., lightly cover 90% of the surface).

3.1.5 Hydroseeding:

3.1.5.1 The Contractor may substitute a hydroseeding process for hand seeding and mulching as specified above.

SECTION 02485

SEEDING

3.1.5.2 Where hydroseeding is used, the Contractor shall mix water, seed fertilizer, mulch and mulch anchorage at the following rates and apply to the prepared seed bed by means of a hand-held hose. No truck mounted spraying equipment shall be driven over the areas to be seeded. Discharge shall be in an uphill direction only.

a.	Fertilizer	- 1000 lbs. per acre
b.	Seed	- 250 lbs. per acre
c.	Mulch	- Sufficient to equal 90% straw mulch coverage
d.	Mulch Anchorage	- Per Manufacturer's instructions
	Chemical	750 lbs. wood fiber/acre
	Wood Cellulose	

3.1.5.3 Where the mulch anchorage is provided ready mixed with the mulch, no additional mulch anchorage will be required.

3.1.5.4 Mulch shall be a commercial cellulose hydromulch such as "Conwed 2000", "Turf Fiber", or equal. Soil seal or mulch anchorage used shall be approved by the Engineer. An asphalt emulsion shall not be used as mulch anchorage.

3.2 MAINTENANCE AND PROTECTION:

3.2.1 The Contractor shall maintain and protect all seeded areas until final acceptance of the Seeding portion of the Contract.

3.2.2 Final acceptance will not be made until an acceptable uniform stand of grass is obtained in all newly seeded areas except that the Engineer at his discretion may accept a portion or portions of the work at various times.

3.2.3 Upon final acceptance of a seeded area by the Engineer, the Owner will assume responsibility for maintenance and protection of that area.

SECTION 02485

SEEDING

3.2.4 Any portions of seeded areas which are unacceptable, and which fail to show a uniform stand of grass from any cause, shall be reseeded as before except the fertilizer shall be applied at one-half the original rate. The seeding shall be repeated until the seeded areas are satisfactorily covered with grass.

END OF SECTION

SPECIFICATIONS

SECTION 02595

POLYVINYL CHLORIDE (PVC) LINING MATERIAL

PART 1 - GENERAL

1.1 DESCRIPTION:

1.1.1 Under this Section, the Contractor shall furnish all labor, materials and equipment for Polyvinyl Chloride (PVC) Lining Material as shown on the Plans, as specified, and/or directed.

1.1.2 The Contractor shall furnish and install 40 mil Polyvinyl Chloride (PVC) Lining Material as landfill cap geomembrane or as otherwise shown on the Contract Drawings.

1.2 SHEET QUALITY:

1.2.1 The Contractor shall submit to the Engineer the following information regarding sheet quality and properties.

1.2.1.1 A material properties sheet including, at a minimum, all specified properties, measured using test methods indicated in the Specifications, or equivalent.

1.2.1.2 A list and description of materials other than the base polymer which comprise the geomembrane.

1.2.1.3 A written certification that property values given in the properties sheet are guaranteed by the Geomembrane Manufacturer.

1.2.1.4 Certification that the sheeting shall contain no deep gas checks, surface divots, blisters, pinholes, windows and shall not exhibit cold flow. In addition, it shall be uniform in color, size and thickness.

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1.3 ROLL QUALITY:

1.3.1 Quality Control Certification:

1.3.1.1 Prior to shipment, the Contractor will provide the Engineer 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, such as the Production Manager. The Quality Control Certificate will include:

a. Roll numbers and identification.

b. Documentation certifying the geomembrane was continuously inspected for uniformity, damage, imperfections, holes, cracks, thin spots and foreign materials.

c. Sampling results of quality control tests; as a minimum, results will be given for thickness, tensile strength, tear resistance and seam strength evaluated in accordance with the methods indicated in the specifications or equivalent methods approved by the Engineer.

d. Documentation certifying non-destructive seam testing was performed on all fabricated seams over their full length using a test method acceptable to the Engineer.

1.4 DELIVERY, HANDLING AND STORAGE:

1.4.1 The Contractor will be liable for all damages to the materials incurred prior to and during transportation to the site.

1.4.2 Handling, storage and care of the geomembrane materials prior to and following installation at the site, is the responsibility of the Contractor.

1.5 CONFORMANCE TESTING:

1.5.1 Upon delivery of the geomembrane, the Contractor shall provide the necessary labor, tools and equipment to obtain samples to be sent to the quality assurance laboratory for testing at the Contractor's expense to ensure conformance to both the design specifications and the list of guaranteed properties.

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1.5.2 As a minimum, tests to determine the following characteristics will be performed on geomembranes:

a. specific gravity, ASTM D792A

b. thickness, ASTM D5199

c. tensile properties, ASTM D882

d. volatility loss, ASTM D1203A

1.5.3 Unless otherwise specified, samples will be 1.5 feet long by 20 feet of the panel width. The Engineer will mark the machine direction on the samples with an arrow.

1.5.4 Unless otherwise specified, geomembrane samples will be taken at a maximum rate of one per 25,000 square feet.

1.6 PRE-QUALIFICATIONS:

1.6.1 Geomembrane Manufacturer:

1.6.1.1 The Contractor shall submit to the Owner and the Engineer for approval the following qualification information regarding the Geomembrane Manufacturer:

a. Corporate background and information.

b. Manufacturing capabilities including:

- daily production quantity available for this Contract
- quality control procedures for manufacturing
- list of material properties including certified test results, to which geomembrane samples are attached.

c. A list of at least ten completed facilities, totaling a minimum of 10,000,000 square feet, for which the Manufacturer has manufactured a geomembrane of the type specified. For each facility, the following information will be provided:

- name and purpose of facility, its location and date of installation
- name of Owner, Project Manager, Designer, Fabricator (if any), and Installer
- thickness of geomembrane, surface area of geomembrane manufactured
- available information on the performance of the lining system and the facility.

d. Origin (resin supplier's name, resin production plan) and identification (brand name, number) of the resin.

1.6.2 Geomembrane Fabricator (if required):

1.6.2.1 The Contractor shall submit to the Engineer for approval the following written information in regards to the Geomembrane Fabricator (if required).

a. Copy of Geomembrane Manufacturer's letter of approval of license.

b. Corporate background and information.

c. Fabrication Capabilities:

- daily fabrication quantity available for this Contract
- quality control procedure
- samples of fabricated seams and a certified list of minimum values of seam properties and employed test methods.

d. A list of at least ten completed facilities for which the Fabricator has fabricated liner factory panels of the type of geomembrane to be used in this project, totaling a minimum of 10,000,000 square feet, the following information will be provided for each fabrication:

- name and purpose of facility, its location, and date of installation
- name of Owner, Project Manager, Designer, Manufacturer, Installer, and the name of the contact at the site who can discuss the project
- thickness of liner and surface area of liner fabricated
- type of seaming and type of seaming apparatus used
- available information on the performance of the lining system and the facility.

1.6.3 Installer:

1.6.3.1 The Installer must be trained and qualified to install geomembrane and must be approved and/or licensed by the Geomembrane Manufacturer and/or Fabricator.

1.6.3.2 The Contractor shall submit to the Engineer for approval the following written information, relative to the Installer.

a. Copy of Installer's letter of approval or license by the Manufacturer and/or Fabricator.

b. Corporate background and information.

c. Description of installation capabilities, including:

- information on equipment and personnel
- average daily production anticipated
- quality control procedures.

d. A list of at least ten completed facilities, totaling a minimum of 3,000,000 square feet for which the Installer has installed geomembrane of the type for this project. For each installation, the following information will be provided:

- name and purpose of facility, its location and date of installation
- name of Owner, Designer, Manufacturer, Fabricator (if any), and name of contact at the facility who can discuss the project
- name and qualifications of the supervisor(s) of the Installer's crew(s)
- thickness of geomembrane and surface area of the installed liner

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- type of seaming and type of seaming apparatus used
- duration of installation
- available information on the performance of the lining system and the facility.

e. Resume of the "master seamer" to be assigned to this project, including dates and duration of employment.

f. Resume of the field engineer or installation supervisor to be assigned to this project, including dates and duration of employment.

1.6.3.3 All personnel performing seaming operations will be qualified by experience or by successfully passing seaming tests. The field crew foreman must have experience seaming a minimum of 3,000,000 square feet of geomembrane of the type for this project, using the same type of seaming apparatus in use at the site.

1.7 SHOP DRAWING SUBMITTALS: The Contractor shall submit detailed shop drawings of all prefabricated PVC fabrications for review prior to installation. Shop drawings shall contain all necessary panel layouts, details, dimensions, etc., sufficient to assure that fabrication shall meet the intended use and will conform to the geometry of its intended application.

1.8 WARRANTY:

1.8.1 The Contractor shall obtain and submit to the Engineer from the Manufacturer and Installer separate written warranties guaranteeing for a 20 year and 2 year period (respectively) from the date of issuance of the Certificate of Substantial Completion that the liner materials and workmanship specifically provided or performed under this Contract shall be free from defects. Said warranty shall apply to normal use and service by the Owner as described in Contract Specifications and as shown on the Contract Drawings. It shall specifically exclude mechanical abuse or puncture by machinery, equipment, or people, exposure of the liner to harmful chemicals or catastrophe due to earthquake, flood or tornado. Such written warranty shall provide for the repair or replacement of the defect or defective area of lining materials upon written notification and demonstration by the Owner of the specific nonconformance of the lining material or installation with the project Specifications. Such defects or nonconformance shall be repaired or replaced within a reasonable period of time of such notification. The Owner agrees to pay an amount equal to the then current sales and installation price of the defective portion of the lining material multiplied by a fraction, the numerator of which shall be the

number of years elapsed since the commencement of the warranty period and the denominator of which shall be the warranty period, provided that portion of the area in question has been made available to the Manufacturer/Installer and that such areas have been cleared of all liquids, sludges, earth, sand or gravel.

PART 2 - PRODUCTS

2.1 RAW MATERIALS:

2.1.1 Prior to installation of any geomembrane material, the Contractor shall submit to the Engineer the following information regarding resin quality.

2.1.1.1 A copy of the Quality Control Certificates issued by the Resin supplier.

2.1.1.2 Reports on the tests conducted by the Manufacturer to verify the quality of the resin used to manufacture the geomembrane rolls assigned to the considered facility.

2.1.1.3 A statement of origin and identification of raw materials used.

2.1.1.4 Documentation demonstrating the chemical compatibility of the materials.

2.2 PVC GEOMEMBRANE MINIMUM SPECIFICATIONS:

2.2.1 PVC liner material shall have a matted finish on at least one side. Matted side of PVC panel to be installed on top.

2.2.2 PVC liner material shall meet the minimum specification values listed below.

Property	Specification Limit	Test Method
Raw Material	(All domestic and Virgin Polyvinyl Chloride)	
Thickness (mils)	40 (± 5%)	ASTM D5199
Specific Gravity	1.23-1.30	ASTM D792

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Property	Specification Limit	Test Method
Cold Crack	Pass	ASTM D1790
Tensile Properties		
- Tensile Strength at Break (lb/in)	90 min.	ASTM D882
- Modulus at 100% Elongation (lb/in)	36 min.	ASTM D882
- Elongation (%) at Break	300%	ASTM D882
Tear Resistance (lbs/in)	10 min.	ASTM D1004
Water Extraction (%)	0.35 (max.)	ASTM D3080
Volatility (% Loss)	0.60 (max.)	ASTM D1203
Resistance to Soil Burial % change, max.:		ASTM D3083
Tensile Strength	±5	
Elongation at Break	±20	
Modulus at 100% Elongation	±20	
Hydrostatic Resistance (psi)	82 (min.)	ASTM D751
Factory Seam Requirements*		
Bonded Seam Strength (factory seam, breaking factor lbs/inch width)	74	ASTM D3083

*Factory bonded seam strength is the responsibility of the fabricator.

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2.3 LABELING GEOMEMBRANE ROLLS OR PANELS:

2.3.1 Labels on each roll or factory panel will identify:

a. The thickness of the material

b. The length and width of the roll or factory panel

c. The Manufacturer

d. Directions to unroll the material

e. Product identification

f. Lot number

g. Roll or field panel number

PART 3 - EXECUTION

3.1 GEOMEMBRANE INSTALLATION:

3.1.1 Related Earthwork:

3.1.1.1 Geomembrane liners will be installed on a firm, smooth, soil surface. The final soil surface will be relatively free from stones greater than 1", clumps, sticks or any other material that may puncture the membrane. Special care should be taken to maintain the prepared soil surface. No geomembrane will be placed onto an area which has become softened by precipitation. The Contractor shall certify in writing that the final soil surface on which the membranes are to be installed is acceptable.

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3.2 GEOMEMBRANE DEPLOYMENT:

3.2.1 Placement of the geomembrane panels will be according to the approved location and position plan provided by the Installer. Placement will follow all instructions on the boxes or wrapping containing the geomembrane materials which describe the proper methods of unrolling, and/or unfolding rolls and panels. The field panel installation schedule is left to the preference of the Contractor, but the method chosen must minimize erosion of the underlying soil liner and the potential for wind damage.

3.2.2 The method of placement must ensure that:

3.2.2.1 No equipment used will damage the geomembrane by handling, trafficking, leakage of hydrocarbons, or other means.

3.2.2.2 No personnel working on the geomembrane will smoke, wear damaging shoes, or engage in other activities which could damage the geomembrane.

3.2.2.3 The prepared surface underlying the geomembrane must not be allowed to deteriorate after acceptance and must remain acceptable up to the time of geomembrane placement.

3.2.2.4 Adequate temporary loading and/or anchoring (e.g., sand bags, tires), not likely to damage the geomembrane, will be placed to prevent uplift by wind (in case of high winds, continuous loading is recommended along edges of panels to minimize risk of wind flow under the panels).

3.2.2.5 Direct contact with the geomembrane will be minimized; i.e., the geomembrane in excessively high traffic areas will be protected by geotextiles, extra geomembrane, or other suitable materials.

3.2.3 Any damage to the geomembrane panels or portions of the panels as a result of placement must be replaced or repaired at no cost to the Owner. The decision to replace or repair any panel or portions of panels will be made by the Engineer.

3.2.4 The Engineer will assign an "identification number" to each geomembrane panel placed. This number will be consistent with the number used by the Installer. The number system used will be simple, logical and identify the relative location in the field.

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3.3 SEAMING DURING INSTALLATION:

3.3.1 At liner penetrations and corners the number of seams will be minimized.

3.3.2 The area of the geomembrane to be seamed shall be cleaned and prepared according to the procedures specified by the material manufacturer. Care will be taken to eliminate or minimize the number of wrinkles and "fishmouths" resulting from seam orientation.

3.3.3 Seaming will not proceed in extreme heat (above 105°F) or extreme cold (below 32°F) conditions. The specified temperature range is for ambient air. In addition, seaming will not be conducted when geomembrane material is wet from precipitation, dew, fog, etc., or during periods when winds are in excess of 20 mph.

3.3.4 Seams will have an overlap beyond the weld large enough to perform destructive peel tests, but not exceed 5 inches. Any material used to temporarily bond adjacent geomembrane panels must not damage or leave the geomembrane altered in any manner.

3.3.5 Trial seams will be made of excess geomembrane material. A 1-foot by 3-foot seamed liner sample will be fabricated with the seam running down the 3-foot length in the center of the sample. Such trial seaming will be conducted prior to the start of each seaming succession (i.e. at the start of each morning and afternoon session). From each trial seam, two sample field test specimens will be taken. The test specimens will be 1-inch by 12-inch strips cut perpendicular to the trial seam. Pass and fail criteria will be based on an approved curing chart submitted by the Contractor to the Engineer. Upon initial failure, a second trial seam will be made; if both test specimens do not pass, then the seaming method will be reviewed and seamer will not perform any seaming operations until the deficiencies are corrected and two successive passing trial seam test specimens are produced. Completed trial seam samples cannot be used as portions of a second sample and must be discarded.

3.3.6 The Contractor shall use a prefabricated PVC boot for all liner penetrations by pipes.

3.3.7 Acceptable seaming method for PVC is lap jointing with an approved cold applied solvent or hot wedge welding (single or double wedge). Lap joints shall be formed by lapping 6 inch minimum of the PVC material. Actual welded surface will be a minimum of 4 inches.

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3.4 SEAM TESTING:

3.4.1 Nondestructive Testing:

3.4.1.1 The Contractor shall perform nondestructive seam testing on 100 percent of all field seams (including patches and boots) under the direct supervision of the Engineer. The Contractor shall test seams as directed in Paragraph 3.4.1.2 or 3.4.1.3.

3.4.1.2 Air Channel Test: The air channel test shall be used on all seams constructed using a double hot wedge welder (except for double wedge seams welded transversely across factory fabricated panels). The following procedures will be followed:

a. Determine the area to be tested, and seal off two ends of the continuous air channel.

b. Insert an air pressure needle into the air channel by penetrating the upper geomembrane.

c. Connect a pressure gage to the needle.

d. Connect an air pump to the pressure gage. The air pump should be capable of generating and sustaining an air pressure of 50 psi.

e. Inflate the air channel to a pressure of between 20 and 30 psi, and disconnect the air pump.

f. Sustain the inflated pressure for 2 minutes, and observe any pressure drop. If more than a 4 psi pressure loss occurs, the tested seam will be subject to repair.

g. testing is to be conducted under the direct observation of the Engineer

3.4.1.3 Air Lance Testing: Air lance testing will be used on all seams not air-channel tested (including patches and boots). The procedure for this method is outlined below:

a. a testing device capable of producing a jet of air at approximately 50 psi through a 3/16-inch diameter orifice will be used as the lance

b. place the lance beneath the overlap

c. move the lance slowly along the solvent bond seam

d. observe the seam for localized fluttering or inflation

e. mark the seam for repair where fluttering or inflation occurs

f. testing is to be conducted under the direct observation of the Engineer

3.4.2 Destructive Testing:

3.4.2.1 In addition to non-destructive seam testing, destructive testing will also be conducted. Test samples will be taken every 500 feet of seam length or more frequently at the discretion of the Engineer. Sample location and size will also be selected by the Engineer. The sample size (12x44 inches) will be large enough to produce three sets of test specimens for the following tests:

a. seam shear strength (ASTM D4437)

b. peel adhesion (ASTM D4437)

3.4.2.2 Ten specimens will compose a set. Half of these will be tested for peel and the other half for shear strength. Each specimen will be 1 inch wide and 12 inches long with the field seam at the center of the specimen. The 44-inch sample length will first be cut at the ends to produce two field peel test specimens. The remaining 42 inches will be divided into thirds and submitted to the Installer for laboratory testing, an independent testing laboratory and the Owner for storage and future reference. The independent laboratory testing shall be performed at the Contractor's expense.

3.4.2.3 Test specimens will be considered passing if the minimum values below are met or exceeded for four of the five test specimens tested by the independent laboratory. All acceptable seams will lie between two locations where samples have passed.

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Field Seam Properties	Specification Limit PVC	Test Method
Thickness (mils)	40	ASTM D5199
Shear Strength at Yield (lb/in width)	74 (80% of Roll Strength)	ASTM D4437
Peel Adhesion	10 lbs/in width or FTB*	ASTM D4437

*FTB = Film tearing bond.

3.4.2.4 If a sample fails destructive testing, the Installer must ensure that: the seam is reconstructed between the location of the sample which failed and the location of the next acceptable sample; or the bonding path is retraced to an intermediate location at least ten feet from the location of the sample which
failed the test, and a second sample is cut from the liner for additional testing. If this second test sample passes, the seam must be then reconstructed between the location of the second test and the original sampled location. If the second sample fails, the process must be repeated.

3.4.2.5 All holes created by the Installer cutting out destructive samples will be patched immediately with an oval patch of the same material bonded to the membrane using solvent-cement (PVC). All solvent-cement seams will cure for a minimum of 24 hours prior to destructive testing. The patch seams will be tested using an air lance and the procedures described above. Work will not proceed with materials covering the geomembrane until passing results of destructive testing have been achieved.

3.5 LINER REPAIR:

3.5.1 All imperfections, flaws, construction damage, destructive and nondestructive seam failures will be repaired by the Contractor at no additional expense to the Owner. The appropriate methods of repair are listed below:

a. patching, used to repair holes, tears, undispersed raw materials and contamination by foreign matter

b. capping, used to repair pinholes or other minor flaws

c. topping, used to repair areas of large length of failed seams or of inadequate seams, which have an exposed edge

d. removing bad seam and replacing with a strip of new material solvent welded into place.

3.5.2 The actual method used will be agreed upon by the Engineer, Installer and Contractor. All defects that are patched will have the patch overlap the edge of the defect by a minimum of 6 inches. The patch will be cut with rounded edges (no corners). In the case of a large patch, the underlying geomembrane will be cut appropriately to avoid trapping gases and moisture between the two sheets.

3.5.3 During repair, the Engineer must be present and observe the procedures as well as all nondestructive testing of the repair seams. If the repair is very large, destructive testing may be required at the discretion of the Engineer. Any failure of repaired seams will require that the patch be removed, replaced and retested until passing results are achieved.

3.6 CONSTRUCTION MATERIAL PLACEMENT:

3.6.1 All granular materials placed above geomembrane shall be spread with a minimum initial lift thickness of 12 inches using tracked equipment with ground pressures not exceeding 7 pounds per square inch. No construction equipment will be driven directly on the geomembrane. All rubber-tired vehicles will access construction above geomembranes from temporary access roads built a minimum of 3 feet above the liner. Extra geotextile or geomembrane layers shall be placed on or beneath all access roads or high trafficked areas. Any placement operation which results in damage to the underlying geomembrane, or in the opinion of the Engineer, has the potential of damaging the underlying geomembrane, shall immediately cease and be modified to prevent such damage.

3.6.2 Placement of overlying cover soil shall be performed in a systematic manner in accordance with this Section and Section 02225. Cover soil must be placed using vertical placement techniques. No horizontal pushing of the initial soil lift above the geomembrane will be allowed.

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3.7 POST-CONSTRUCTION:

3.7.1 The Installer of the geomembrane materials will prepare and the Contractor shall submit, to the Engineer, record drawings illustrating the following information:

a. dimensions of all geomembrane field panels

b. panel locations referenced to the Contract Drawing plans

c. identify all field seams and panels with the appropriate number or code

d. location of all patches, repairs and destructive testing samples

e. warranties

END OF SECTION

SPECIFICATIONS

SECTION 02598

LINEAR LOW DENSITY POLYETHYLENE (LLDPE) LINING MATERIAL

PART 1 - GENERAL

1.1 DESCRIPTION:

1.1.1 Under this Section, the Contractor shall furnish all labor, materials and equipment for Linear Low Density Polyethylene (LLDPE) Lining Material as shown on the Plans, as specified and/or directed.

1.1.2 The lining material will be used as the barrier layer of the capping system.

1.1.3 The lining material will be textured on both sides for all applications.

1.2 PRE-QUALIFICATIONS:

1.2.1 Geomembrane Manufacturer:

1.2.1.1 The Contractor shall submit to the Owner and the Engineer for approval the following qualification information regarding the Geomembrane Manufacturer:

a. Corporate background and information.

b. Manufacturing capabilities including:

- daily production quantity available for this Contract
- quality control procedures for manufacturing
- list of material properties including certified test results, to which geomembrane samples are attached.

c. A list of at least ten completed facilities, totaling a minimum of 10,000,000 square feet, for which the Manufacturer has manufactured a geomembrane. For each facility, the following information will be provided:

- name and purpose of facility, its location and date of installation
- name of Owner, Project Manager, Designer, Fabricator (if any), and Installer
- thickness of geomembrane, surface area of geomembrane manufactured
- available information on the performance of the lining system and the facility.

d. Origin (resin supplier's name, resin production plan) and identification (brand name, number) of the resin.

1.2.2 Geomembrane Fabricator (if required):

1.2.2.1 The Contractor shall submit to the Engineer for approval the following written information in regards to the Geomembrane Fabricator (if required).

a. Copy of Geomembrane Manufacturer's letter of approval of license.

b. Corporate background and information.

c. Fabrication Capabilities:

- daily fabrication quantity available for this Contract
- quality control procedure
- samples of fabricated seams and a certified list of minimum values of seam properties and employed test methods.

d. A list of at least ten completed facilities for which the Fabricator has fabricated liner factory panels of the type of geomembrane to be used in this project, totaling a minimum of 3,000,000 square feet, the following information will be provided for each fabrication:

- name and purpose of facility, its location, and date of installation
- name of Owner, Project Manager, Designer, Manufacturer, Installer, and the name of the contact at the site who can discuss the project
- thickness of liner and surface area of liner fabricated
- type of seaming and type of seaming apparatus used
- available information on the performance of the lining system and the facility.

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1.2.3 Installer:

1.2.3.1 The Installer must be trained and qualified to install geomembrane and must be approved and/or licensed by the Geomembrane Manufacturer and/or Fabricator.

1.2.3.2 The Contractor shall submit to the Engineer for approval the following written information, relative to the Installer.

a. Copy of Installer's letter of approval or license by the Manufacturer and/or Fabricator.

b. Corporate background and information.

c. Description of installation capabilities, including:

- information on equipment and personnel
- average daily production anticipated
- quality control procedures.

d. A list of at least ten completed facilities, totaling a minimum of 3,000,000 square feet for which the Installer has installed geomembrane of the type for this project. For each installation, the following information will be provided:

- name and purpose of facility, its location and date of installation
- name of Owner, Designer, Manufacturer, Fabricator (if any), and name of contact at the facility who can discuss the project
- name and qualifications of the supervisor(s) of the Installer's crew(s)
- thickness of geomembrane and surface area of the installed liner
- type of seaming and type of seaming apparatus used
- duration of installation
- available information on the performance of the lining system and the facility.

e. Resume of the "master seamer" to be assigned to this project, including dates and duration of employment.

f. Resume of the field engineer or installation supervisor to be assigned to this project, including dates and duration of employment.

1.2.3.3 All personnel performing seaming operations will be qualified by experience or by successfully passing seaming tests. At least one seamer will have experience seaming a minimum of 3,000,000 square feet of geomembrane of the type for this project, using the same type of seaming apparatus in use at the site.

1.2.4 Sheet Quality:

1.2.4.1 The Contractor shall submit to the Engineer the following information regarding sheet quality and properties.

a. A material properties sheet including, at a minimum, all specified properties, measured using test methods indicated in the specifications, or equivalent.

b. Complete stress rupture curve (Geosynthetic Research Institute, GM5) for test specimen.

c. A list and description of materials other than the base polymer which comprise the geomembrane.

d. A written certification that property values given in the properties sheet are guaranteed by the Geomembrane Manufacturer.

1.2.5 Roll Quality:

1.2.5.1 Prior to shipment, the Contractor will provide the Engineer 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, such as the Production Manager. The Quality Control Certificate will include:

a. Roll numbers and identification.

b. Documentation certifying the geomembrane was continuously inspected for uniformity, damage, imperfections, holes, cracks, thin spots, foreign materials, tears, punctures and blisters.

c. Sampling results of quality control tests; as a minimum, results will be given for thickness, tensile strength, tear resistance and seam strength evaluated in accordance with the methods indicated in the specifications or equivalent methods approved by the Engineer.

d. Documentation certifying non-destructive seam testing was performed on all fabricated seams over their full length using a test method acceptable to the Engineer.

1.2.6 Prior to delivery of material, the Contractor shall submit a sample of the warranty to be provided as described in paragraph 3.2.3.

1.3 DELIVERY, HANDLING AND STORAGE:

1.3.1 The Contractor will be liable for all damages to the materials incurred prior to and during transportation to the site.

1.3.2 Handling, storage and care of the geosynthetic materials prior to and following installation at the site, is the responsibility of the Contractor. The Contractor will be liable for all damages to the materials incurred prior to final acceptance of the lining system by the Owner.

1.3.3 The Contractor shall notify the Owner of the anticipated delivery time.

1.4 CONFORMANCE TESTING:

1.4.1 Within one week of delivery of the geomembrane, and at the Engineer's direction, the Contractor shall provide the necessary labor, tools and equipment to obtain samples of the geomembrane at the specified frequency for forwarding to the approved testing laboratory for testing at the Contractor's expense to ensure conformance to both the design specifications and the list of guaranteed properties.

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1.4.2 As a minimum, tests to determine the following characteristics will be performed on geomembranes:

a. density, ASTM D792/D1505

b. carbon black content, ASTM D 603

c. carbon black dispersion, ASTM D3015

d. thickness, ASTM D1593

e. tensile properties, ASTM D638

1.4.3 Geomembrane samples will be taken across the entire width of the roll. Unless otherwise specified, samples will be 2.0 feet long by the roll width. The Engineer will mark the machine direction on the samples with an arrow.

1.4.4 Unless otherwise specified, geomembrane samples will be taken at a maximum rate of one per 100,000 square feet.

1.4.5 For each lot number of geomembrane material that arrives at the site, a sample shall be taken by the Contractor and provided to the Owner for archiving. This sample shall be 3.0 feet long by the width of the roll.

1.4.6 Any samples which fail the conformance testing will require the failed material to be removed from site and replaced with new material at the Contractor's expense.

1.5 WARRANTY:

1.5.1 The Contractor shall submit a draft copy of the warranty to be provided upon completion of the project. The warranty shall meet the requirements of Article 3.2.3 of this Specification.

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LINEAR LOW DENSITY POLYETHYLENE (LLDPE) LINING MATERIAL

1.6 ADDITIONAL SUBMITTALS:

1.6.1 The Contractor shall submit detailed shop drawings. Shop drawings shall contain all necessary panel layouts, details, dimensions, penetration fabrications, etc., sufficient to assure that fabrication shall meet the intended use and will conform to the geometry of its intended application.

PART 2 - PRODUCTS

2.1 MATERIALS:

2.1.1 Raw Materials:

2.1.1.1 Prior to installation of any geomembrane material, the Contractor shall submit to the Engineer the following information regarding resin quality.

a. A copy of the Quality Control Certificates issued by the Resin supplier.

b. Reports on the tests conducted by the Manufacturer to verify the quality of the resin used to manufacture the geomembrane rolls assigned to the considered facility. These tests should include for resins, specific gravity (ASTM D792 Method A), melt flow index (ASTM D1238 Condition E), percent carbon black (ASTM D1603) and percent carbon dispersion (ASTM D3015).

c. A statement of origin and identification of raw materials used.

d. Documentation demonstrating the chemical compatibility of the materials to withstand leachate generated by municipal solid waste.

2.1.2 LLDPE Geomembrane Minimum Specifications:

SECTION 02598

LINEAR LOW DENSITY POLYETHYLENE (LLDPE) LINING MATERIAL

2.1.2.1 LLDPE liner material shall meet the minimum Specification values listed below.

LLDPE Geomembrane Resin:

Property	Specification Limit	Test Method
Specific Gravity (min.)	0.915	ASTM D1505
Melt Flow Index	0.1-1.1 g/10	ASTM D1238 Condition E
Carbon Black Content	2-3%	ASTM D1603
Carbon Dispersion	A1 or A2 Rating	ASTM D3015

LLDPE Geomembrane Rolls:

Property	Specification Limit	Test Method
Mechanical		
Thickness	40 mil	ASTM D1593
Specific Gravity (min.)	0.915	ASTM D1505
Tensile Properties		ASTM D638
Tensile Strength at Break (min.)	80 lbs./in.	
Tensile Strength at Yield (min.)	58 lbs./in.	

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Property	Specification Limit	Test Method
Elongation at Break (min.)	350%	
Elongation at Yield (min.)	13%	
Modulus of Elasticity (min.)	45,000 psi	ASTM D638
Tear Resistance (min.)	23 lbs.	ASTM D1004
Puncture Resistance (min.)	48 lbs.	FTMS 101C Method 2065
Environmental		
Water Vapor Transmission Rate	$\leq$ 0.03 gm/m^2-day	ASTM E96
Low Temperature Brittleness (max.)	-70° C	ASTM D746
Water Absorption (max. % wt. change)	0.1%	ASTM D570
Volatile Loss (max.)	0.1%	ASTM D1203
Dimensional Stability (each direction, % change max.)	+/-1%	ASTM D1204

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LINEAR LOW DENSITY POLYETHYLENE (LLDPE) LINING MATERIAL

2.1.3 Labeling Geomembrane Rolls:

2.1.3.1 Labels on each roll or factory panel will identify:

- The thickness of the material.
- The length and width of the roll or factory panel.
- The Manufacturer.
- Directions to unroll the material.
- Product identification.
- Lot number.
- Roll or field panel number.

PART 3 - EXECUTION

3.1 GEOMEMBRANE INSTALLATION:

3.1.1 Related Earthwork:

3.1.1.1 The Contractor shall insure that all related earthwork requirements under this Section are complied with:

a. Geomembrane liners will be installed as shown on the construction drawings. The geomembrane installations will be performed on a firm, smooth, soil or geosynthetic constructed according with the Specifications. The final surface will be free from stones, clumps, sticks or any other material that may puncture the membrane. Installation of the geomembrane on loose or gravelly soils is prohibited.

b. No geomembrane will be placed onto an area which has become softened by precipitation or which has cracked due to desiccation. Appropriate methods of moisture control are the responsibility of the Contractor.

c. The Geomembrane Installer shall certify in writing that the final soil material or geosynthetic surface on which the membranes are to be installed are acceptable.

d. Free edges of LLDPE liner shall be secured in such a manner as to prevent uplift by wind or the intrusion of water under the liner. Edge protection shall include sandbags, polyethylene sheeting or other methods as deemed necessary by the Contractor and approved by the Engineer. Any damage to underlying soil material or geosynthetic shall be repaired at the Contractor's expense.

e. The LLDPE membrane will be temporarily anchored within an anchor trench constructed to the dimensions shown in the Contract Drawings. Care will be taken while backfilling the trenches to prevent damage to the geomembrane.

3.1.2 Geomembrane Deployment:

3.1.2.1 LLDPE membrane will be deployed according to the following procedures:

a. Placement of the geomembrane panels will be according to the approved location and position plan provided by the Installer. Placement will follow all instructions on the boxes or wrapping containing the geomembrane materials which describe the proper methods of unrolling panels. The field panel installation schedule is left to the preference of the Contractor, but the method chosen must minimize erosion of the underlying soil material and the potential for wind damage.

b. The method of placement must ensure that:

- Deployed geomembrane must be visually inspected for uniformity, tears, punctures, blisters or other damage or imperfections. Any such imperfections shall be immediately repaired and reinspected.

- No equipment used will damage the geomembrane by handling, trafficking, leakage of hydrocarbons, or other means. Equipment or ATVs, will not be allowed to travel directly on the geomembrane during the installation of overlying soils or geosynthetic layers unless otherwise determined by the Engineer.

- No personnel working on the geomembrane will smoke, wear damaging shoes, or engage in other activities which could damage the geomembrane.

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- The prepared surface underlying the geomembrane must not be allowed to deteriorate after acceptance and must remain acceptable up to the time of geomembrane placement and until completion of the project.

- Adequate temporary loading and/or anchoring (e.g., sand bags, tires), not likely to damage the geomembrane, will be placed to prevent uplift by wind (in case of high winds, continuous loading is recommended along edges of panels to minimize risk of wind flow under the panels).

- Direct contact with the geomembrane will be minimized; i.e., the geomembrane in excessively high traffic areas will be protected by geotextiles, extra geomembrane, or other suitable materials.

c. Any damage to the geomembrane panels or portions of the panels as a result of placement must be replaced or repaired at no cost to the Owner. The decision to replace or repair any panel or portions of panels will be made by the Engineer.

d. The Engineer will assign an "identification number" to each geomembrane panel placed. This number will be consistent with the number used by the Installer. The number system used will be simple, logical and identify the relative location in the field.

e. When deploying a textured LLDPE geomembrane over a GCL or geocomposite, a temporary slip sheet will be used to minimize friction and to allow the textured geomembrane to be more easily moved into its final position. To prevent premature hydration, only the amount of GCL that can be inspected, repaired, and covered in the same day shall be installed.

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LINEAR LOW DENSITY POLYETHYLENE (LLDPE) LINING MATERIAL

3.1.3 Seaming:

3.1.3.1 The seaming procedures below shall be implemented, where applicable, during installation of the geomembrane. The seaming procedures are as follows:

a. Generally, all seams whether field or factory will be orientated parallel to the line of slope, not across slope. This specification applies to all slopes in excess of 10 percent grade. All horizontal seams will be a minimum of 5 feet from the toe of the side slopes. At liner penetrations and corners the number of seams will be minimized.

b. The area of the geomembrane to be seamed shall be cleaned and prepared according to the procedures specified by the material manufacturer. Any abrading of the geomembrane will not extend more than one-half inch on either side of the weld. Care will be taken to eliminate or minimize the number of wrinkles and "fishmouths" resulting from seam orientation.

c. Field seaming is prohibited when either the air or sheet temperature is below 32°F or when the sheet temperature exceeds 158°F or when the air temperature is above 104°F. At air or sheet temperatures between 32°F and 40°F seaming shall be conducted directly behind a preheating device. In addition, seaming shall not be conducted when geomembrane material is wet from precipitation, dew, fog, etc., or when winds are in excess of 20 miles per hour.

d. Seaming shall not be performed on frozen or excessively wet underlying soil surfaces.

e. Seams will have an overlap beyond the weld large enough to perform destructive peel tests, but not exceed 5 inches. Any material used to temporarily bond adjacent geomembrane panels must not damage or leave the geomembrane altered in any manner.

f. The Contractor shall perform trial seams on excess geomembrane material. A 1 foot by 3 foot seamed liner sample will be fabricated with the seam running down the 3 foot length in the center of the sample. Such trial seaming will be conducted prior to the start of each seaming succession for each seaming crew, change in machine or every 4 hours, after any significant change in weather conditions or geomembrane temperature, or after any change in seaming equipment. From each trial seam, two

field test specimens will be taken. The test specimens will be 1-inch by 12-inch strips cut perpendicular to the trial seam. These specimens will be peel tested using a field tensiometer, and recorded as pass (failure of liner material) or fail (failure ofseam). Upon initial failure, a second trial seam will be made; if both test specimens do not pass, then the seaming device and its operator will not perform any seaming operations until the deficiencies are corrected and two successive passing trial seam test specimens are produced. Completed trial seam samples cannot be used as portions of a second sample and must be discarded.

g. Seams will be continuous through the anchor trench. No fishmouths shall be allowed within the seam area. Where fishmouths occur, the material shall be cut, overlapped and an overlap weld shall be applied. Where necessary, patching using the same liner material will be welded to the geomembrane sheet.

h. Where seams cannot be nondestructively tested in accordance with Section 3.1.4.1 of this Specification due to the geometry of the completed seams, a single layer of geomembrane shall be cap seamed over the subject seam and nondestructively tested if practical.

i. Acceptable seaming methods for LLDPE geomembrane are:

- extrusion welding using extrudate with identical physical, chemical and environment properties
- hot wedge welding using a proven fusion welder and master seamer.

j. Seaming device shall not have any sharp edges which might damage the geomembrane liner. Where self-propelled seaming devices are used, it will be necessary to prevent "bulldozing" of the device into the underlying soil or geosynthetic material.

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LINEAR LOW DENSITY POLYETHYLENE (LLDPE) LINING MATERIAL

3.1.4 Seam Testing:

3.1.4.1 The Contractor shall perform nondestructive seam testing on 100 percent of all field seams. The following test method and procedures may be used:

a. Vacuum testing will be used on all seams not tested using air pressure testing. Using an approved vacuum box, the following procedures will be followed:

- apply a soapy water mixture over the seam
- place vacuum box over soapy seam and form a tight seal
- create a vacuum by reducing the vacuum box pressure to 5 psi (35 KPa)
- observe through the vacuum box window any bubbles
- where bubbles are observed, mark seam for repair
- move vacuum box further down seam overlapping tested seam by 3 inches
- where hot wedge seaming has been performed, the overlap must be cut back to the weld
- all vacuum testing will be conducted under the direct observation of the Engineer.

b. Air pressure testing may be used in place of the vacuum box if double track hot wedge welding has been utilized to seam LLDPE geomembrane. Using approved pressure testing equipment, the following procedures will be followed:

- seal one end of the air channel separating the double hot wedge welds
- insert pressure needle into air channel at this end
- seal open end of channel, and pressurize the air channel to 25 psi
- monitor pressure gauge for 3 minutes and determine whether pressure is maintained without a loss of more than 3 psi.
- if the pressure test fails, then localize the leak and mark the area for repair
- air pressure testing will be conducted under the direct observation of the Engineer.

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3.1.4.2 In addition to nondestructive seam testing, the Contractor will perform destructive testing. The destructive testing procedures are as follows:

a. Test samples will be prepared by the Installer every 500 feet of seam length, a minimum of one test for each seaming machine per day, or more frequently at the discretion of the Engineer. Sample location and size will be selected by the Engineer. The sample size (12 x 56 inches) will be large enough to produce three sets of test specimens for the following tests:

   - Seam Shear Strength, ASTM D4437
   - Peel Adhesion, ASTM D4437

b. Ten specimens will compose a set. Half of these will be tested for peel and the other half for shear strength. Each specimen will be 1-inch wide and 12-inches long with the field seam at the center of the specimen. The 56-inch sample length will first be cut at the ends to produce two field peel test specimens. The remaining 54-inches will be divided into thirds and one-third submitted to the Contractor, one-third to the independent testing laboratory and one-third to the Engineer for storage and future reference.

c. Test specimens will be considered passing if the minimum values below are met or exceeded for four of the five test specimens tested by the independent laboratory. All acceptable seams will lie between two locations where samples have passed.

Field Seam Properties	Specification Limit LLDPE	Test Method
Shear Strength at Yield (lb/in width)	53	ASTM/D4437
Peel Strength (lb/in)	44 and Film Tear Bond	ASTM D4437

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3.1.4.3 If a sample fails destructive testing, the Contractor shall ensure that: the seam is reconstructed in each direction between the location of the sample which failed and the location of the next acceptable sample; or the welding path is retraced to an intermediate location at least ten feet in each direction from the location of the sample which failed the test, and a second sample is taken for an additional field test. If this second test sample passes, the seam must be then reconstructed between the location of the second test and the original sampled location. If the second sample fails, the process must be repeated.

3.1.4.4 If double track hot-wedge welding is used, the Engineer and the Installer must agree on the track weld that will be used in the destructive testing. The weld chosen inside or outside must be consistently tested and pass according to the criteria above.

3.1.4.5 All holes created by cutting out destructive samples will be patched by the Contractor immediately with an oval patch of the same material welded to the membrane using extrusion welding. The patch seams will be tested using a vacuum box and using the procedures described above. Work will not proceed with materials covering the geomembrane until passing results of destructive testing have been achieved.

3.1.5 Liner Repair:

3.1.5.1 All imperfections, flaws, construction damage, destructive and nondestructive seam failures will be repaired by the Installer. The appropriate methods of repair are listed below:

- patching, used to repair holes, tears, undispersed raw materials and contamination by foreign matter
- grinding and rewelding, used to repair small sections of extruded seams
- spot welding or seaming, used to repair pinholes or other minor, localized flaws
- capping, used to repair large lengths of failed seams
- topping, used to repair areas of inadequate seams, which have an exposed edge
- removing bad seam and replacing with a strip of new material welded into place (used with large lengths of fusion seams).

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3.1.5.2 The actual method used will be agreed upon by the Engineer, Installer and Contractor. All repair requiring abrading will be patched within one hour of the abrasion procedure. All defects that are patched will have the patch overlap the edge of the defect by a minimum of 6 inches. The patch will be cut with rounded edges (no corners). In the case of a large patch, the underlying geomembrane will be cut appropriately to avoid trapping gases and moisture between the two sheets.

3.1.5.3 During repair, the Engineer must be present and observe the procedures as well as all nondestructive testing of the repair seams. If the repair is very large, destructive testing may be required at the discretion of the Engineer. Any failure of repaired seams will require that the patch be removed, replaced and retested until passing results are achieved.

3.1.6 Construction Material Placement and Penetrations:

3.1.6.1 All granular materials placed above geomembrane shall be spread with a minimum initial lift thickness of 12 inches using tracked equipment with ground pressures not exceeding 7 pounds per square inch. No construction equipment will be driven directly on the geomembrane.

All rubber-tired vehicles will access construction above geomembranes from temporary access roads built a minimum of 3 feet above the liner. Extra geotextile or geomembrane layers shall be placed on or beneath all access roads or high trafficked areas. Any placement operation which results in damage to the underlying geomembrane, or in the opinion of the Engineer, has the potential of damaging the underlying geomembrane, shall immediately cease and be modified to prevent such damage.

3.1.6.2 Placement of overlying select fill or common fill shall be performed in a systematic manner in accordance with this Section and Section 02225 and/or Section 02257. Multiple cover spreading points will not be allowed. One initial spreading location shall be established, and the work shall proceed from this location towards a free end of the geomembrane where possible. Soil material must be placed using vertical placement techniques. No horizontal pushing of the initial soil lift above the geomembrane will be allowed.

3.1.6.3 To minimize the potential for slope failures, the initial soil lift above the geomembrane must be installed pushing up slope. Downslope lift placement is prohibited.

3.1.6.4 Wrinkles that develop from normal placement procedures must be controlled such that the underlying geomembrane does not fold over. Small wrinkles, defined as having their height less than or equal to one-half their base width, may be trapped and pushed down by the overlying soil. Any wrinkle which becomes too large and uncontrollable or which folds the geomembrane over must be brought to the attention of the Engineer. The Engineer will determine how to proceed, and his decision will be final. If necessary, the geomembrane will be uncovered, cut, laid flat, seamed by extrusion welding and non-destructively tested.

3.1.6.5 Cover system penetrations will be constructed for the landfill cap development. The configuration of these penetrations is detailed in the Contract Drawings. A prefabricated LLDPE boot shall be installed around each cover system penetration as shown. The penetration assembly shall be attached to each respective geomembrane liner by the extrusion weld process. Seams and materials used at these locations will be carefully constructed and inspected to insure proper construction has been achieved. Nondestructive testing will be performed on all seams where such testing is possible, otherwise refer to Paragraph 3.1.3.1(h).

3.2 POST-CONSTRUCTION:

3.2.1 The Installer of the geomembrane materials will prepare and the Contractor shall submit, to the Engineer, record drawings illustrating the following information:

- dimensions of all geomembrane field panels
- panel locations referenced to the Contract Drawing Plans
- identify all field seams and panels with the appropriate number or code
- location of all patches, repairs and destructive testing samples

3.2.2 Record drawing(s) will be submitted for each geomembrane layer constructed.

3.2.3 Warranty: The Contractor shall obtain and submit to the Engineer from the Manufacturer and Installer separate written warranties guaranteeing for a 20 year and 2 year period (respectively) from the date of issuance of the Certificate of Substantial Completion that the liner materials and workmanship specifically provided or performed under this Contract shall be free from defects. Said warranty shall apply to normal use and service by the Owner as described in Contract Specifications and as shown on the Contract Drawings. It shall specifically exclude mechanical abuse or puncture by machinery, equipment, or people, exposure of the liner to harmful chemicals or catastrophe due to earthquake, flood or tornado. Such written warranty

shall provide for the repair or replacement of the defect or defective area of lining materials upon written notification and demonstration by the Owner of the specific nonconformance of the lining material or installation with the project Specifications. Such defects or nonconformance shall be repaired or replaced within a reasonable period of time of such notification. The Owner agrees to pay an amount equal to the then current sales and installation price of the defective portion of the lining material multiplied by a fraction, the numerator of which shall be the number of years elapsed since the commencement of the warranty period and the denominator of which shall be the warranty period, provided that portion of the area in question has been made available to the Manufacturer/Installer and that such areas have been cleared of all liquids, sludges, earth, sand or gravel.

PART 4 - MEASUREMENT & PAYMENT

4.1 MEASUREMENT - LINEAR LOW DENSITY POLYETHYLENE (LLDPE) LINING MATERIAL:

4.1.1 Measurement for payment for Linear Low Density Polyethylene (LLDPE) Lining Material shall be based on the number of square feet of material placed as measured to the nearest foot, excluding any overlaps and material in the anchor trench.

4.2 PAYMENT - LINEAR LOW DENSITY POLYETHYLENE (LLDPE) LINING MATERIAL:

4.2.1 For Linear Low Density Polyethylene (LLDPE) Lining Material, not included in other unit or lump sum price items, payment for Linear Low Density Polyethylene (LLDPE) Lining Material will be made at the applicable price stated in the Bid.

4.2.2 The Owner will pay for LLDPE Lining Material delivered and properly stored on-site upon receipt and acceptance of all required submittals, shop drawings and conformance test results. Payment for installation of the material will not be made until all acceptable destructive and non-destructive test results have been received. The Owner shall retain 10 percent of the price of the LLDPE Lining Material until the Contractor provides acceptable quality control documentation, record drawings and warranties.

END OF SECTION

SPECIFICATIONS

SECTION 02677

ROTARY-DRILLED LANDFILL GAS VENT WELLS

PART 1 - GENERAL

1.1 DESCRIPTION: Under this Section, the Contractor shall furnish all labor, materials and equipment for Rotary-Drilled Landfill Gas Extraction Wells, as shown on the Plans, as specified, and/or directed. The installation of extraction wells will be approved in the field by the Engineer.

1.2 REFERENCES: (Not Used)

1.3 SUBMITTALS:

1.3.1 The Contractor shall submit six (6) copies of the manufacturer's material Specifications for each item to be supplied under this Section.

1.3.2 The Contractor shall submit to the Engineer samples of all well backfill materials furnished.

1.3.3 The Contractor shall maintain detailed well logs and construction diagrams for all wells drilled, including the total depth of the well, the static water level (if present), depth, thickness, and description of soil or waste strata (including dates from any readable material, and the occurrence of any water bearing zones. Well logs shall be submitted to the Engineer.

1.4 DELIVERY, STORAGE, AND PROTECTION: Deliver materials in an undamaged condition. Store materials off the ground to provide protection against oxidation caused by ground contact. Replace defective or damaged materials with new materials.

1.5 QUALITY ASSURANCE: All materials will be inspected on delivery, and materials that do not comply with the Specification will be rejected. The Contractor shall furnish all labor and equipment required to handle the materials and inspection, and shall remove the rejected materials from the site of work.

SECTION 02677

ROTARY-DRILLED LANDFILL GAS VENT WELLS

1.6 SITE CONDITIONS: Obstructions and saturated conditions are sometimes encountered when drilling in a landfill, many of which can be drilled through. The Contractor shall make reasonable efforts to drill through obstructions or saturated conditions, and will be paid for offset re-drilling or borehole abandonment only, if approved in writing by the Owner. The Contractor will be paid for abandonment of abandoned hole and for well installation at a new location.

1.7 GENERAL REQUIREMENTS: Provide each extraction well complete and ready for operation. Each extraction well, including equipment, materials, installation, and workmanship shall be to the satisfaction of the Engineer.

PART 2 - PRODUCTS

2.1 EQUIPMENT: The Contractor shall utilize equipment mounted on a crawler chassis, an all-terrain vehicle chassis, or other low-ground pressure equipment approved by the Engineer during construction of all phases of well construction.

2.2 MATERIALS: Shall conform to the respective Specifications as referenced herein and as shown on the Plans.

2.2.1 Aggregate:

2.2.1.1 Gravel pack shall be Type B Select Fill, as specified in Section 02225 "Select Fill Materials".

2.2.2 Pipe: PVC, Schedule 80, as specified in Section 02436, "Polyvinyl Chloride (PVC) Pipe and Fittings".

2.2.2.1 Perforated/Slotted Pipe: Slots in PVC extraction well piping shall be 6-inch long by 1/4-inch wide, spaced 8 inches on vertical centers, spaced 90 degrees around circumference of pipe.

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ROTARY-DRILLED LANDFILL GAS VENT WELLS

PART 3 - EXECUTION

3.1 DRILLING:

3.1.1 Extraction wells shall be 36-inch diameter, drilled to the depth shown on the drawings. Contractor shall use track-mounted dry drilling equipment; wet rotary drilling equipment may not be used.

3.1.2 The boring depths shown on the drawings are estimated and may be adjusted in the field by the Engineer. Two reasons limiting depth might be as follows:

a. If water is encountered in a boring, the Contractor shall drill beyond the point at which it was encountered. If wet conditions remain, the boring may be terminated and the length of perforated pipe adjusted by the Engineer, or the well may be relocated. If wet conditions cease (e.g., due to trapped water layer), then drilling will continue to the design depth.

b. Since base grades of this landfill are unknown, the depth of drilling may vary. When within 10 feet of estimated base grade, advance bucket with care noting drilling torque and pressure.

3.1.3 As soon as drilling is completed, a safety screen shall be placed over the top of the bore. This screen shall stay in place until backfilling is within 4 feet of the surface. Safety screen size shall be large enough to accommodate all backfill and materials, and any tools used during backfill yet not large enough for any person to accidently fall through.

3.2 PLACEMENT OF THE EXTRACTION WELL RISER: The Contractor shall supply and install the perforated and solid Schedule 80 PVC landfill gas riser, as specified in Section 02435, "Polyvinyl Chloride (PVC) Pipe and Fittings", as illustrated on the Plans.

3.2.1 The bore for the well shall be straight and the PVC well pipe as specified in Section 02435 shall be installed in the center of the borehole. The Contractor will take all tension off of the pipe by mechanical means and center the pipe in the middle of the borehole before starting to backfill. Pipe shall be slotted to within 3 foot of existing grade. Terminate solid pipe flush with existing grade and install temporary loose cap.

SECTION 02677

ROTARY-DRILLED LANDFILL GAS VENT WELLS

3.3 PLACEMENT OF GRANULAR BACKFILL MATERIALS: The Contractor shall place Type B Select Fill materials, as specified in Section 02225, "Select Fill Materials", in the annular space between the borehole wall and the outside of the riser pipe, up to existing grade.

3.3.1 Backfilling of the well shall commence immediately after well drilling is completed and the well piping has been installed in the borehole. Backfill materials shall be installed as indicated on the drawings and as approved by the Engineer.

3.3.2 Gravel pack shall be poured or scooped through the screen at a rate that will not endanger the integrity of the well casing.

3.4 DISPOSITION OF EXCAVATED MATERIALS: The Contractor shall dispose of all waste excavated during construction of these wells on site as directed by the Engineer. Equipment to transport excavated materials shall be mounted on a crawler chassis, an all-terrain vehicle, or other low-ground pressure equipment approved by the Engineer.

3.5 STANDBY TIME: The Contractor shall not charge the Owner nor the Engineer for standby time.

END OF SECTION

SPECIFICATIONS

SECTION 02721

DRAINAGE SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION:

1.1.1 Under this Section, the Contractor shall furnish all labor, materials and equipment for Drainage Systems as show on the Plans, as specified, and/or directed.

1.2 REFERENCES: The publications listed below and their latest revisions form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1.2.1 Federal Specification (Fed. Spec.):

WW-P-405B Pipe, Corrugated (Iron or Steel, Zinc Coated)

1.2.2 American Association of State Highway and Transportation Officials (AASHTO) Specification:

M196

1.3 DESCRIPTION OF WORK: The work includes providing new storm systems and related work.

1.4 SUBMITTALS:

1.4.1 Manufacturer's Data:

a. Pipe, Fittings, Joints, Couplings, and Gaskets

SECTION 02721

DRAINAGE SYSTEMS

1.5 DELIVERY, STORAGE, AND HANDLING OF MATERIALS:

1.5.1 Delivery and Storage:

1.5.1.1 Piping: Inspect materials delivered to site for damage. Store materials on site in enclosures or under protective coverings. Store rubber gaskets under cover, out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes and fittings free of dirt and debris.

1.5.2 Handling: Handle pipe, fittings, storage tank and other accessories in such manner as to ensure delivery to the trench or excavation in sound, undamaged condition. Carry pipe to trench; dragging of pipe shall not be permitted.

1.5.3 Earthwork: Provide in accordance with Section 02220, "Excavation".

PART 2 - PRODUCTS

2.1 STORM DRAINAGE PIPING:

2.1.1 Corrugated Steel Piping: Fed. Spec. WW-P-405, Class I or II, Shape 1, circular 2-2/3 inch x 1/2 inch. Minimum thickness of metal shall be 16 gage.

2.1.1.1 Helical Corrugations: Helically-corrugated pipe and fittings, when used with pipe joints, shall have a minimum of two factory-rolled annular corrugations at each end.

2.1.1.2 Standard Joints: Fed. Spec. WW-P-405 with coupling bands, except bands with projections will not be permitted.

2.1.1.3 Flared Ends: AASHTO M196.

PART 3 - EXECUTION

3.1 INSTALLATION: The following requirements shall apply to piping installation except as specified otherwise.

SECTION 02721

DRAINAGE SYSTEMS

3.1.1 Pipe Laying and Jointing: Inspect pipe and fittings before and after installation; defective piping shall be replaced with new materials. Provide facilities for lowering sections of pipe into trenches. At the end of each day's work, close open ends of pipe temporarily with wood blocks or bulkheads. Provide batterboards spaced not more than 26 feet apart along the trench or use the laser beam method for ensuring proper slope and elevation. Pipe grades or joints that are disturbed after laying shall be removed, cleaned, and reinstalled.

3.2 SPECIAL REQUIREMENTS SYSTEM:

3.2.1 Installation of Corrugated Steel Piping: Install in accordance with the recommendations of pipe manufacturer, except as specified herein.

3.2.1.1 Jointing: In making pipe joints, keep space between pipe and coupling free from dirt and grit so that corrugations will fit snugly. While tightening the coupling band, tap it with a soft-head mallet of wood, rubber, or plastic to take up slack and ensure a tight joint.

END OF SECTION

SPECIFICATIONS

SECTION 13052

LANDFILL GAS VENTS

PART 1 - GENERAL

1.1 DESCRIPTION:

1.1.1 Under this Section, the Contractor shall furnish all labor, materials and equipment for Landfill Gas Vents, as shown on the Plans, as specified, and/or directed.

1.1.2 The work shall include but not necessarily be limited to:

- Excavation
- Schedule 80 PVC Gas Vent Pipe with top fitting and bird screens
- Perforated PVC Pipe as shown on Contract Drawings
- Type A Select Fill, Section 02225, or approved material
- Installation as shown on Contract Drawings

1.1.3 The Contractor shall maintain the installed gas vents free of any obstruction (cave-in, backfill) and damage during placement of the soil layers and until final acceptance of the work required by this Contract.

PART 2 - PRODUCTS

2.1 MATERIALS:

2.1.1 PVC pipe, fittings and miscellaneous related materials as specified in Section 02436.

2.1.2 Type A Select Fill as specified in Section 02225 or approved alternate material.

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LANDFILL GAS VENTS

PART 3 - EXECUTION

3.1 LANDFILL GAS VENTS INSTALLATION:

3.1.1 Installation of the gas vent shall be completed as the layers for the final cap are placed.

3.1.2 After grading the in-place intermediate cover layer, excavation to install the gas vent shall be performed. A backhoe or power auger shall be used to excavate into the refuse as shown on the Contract Drawings. Excavation shall be in accordance with Section 02220.

3.1.3 The PVC pipe for the gas vent shall be centered in the excavation and backfilled with Type B Select Fill to the top of subgrade. A coupling shall be installed on the PVC pipe about even with the subgrade.

3.1.4 The remainder of the solid PVC pipe for the vent shall be attached to the coupling.

3.1.5 The geomembrane shall be placed in the configuration as shown on the Contract Drawings and as specified in Section 02595 "Polyvinyl Chloride (PVC) Lining Material."

END OF SECTION

SPECIFICATIONS

SECTION 15011

MECHANICAL GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 DESCRIPTION:

1.1.1 Under this Section, the Contractor shall furnish all labor, materials and equipment for Mechanical General Requirements, as shown on the Plans, as specified and/or directed.

1.2 REFERENCES: The publications listed below and their latest revisions form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1.2.1 Code of Federal Regulations (CFR) Publications:

29-1910-SUBPART O	Machinery and Machine Guarding
29-1910.219	Mechanical Power-Transmission Apparatus

1.3 RELATED REQUIREMENTS: This Section applies to certain sections of Division 1, "General Requirements" and Division 2, "Site Work"; Division 11, "Equipment"; Division 13, "Special Construction"; and all sections of Division 15, "Mechanical" of this Project Specification, unless specified otherwise in the individual section.

1.4 SUBMITTALS: Submittals shall include the manufacturer's name, trade name, place of manufacture, catalog model or number, nameplate data, size, layout dimensions, capacity, project specification and paragraph reference, applicable Federal, Military, industry, and technical society reference standards, years of satisfactory service, and other information necessary to establish contract compliance of each item the Contractor proposes to be provided. Photographs of existing installations are unacceptable and will be returned without approval.

1.4.1 Manufacturer's Data: Submittals for each manufactured item shall be current manufacturer's descriptive literature of cataloged products, equipment drawings, diagrams, performance and characteristic curves, and catalog cuts.

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MECHANICAL GENERAL REQUIREMENTS

1.4.2 Shop Drawings: Drawings shall be a minimum of 8.5 inches by 11 inches in size, except as specified otherwise. Drawings shall include floor plans, sectional views, wiring diagrams, and installation details of equipment; and equipment spaces identifying and indicating proposed location, layout and arrangement of items of equipment, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals, and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices.

1.4.3 Manufacturer's Certificates of Compliance: Submit certification from manufacturer attesting that materials and equipment to be furnished for this project comply with the requirements of this specification and of the reference publications. Pre-printed certifications will not be acceptable; certifications shall be the manufacturer's original; certifications shall be not more than one year old. The certification shall not contain statements that could be interpreted to imply that the product does not meet all requirements specified, such as "as good as"; "achieve the same end use and results as materials formulated in accordance with the referenced publications"; "equal or exceed the service and performance of the specified material". The certification shall simply state that the product conforms to the requirements specified. Certificates shall be signed by the manufacturer's official authorized to sign certificates of compliance.

1.4.4 Reference Standards Compliance: Where equipment or materials are specified to conform to industry and technical society reference standards of organizations such as the American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), National Electrical Manufacturers Association (NEMA), American Society of Mechanical Engineers (ASME), American Gas Association (AGA), American Refrigeration Institute (ARI), and Underwriters' Laboratories (UL), proof of such conformance shall be submitted. If an organization uses a label or listing to indicate compliance with a particular reference standard, the label or listing will be acceptable evidence, unless otherwise specified in the individual sections.

1.4.4.1 Independent Testing Organization Certificate: In lieu of the label or listing, submit a certificate from an independent testing organization, competent to perform testing and approved by the Engineer. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard.

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MECHANICAL GENERAL REQUIREMENTS

1.5 OPERATION AND MAINTENANCE MANUAL: Furnish an operation and maintenance manual for each item of equipment. Furnish three copies of the manual bound in hardback binders or an approved equivalent. Furnish one complete manual to the Owner's Representative for review and approval not more than 90 calendar days after an item is approved, but at least 60 calendar days prior to field acceptance testing of the item. Furnish the remaining manuals at least 60 days prior to contract completion. Inscribe the following identification on the cover: the words "OPERATION AND MAINTENANCE MANUAL", the name and location of the equipment or the building, the name of the Contractor, and the contract number. The manual shall include the names, addresses, and telephone numbers of each subcontractor installing equipment, and of the local representatives for each item of equipment. The manual shall have a table of contents and be assembled to conform to the table of contents with the tab sheets placed before instructions covering the subject. The instructions shall be legible and easily read, with large sheets of drawings folded in. The manual shall include: wiring and control diagrams with data to explain detailed operation and control of each item of equipment; a control sequence describing start-up, operation and shut-down; description of the function of each principal item of equipment; the procedure for starting; the procedure for operating; shut-down instructions; installation instructions; maintenance instructions; lubrication schedule including type, grade, temperature range, and frequency; safety precautions, diagrams, and illustrations; test procedures; performance data; and parts list. The parts lists for equipment shall indicate the sources of supply, recommended spare parts, and the service organization which is reasonably convenient to the project site. The manual shall be complete in all respects for equipment, controls, accessories, and associated appurtenances provided.

1.6 CATALOGED PRODUCTS: Materials and equipment shall be cataloged products of manufacturers regularly engaged in production of such materials or equipment and shall be manufacturer's latest design that complies with the specification requirements. Materials and equipment shall duplicate items that have been in satisfactory commercial or industrial use. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the items need not be the products of the same manufacturer. Each item of equipment shall have the manufacturer's name, address, model number and serial number on the nameplate securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

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MECHANICAL GENERAL REQUIREMENTS

1.7 LAYOUT OF THE WORK: Coordinate the proper relation of the work to the building structure, existing utilities and to the work of all trades. Visit the premises and become familiar with the dimensions in the field, and advise the Owner's Representative of any discrepancy before performing any work.

1.7.1 Contract Drawings: The Contract Drawings represent the general intent as to piping and equipment arrangements. All locations and dimensions shown shall be field verified and minor alterations made if so required. Where dimensions are not given for the location and arrangement of mechanical systems, locations may be assumed to be approximate, and may be altered if required. Major modifications to the indicated arrangements shall be approved by the Owner's Representative prior to the installation of mechanical systems. Schematic diagrams represent the overall system requirements and do not necessarily indicate the physical orientation, location or dimensions of that system.

1.7.2 Record Drawings: The Contractor shall maintain a record of the progress of the work and shall submit three (3) sets of As-Built Drawings upon completion of the project.

1.8 MANUFACTURER'S RECOMMENDATIONS: Unless otherwise stated in the Contract Specifications, all new equipment items, and specialties shall be installed in strict accordance with the recommendations of the manufacturer of the items being installed. Prior to the installation of new items, the Contractor shall submit to the Owner's representative printed copies of the manufacturer's installation recommendations. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material. Failure to install items in accordance with manufacturer's recommendations can be cause for rejection of the work items installed.

1.9 DELIVERY, STORAGE, AND HANDLING: Properly store, adequately protect, and carefully handle equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Engineer. Replace damaged or defective items.

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MECHANICAL GENERAL REQUIREMENTS

1.10 SAFETY REQUIREMENTS:

1.10.1 Equipment Safety: Fully enclose or properly guard in accordance with 29 CFR 1910.219 belts, pulleys, chains, gears, couplings, projecting setscrews, keys, rotating parts, and other power transmission apparatus, located where persons can come in close proximity thereto. Points of operation, ingoing nip points, and machinery producing flying chips and sparks shall be guarded in accordance with the applicable portions of 29 CFR 1910-SUBPART O. Provide positive means of locking out equipment so that equipment cannot be accidentally started during maintenance procedures. High-temperature equipment and piping so located as to endanger personnel or create a fire hazard shall be properly guarded or covered with insulation of the type specified. Provide catwalks, maintenance platforms, and guardrails where required for safe operation and maintenance of equipment. Provide ladders or stairways to reach catwalks and maintenance platforms. Ensure that access openings leading to equipment are large enough to carry through routine maintenance items such as filters and tools.

1.10.2 Warning Sign: Provide a permanent placard or sign at the entrance to confined spaces contained in the equipment. The sign shall warn personnel not to enter the space until the atmosphere inside has been tested and systems have been de-energized.

1.11 ELECTRICAL REQUIREMENTS: Motors, controllers, contactors, and disconnects shall conform to and shall have electrical connections provided under Division 16 - Electrical. Furnish internal wiring for components of packaged equipment as an integral part of the equipment. Power wiring and conduit for field installed equipment shall be provided under and conform to the requirements under Division 16 - Electrical.

1.12 SPECIAL CONDITIONS: The Contractor shall be performing work within an existing landfill area and shall be responsible to coordinate with the Owner regarding planned interruptions to mechanical and electrical services.

1.12.1 Protection of Existing Work: The Contractor shall take all necessary precautions to insure against damage to existing work to remain in place, or to be reused. The Contractor shall insure that structural elements are not overloaded and additional structural supports required as a result of any cutting, removal or demolition work performed under any part of this Contract are added. The Contractor shall minimize disruption of existing non-contract work areas as much as possible.

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MECHANICAL GENERAL REQUIREMENTS

1.12.2 Upon damage to existing equipment, buildings and/or structures, the Contractor shall immediately notify the Owner. All damages shall be repaired by the Contractor, or shall be replaced if beyond repair to match the existing to the Owner's satisfaction.

1.12.3 Protection of Personnel Where the safety of non-contractor personnel is endangered in the area of the work, barricades shall be used. Additional protection shall be provided, if required, to preserve the safety of non-contractor personnel in the immediate area of the work.

1.13 INSTRUCTION TO OWNER'S PERSONNEL: When specified in other sections, furnish the services of competent instructors to give full instruction to the designated Owner's personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the specified equipment or system. Instructors shall be thoroughly familiar with all parts of the installation and shall be trained in operating theory as well as practical operation and maintenance work. Instruction shall be given during the first regular work week after the equipment or system has been accepted and turned over to the Owner for regular operation. The number of days (8 hours per day) of instruction furnished shall be as specified in the individual section. When more than 4 days of instruction are specified, use approximately half of the time for classroom instruction. Use other time for instruction with the equipment or system. When significant changes or modifications in the equipment or system are made under the terms of the Contract, provide additional instruction to acquaint the operating personnel with the changes or modifications.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

3.1 FIELD PAINTING: Conform to Section 09900, "Painting."

END OF SECTION

SPECIFICATIONS

SECTION 15120

MECHANICAL EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION:

1.1.1 Under this Section, the Contractor shall furnish all labor, materials and equipment for the complete installation and operation of those Mechanical Equipment items as shown on the Plans, as specified and/or directed.

1.1.2 Mechanical Equipment shall include:

- Leachate Pump Station Pumps (LP-1, LP-2)
- Liquid Level Sensors

1.1.3 Control Panels:

- Leachate Pump Station Control Panel (LP-CP)

1.1.4 The work also includes all accessories, control stations, appurtenances or other work required for a complete operating installation of the specified equipment, except those items specifically included under other items of this Contract.

1.2 GENERAL REQUIREMENTS: Section 15011, "Mechanical - General Requirements", with the additions and modifications specified herein, applies to this Specification.

1.3 SUBMITTALS:

1.3.1 Manufacturer's Data: Submit shop drawings and schematics for the following:

a. Leachate Pump Station Pumps (LP-1, LP-2)
b. Leachate Pump Station Control Panel (LP-CP)
c. Liquid Level Sensors

1.3.2 Standards of Compliance and Manuals: Submit standards compliance information as well as operation and maintenance manuals for the equipment furnished.

SECTION 15120

MECHANICAL EQUIPMENT

PART 2 - PRODUCTS

2.1 LEACHATE PUMP STATION PUMPS (LP-1, LP-2):

2.1.1 Leachate Pumps: Pumps shall be explosion-proof, submersible, centrifugal type, suitable for pumping landfill leachate as manufactured by Flygt Corporation, Model Number C-3067-265, or equal.

2.1.2 The pumps shall be provided with an integral duplex guide rail system with stainless steel lifting chains for the removal and installation of the pumps from the top of the pump station. Guide rail system shall provide for a tight non-gasketed metal-to-metal seal of the pump discharge to the base assembly when the pump is lowered into place. Guide rail system shall be a product of the pump manufacturer.

2.1.3 The pumps shall be designed to operate under the following conditions at optimum efficiency with the characteristics noted:

Pump Nos.	1 and 2
Capacity, gpm	100
Total Head, ft.	35
Shut-off Head, ft.	63
Minimum Efficiency	53%
Discharge, Inches	2"
Motor horsepower, min.	2.0

2.1.4 Pump Construction:

2.1.4.1 Pump casing shall consist of an air filled, watertight casing constructed of close-grained ASTM A48 Class 30 grey cast iron. All iron castings shall be factory finished with an alkyd primer and chlorinated rubber paint finish on all exterior surfaces. All fasteners shall be 304 stainless steel, and all O-rings and seals shall be viton.

2.1.4.2 The pump impeller shall be double shrouded non-clog type constructed of Class 30 cast iron, capable of passing a minimum 3/4-inch solids. Impellers shall be statically, dynamically and hydraulically balanced and keyed to a Type 420 stainless steel shaft. Impellers shall be coated with a baked on epoxy finish.

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MECHANICAL EQUIPMENT

2.1.5 Motor: Motor shall be capacitor start, capacitor run type designed for 230 volt, 1 phase, 60 hertz power. Motor shall have Class F insulation capable of resisting a maximum operating temperature of 155° C under full load in a submerged condition. Motor shall have bearings designed for a B-10 life of 30,000 hours. A heat sensor thermostat shall be attached to the top end of motor winding and shall be connected in series with the magnetic contactor coil in control panel to stop motor if winding temperature reaches 140° C. Thermostat shall automatically reset when motor cools.

2.1.5.1 The motor shall be protected by two mechanical seals mounted in tandem with an oil filled chamber between the seals for lubrication. Seal faces shall be carbon and ceramic lapped to a flatness tolerance of one light band. Metal parts and spring shall be stainless steel.

2.1.5.2 Motor power cable shall be Type SO (7 conductor, or number as required by manufacturer), cable of sufficient length to reach from existing pump station basin to termination strip in new control panel. Provide enough slack in basin to allow for pump removal. Cable shall be potted into motor end cap with epoxy potting compound or other acceptable method. In addition, a rubber grommet that seals cable shall be clamped onto cable by end holding cap.

2.1.5.3 Ends of cable shall be suitably protected by a watertight seal until final installation.

2.1.6 Warranty: The manufacturer shall warrant the pumps against defects in workmanship and materials for a period of one (1) year from the date of initial operation under normal use, operation and service. In addition, the manufacturer shall replace certain parts which shall become defective through normal use and wear on a progressive schedule of cost for a period of one (1) year; parts included are the mechanical seal, impeller, pump housing, and ball bearings. The warranty shall be in published form and apply to all similar units.

2.1.7 Leachate Pump Station Controls:

2.1.7.1 Control Panel (LP-CP): A duplex automatic pump control panel in a NEMA 4 door within a door type enclosure constructed of 14 gauge cold rolled steel and finished in baked enamel shall be furnished and installed. The panel shall have a tamperproof cover, shall be furnished with padlock hasp and full inner sub-door and shall be designed for connection to

existing 230 volt, 1 phase, 60 hertz service. Panel shall be floor stand mounted and installed on the concrete top of the existing Leachate Pumping Station Manhole. Floor stand shall be of heavy steel construction with corrosion resistant finish which shall match color of control panel. Height of floor stand shall be 2'-0".

2.1.7.1.1 For each pump, the panel shall include a circuit breaker with door-mounted operating handle, an across-the-line 230 volt rated magnetic type starter with ambient compensated overloads and applicably sized heaters, motor starters shall have a minimum of two (2) field convertible auxiliary control contacts, a hand-off-automatic selector switch, a through-the-door thermal reset button, run pilot light, and a digital elapsed time meter accurate to one-hundreth of an hour. Controls shall be 120 volt rated. Panel shall also include the following:

a. A main circuit breaker sized for 60 ampere, 230 volt, 1 phase service.

b. An automatic electric alternator to sequence the pumps.

c. Test switches to manually monitor sensor operation.

d. Fused primary and secondary control power transformer to provide the panel control power.

e. Time delay relays to allow starting of one pump at a time with a time delay before the second pump (if required) starts.

f. A control circuit reconnect relay which will allow operation of the #2 pump should the circuit breaker for #1 pump trip.

g. A "high level" top of cabinet, weatherproof flashing alarm light which will light when high level alarm float is tripped.

h. Thermostatically controlled condensation heater.

i. Heavy-duty pilot lights with replaceable bulbs.

j. Intrinsically safe type relays for connection to the four (4) remote ("Off", "Pump On", "Lag On" and "High Level") pump station control floats.

k. An automatic motor installation monitoring unit for each pump that constantly monitors each pump's motor winding insulation resistance. Unit will prevent pump from operating if a fault condition is sensed and will initiate a flashing pilot light on the face of the control panel.

l. One (1) normally open and one (1) normally closed non-powered contact from the high level alarm relay system for connection to remote alarm system.

2.1.7.2 All internal panel wiring shall be run in neat bundles secured by wire ties or nonmetallic slotted raceways. All wires shall have wire numbers at each termination.

2.1.7.3 All items shall be wired to numbered terminal strips for connection to external wiring.

2.1.7.4 Control Logic: Control panel shall provide for the lead-lag pumping operation controlled by the wet well float switches as follows:

Float Activation	Operation
"Off"	All Pumps Off
"Pump On"	First Pump Run
"Lag On"	Second Pump Run
"High Level"	High Level Alarm and Warning

2.1.7.5 Provide four (4) liquid level sensors as specified herein for new, "Off", "Pump On", "Lag On", and "High Level" indications.

2.1.7.6 Each sensor shall be suitable for use in an intrinsically safe control system.

2.1.7.7 Furnish new stainless steel cable rack supports for existing and new floats.

2.1.8 Special Tools and Spare Parts:

2.1.8.1 The pump manufacturer shall furnish the following:

a. One set of special tools required for the maintenance of the pumps.

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MECHANICAL EQUIPMENT

b. One complete set of shaft seals.

c. One set of wearing rings for each pump.

d. Two spare intrinsically safe couplers.

e. Two spare fuses of each kind and size used.

f. Four spare bulbs for each kind and size of pilot light.

g. One spare control float.

2.1.9 Nameplate:

2.1.9.1 A stainless steel data plate shall be attached to each leachate pump. Plate shall show manufacturer's name, pump size and type, serial number, speed, impeller diameter, capacity, head rating and other pertinent data.

2.2 LIQUID LEVEL SENSORS:

2.2.1 Each sensor shall consist of a mercury switch in a smooth, non-fiberglass, chemical resistant casing, internally weighted, and suspended on its own cable. Cable length shall be adequate to reach control panel in one continuous length.

2.2.2 Sensors shall be field-mounted and wired to control panel.

2.2.3 Each sensor shall be suitable for use in an intrinsically safe control system.

2.2.4 Furnish new stainless steel cable rack supports for new floats.

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MECHANICAL EQUIPMENT

PART 3 - EXECUTION

3.1 INSTALLATION: Install mechanical equipment as indicated and in accordance with the manufacturers' instructions. Provide clearance for inspection, repair, replacement and service. Electrical work shall conform with NFPA 70 and DIVISION 16, "Electrical". Include overload protection in the operating disconnect switches and magnetic starters where provided.

3.2 INITIAL OPERATION AND FIELD TESTS:

3.2.1 Initial Operation: The Contractor shall provide for an authorized manufacturer's representative to initially start and operate each equipment item to show that it is properly installed and will perform satisfactorily. In addition to the time assigned for equipment start-up, sufficient working days shall be allotted to enable the qualified representative to thoroughly instruct the Owner's operating personnel in the operation and maintenance of the equipment.

3.2.2 FIELD TESTS: Schedule and administer operational performance tests for each item of mechanical equipment as applicable. Operational tests shall be of the duration necessary to compile the test information required, but not less than 2 hours for each equipment item. Provide for a minimum of 8 hours of start-up service by an authorized factory service personnel for each item of equipment.

3.2.2.1 A start-up report shall be issued by the manufacturer's representative at the initial start-up and operational testing of the equipment items. As a minimum, the recorded information shall list the following items:

a. Meg ohm readings of power and control conductors.

b. Amperage reading of each leg of motor leads.

c. Rated voltage and measured voltage.

d. Elapsed time readings on each pump at the time of each test.

e. Actual equipment output performance quantities derived from field readings of equipment systems measurements.

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3.2.3 Oil and grease as required for initial operation will be furnished and shall be in accordance with the manufacturer's recommendation.

END OF SECTION

SPECIFICATIONS

SECTION 15884

LANDFILL GAS VENT FLARE

PART 1 - GENERAL

1.1 DESCRIPTION:

1.1.1 Under this Section, the Contractor shall furnish all labor, equipment, materials and freight for the complete and operational Landfill Gas Vent Flare, as shown on the Plans, as specified and/or directed.

1.1.2 The work also includes all accessories, control stations, appurtenances or other work required for a complete operating installation of the specified equipment, except those items specifically included under other items of this Contract.

1.2 REFERENCES: The publications listed below and their latest revisions form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1.2.1 American Society for Testing and Materials (ASTM) Publications:

A36	Structural Steel
A53	Pipe, Steel Black and Hot-Dipped, Zinc-Coated Welded and Seamless

1.3 SUBMITTALS:

1.3.1 Shop Drawings: Submit four complete sets of shop drawings for approval. They shall contain enough detailed information to determine that the equipment conforms with the requirements of this Specification and not less then the following information:

n. Flare
o. Solar Ignition System

1.3.1.1 Dimensional equipment and fabrication drawings, including equipment weights, materials equipment locations, support details for all items and equipment.

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LANDFILL GAS VENT FLARE

1.3.1.2 Control panel and all remote control devices.

1.3.1.3 Control schematic diagrams and complete wiring and hydraulic piping diagrams.

1.3.2 Operation and Maintenance Instructions: Four complete sets of neatly and substantially bound operating and maintenance instructions shall be furnished specifically for this installation. Operating instructions shall include detailed information relative to type, method and sequence of controls and operation, with sufficient illustrations to prevent misinterpretation. Maintenance instructions shall include complete detailed data sufficient for adequately servicing the complete system, repairing, and ordering of all replacement parts, and shall be fully illustrated for clarity. Any components or methods peculiar to a particular system shall be explained in detail.

1.4 DELIVERY, STORAGE AND PROTECTION: Inspect materials delivered to the site for damage. Unload and store electrical equipment with minimum handling. Provide storage space in dry location, free from dust or water, and easily accessible for inspection and handling. Do not cover with tarps, polyethylene film or similar coverings. Handle, store and protect other materials in accordance with the manufacturer's recommendations. Replace damaged items with new items or repair as approved by the Owner.

1.6 WARRANTY: The Contractor shall warrant in writing all the work, materials and equipment called for in the Contract against defects in materials or workmanship for a period of twelve months following the date of the Owner's acceptance, whichever occurs first. Under this warranty, the Contractor shall make good, at his own expense and without delay, any failure of any part due to poor or faulty materials, construction or installation, or to the failure of any equipment to satisfactorily perform the work required of it by the Specifications. Any work replaced or rebuilt during the above-mentioned guarantee period shall be similarly guaranteed for a 12-month period starting from the date of acceptance of the repair, reconstruction or replacement.

PART 2 - PRODUCTS

2.1 LANDFILL GAS VENT FLARE: The unit shall be equipped with the following; solar-powered a continuous ignition system an all-weather variable flow flarehead, inline flame arrester, Flare stainless steel shut-off valve, Scheduled 40 black galvanized steel piping and cold weather insulation and jacketing kit.

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LANDFILL GAS VENT FLARE

2.1.1 Performance Criteria:

a. Gas Flow Rate: Unit shall be designed for effective combustion and reignition over a range of 2-60 SCFM of landfill gas or other low-grade biogas having an equivalent methane concentration between approximately 30-80 percent. Inlet gas pressure 0.5 to 5 inches of water column.

b. Flame Temperature: Average reading approximately 900°F - 1300°F depending upon gas quality, flow rate and wind velocity.

c. Reignition Limits: Continuous reignition of gases in less than 60 seconds after flameout regardless of wind direction or velocity.

d. Operating Temperature: Unit shall be designed to operate at ambient temperatures between - 40 degrees F and 120 degrees F.

2.1.2 Acceptable Manufacturers: Landfill gas candlestick flare shall be Model CF-5 as manufactured by Landfill Technologies, Inc., 2-inch Vent Flare as manufactured by LFG Specialties, or approved equal.

2.1.3 Combustion Flarehead: Double expansion gas/air mixing chamber. Heavy carbon steel construction with high-wind carburetion profile. Two spark plug taps for extra low or normal gas flows.

2.1.3.1 Flame Arrester: Inline stainless wire-gauge flame arrester. Design of flame arrester shall prevent flameout regardless of wind direction on velocity.

2.1.3.2 Height: 96-inches inlet to top of flarehead (add ground height of flange to determine ground height of flame).

2.1.4 Solar Ignition System

2.1.4.1 Solar Collector: Solar-electric trickle charge plate; not less than 75 square inches, 5 watt, panel providing 10 volts peak with minimum 8 volts at 300 mA normal charging power.

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LANDFILL GAS VENT FLARE

2.1.4.2 Battery Type & Voltage: 12-volt rechargeable gel cell fully-charged shall be capable of providing system will adequate reserve power to function for 15 days in darkness.

2.1.4.3 Spark Interval: 5.0 seconds maximum.

2.2 MATERIALS: Products shall conform to the respective reference specifications and standards and to the requirements specified herein.

2.2.1 Steel and Iron: If not specified otherwise, use standard mill finished structural steel shapes or bar iron in compliance with AISC Specifications for Structural Steel Buildings.

2.2.2 Structural Carbon Steel: ASTM A36.

2.2.3 Structural Tubing: ASTM A500, Grade B or ASTM A501.

2.2.4 Steel Pipe: ASTM A53, galvanized, Type S, Grade B, standard weight unless otherwise specified.

2.2.5 Fittings for Steel Pipe: Standard malleable iron fittings, galvanized.

2.2.6 Anchors and Fasteners: Where exposed, shall be of the same material, color, and finish as the metal to which applied.

PART 3 - EXECUTION

3.1 INSTALLATION: The equipment and material shall be installed in accordance with the best commercial practices. All systems shall be neat in appearance, compact, workmanlike in construction and assembly, and installed for long and continuous service. All parts shall be readily accessible for inspection, repair and renewal. The equipment and material shall be inspected upon delivery and shall be tested after installation. Correct defects or errors in the fabrication of components in an approved manner. If defects or errors in fabrication of components cannot be corrected in an approved manner, remove and provide non-defective components. Performance testing shall be conducted in a manner approved by the Engineer. Performance criteria shall be utilized by the gas flare manufacturer as a basis of design for that system.

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LANDFILL GAS VENT FLARE

3.2 PERFORMANCE TEST

3.2.1 The Contractor shall conduct a performance test within five days of equipment installation which shall be witnessed and verified by Owner. This performance test shall include a positive demonstration that the provided equipment is capable of the following specified performance.

a. Ignition and Reignition: After verification of gas quality and flow rate, and after installation of the flare according to manufacturer's instructions, the flare shall ignite within 60 seconds of opening gas valve and turning igniter to "ON" position. The average of 10 consecutive cycles will be used to determine acceptance.

b. Flame Temperature shall be in the approximate range from 900° to 1300°F as measured by a thermocouple probe inserted into the combustion zone. Metering by multimeter type thermocouple thermometer or equivalent device.

3.3 INSTRUCTION TO OWNER PERSONNEL: Upon completion of the work and after field testing and final operational acceptance of the flares, and at a time designated by the Owner, the services of a competent technician regularly employed or authorized by the manufacturer shall be provided for instructing personnel in the proper maintenance, and trouble shooting for the flares. The period of instruction shall be one eight-hour working day. Training shall be done at the job site during actual operations.

END OF SECTION

SPECIFICATIONS

SECTION 16011

ELECTRICAL GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 DESCRIPTION:

1.1.1 Under this Section, the Contractor shall furnish all labor, materials and equipment for Electrical General Requirements, as shown on the Plans, as specified and/or directed.

1.2 REFERENCES: The publications listed below and their latest revisions form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1.2.1 Federal Specification (Fed. Spec.):

L-P-387A & Int Am2	Plastic Sheet, Laminated, Thermosetting (for Design Plates)

1.2.2 American National Standards Institute (ANSI) Publications:

C37.20	Switchgear Assemblies, Including Metal-Enclosed Bus
Z35.1	Accident Prevention Signs

1.2.3 Institute of Electrical and Electronics Engineers (IEEE) Publication:

100	Standard Dictionary of Electrical and Electronics Terms

1.2.4 National Electrical Manufacturers Association (NEMA) Publication:

ICS 6	Enclosures for Industrial Controls and Systems

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ELECTRICAL GENERAL REQUIREMENTS

1.2.5 National Fire Protection Association (NFPA) Publication:

70B	Electrical Equipment Maintenance
70	National Electrical Code

1.3 APPLICATION: This Section applies to all sections of Division 16, "Electrical", of this Project except as specified otherwise in each individual section.

1.4 DEFINITION OF ELECTRICAL TERMS: Unless otherwise specified or indicated, electrical terms used in these Specifications, and on the drawings, shall be as defined in IEEE Standard No. 100.

1.5 SUBMITTALS: Obtain approval before procurement, fabrication, or delivery of items to the job site. Partial submittals will not be acceptable and will be returned without review. Submittals shall include the manufacturer's name, trade name, place of manufacture, catalog model or number, nameplate data, size, layout dimensions, capacity, project specification and paragraph reference, applicable Federal, Military, industry, and technical society publication references, and other information necessary to establish contract compliance of each item to be furnished. Furnish a minimum of six (6) copies of shop drawings for each major device specified.

1.5.1 Shop Drawings: In addition to the requirements specified elsewhere, shop drawings shall meet the following requirements. Drawings shall be a minimum of 8.5 inches by 11 inches in size, except as specified otherwise. Drawings shall include complete ratings information, wiring diagrams, and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to assure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. If equipment is disapproved, revise drawings to show acceptable equipment and resubmit.

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ELECTRICAL GENERAL REQUIREMENTS

1.5.2 Manufacturer's Data: Submittals for each manufactured item shall be current manufacturer's descriptive literature of cataloged products, equipment drawings, diagrams, performance and characteristic curves, and catalog cuts.

1.5.3 Publication Compliance: Where equipment or materials are specified to conform to industry and technical society publications of organizations such as American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), and Underwriters' Laboratories Inc. (UL), submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance. In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction", or words of similar meaning, to mean the Owner. In lieu of the label or listing, submit a certificate from an approved independent testing organization, adequately equipped and competent to perform such services, stating that the item has been tested in accordance with the specified organization's test methods and that the item conforms to the specified organization's publication.

1.5.4 Submittals Required: Supply shop drawing submittal information on the following equipment and as otherwise noted in each individual Section:

Panelboards	Disconnect
Light Fixtures	Transformer

1.6 OPERATION AND MAINTENANCE MANUAL: Submit as required for systems and equipment indicated in the technical sections. Furnish three copies, bound in hardback binders or an approved equivalent. Furnish one complete manual prior to performance of systems or equipment tests, and furnish the remaining manuals prior to contract completion. Inscribe the following identification on the cover: the words "OPERATION AND MAINTENANCE MANUAL", the name and location of the system, equipment, building, name of Contractor, and contract number. Include in the manual the names, addresses, and telephone numbers of each subcontractor installing the system or equipment and the local representatives for the system or equipment. Include a table of contents and assemble the manual to conform to the table of contents, with the tab sheets placed before instructions covering the subject. The instructions shall be legible and easily read, with large sheets of drawings folded in. The manual shall include:

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ELECTRICAL GENERAL REQUIREMENTS

a. Internal and interconnecting wiring and control diagrams with data to explain detailed operation and control of the system or equipment.

b. A control sequence describing startup, operation, and shutdown.

c. Description of the function of each principal item of equipment.

d. Installation and maintenance instructions.

e. Safety precautions.

f. Diagrams and illustrations.

g. Testing methods.

h. Performance data.

i. Lubrication schedule including type, grade, temperature range, and frequency.

j. Parts list. The list shall indicate sources of supply, recommended spare parts, and name of servicing organization.

k. Appendix: List qualified permanent servicing organizations for support of the equipment, including addresses and certified qualifications.

1.7 SPARE PARTS: Provide the following spare parts for all equipment installed under this Contract, unless indicated otherwise elsewhere.

a. Three (3) power fuses for each different size and type used.

b. Two (2) space lamps for each light fixture furnished.

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ELECTRICAL GENERAL REQUIREMENTS

1.8 POSTED OPERATING INSTRUCTIONS: Furnish approved operating instructions for systems and equipment indicated in the technical sections for use by operation and maintenance personnel. The operating instructions shall include wiring diagrams, control diagrams, and control sequence for each principal system and equipment. Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions as directed. Attach or post operating instructions adjacent to each principal system and equipment including startup, proper adjustment, operating, lubrication, shutdown, safety precautions, procedure in the event of equipment failure, and other items of instruction as recommended by the manufacturer of each system or equipment. Provide weather-resistant materials or weatherproof enclosures for operating instructions exposed to the weather. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal or peeling.

1.9 INSTRUCTION TO OWNER'S PERSONNEL: Where indicated in the technical sections, furnish the services of competent instructors to give full instruction to Owner's personnel in the adjustment, operation, and maintenance of systems and equipment, including pertinent safety requirements as required. Each instructor shall be thoroughly familiar with all parts of the installation and shall be trained in operating theory as well as practical operation and maintenance work. Instruction shall be given during the first regular work week after the equipment or system has been accepted and turned over to the Owner for regular operation. The number of man days (8 hours) of instruction furnished shall be as specified in each individual section.

1.10 DELIVERY AND STORAGE: Handle, store, and protect equipment and materials in accordance with the manufacturer's recommendations and with the requirements of NFPA 70B, Appendix I, titled "Equipment Storage and Maintenance During Construction". Replace damaged or defective items with new items.

1.11 SPECIAL CONDITIONS: The Contractor shall be performing work within active landfill capping construction and shall be responsible to coordinate with the Owner regarding planned interruptions to electrical services and road access. Contractor must maintain in service the existing electrical services at the existing building unless otherwise coordinated with the Owner until the new service and equipment is operational.

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ELECTRICAL GENERAL REQUIREMENTS

1.11.1 Protection of Existing Work: The Contractor shall take all necessary precautions to insure against damage to existing work to remain in place, or to be reused. The Contractor shall insure that structural elements are not overloaded and additional structural supports required as a result of any cutting, removal or demolition work performed under any part of this Contract are added. The Contractor shall minimize disruption of existing non-contract work areas as much as possible.

1.11.2 Upon damage to existing equipment, buildings, and/or structures, the Contractor shall immediately notify the Owner. All damages shall be repaired by the Contractor, or shall be replaced if beyond repair, to match the existing to the Owner's satisfaction.

1.11.3 Protection of Buildings from the Weather: The interior of the buildings and all materials and equipment shall be protected from the weather at all times.

1.11.4 Protection of Personnel: Where the safety of non-contractor personnel is endangered in the area of the work, barricades shall be used. Additional protection shall be provided if required, to preserve the safety of non-contractor personnel in the immediate area of the work.

1.11.5 Contractor shall maintain open road access at all times to the existing building and leachate storage tank. Contractor shall stage construction such that at least one lane of the existing access road is open at all times. Contractor shall coordinate with the Owner a minimum of one week prior to any planned road closings.

1.11.6 Construction in Existing Buildings: Verify with Owner expected routing of new wire and/or conduit within existing equipment or buildings prior to field construction of systems. Coordinate with the Owner a minimum of ten (10) working days prior to any planned disruption of existing working systems.

1.12 CATALOGED PRODUCTS/SERVICE AVAILABILITY: Materials and equipment shall be current products by manufacturers regularly engaged in the production of such products. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The 2-year period shall be satisfactorily completed by a

product for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures. Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished. The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the Contract.

1.13 MANUFACTURER'S RECOMMENDATIONS: Where installation procedures or any part thereof are required to be in accordance with manufacturer's recommendations, furnish printed copies of the recommendations prior to installation. Installation of the item shall not proceed until recommendations are received. Failure to furnish recommendations shall be cause for rejection of the equipment or material. Obtain manufacturer's recommendations from the Owner for equipment and/or material provided by the Owner.

1.14 MOTORS AND MOTOR CONTROLS FOR MECHANICAL EQUIPMENT: The electrical components of mechanical equipment, such as motors, motor starters, control or push button stations, float or pressure switches, solenoid valves, and other devices functioning to control mechanical equipment, and control wiring and conduit for circuits rated 100 volts or less, are specified in the section covering the associated mechanical equipment, rather than in Division 16, unless otherwise shown. The interconnecting power wiring and conduit, control wiring rated 120 volts (nominal) and conduit, and the electrical power circuits shall be furnished and installed under Division 16.

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ELECTRICAL GENERAL REQUIREMENTS

1.15 EQUIPMENT FURNISHED BY OTHERS:

CONTRACT NO.	ITEM	FURNISHED INSTALLED	FURNISHED ONLY	WORK BY D

NOTE KEY

1 - Power & Control Wiring & Conduit
2 - Control Wiring & Conduit
3 - Push Button Stations
4 - Starters
5 - Mount Equipment
6 - Disconnect
7 - Power Wiring & Conduit
8 - Timer Switch

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT: All materials, equipment, and devices shall, as a minimum, meet the requirements of UL where UL standards are established for those items, and the requirements of NFPA 70. All items shall be new unless specified or indicated otherwise.

2.2 NAMEPLATES: Fed. Spec. L-P-387. Provide laminated plastic nameplates for each panelboard, equipment enclosure, relay, switch, and device. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 0.125-inch thick, white with black center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the black core. Minimum size of nameplates shall be 1.0 inch by 2.5 inches. Lettering shall be a minimum of 0.25-inch high normal block style.

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ELECTRICAL GENERAL REQUIREMENTS

PART 3 - EXECUTION

3.1 NAMEPLATE MOUNTING: Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.2 PAINTING OF EQUIPMENT:

3.2.1 Factory Applied: Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA ICS 6 corrosion-resistance test, except equipment specified to meet requirements of ANSI C37.20 shall have a finish as specified in ANSI C37.20.

3.3 TESTS:

3.3.1 General: Perform and record all tests in the presence of the Owner's authorized representative and/or the Engineer. Furnish all instruments and personnel. Perform preliminary tests and correct all defective material and/or workmanship prior to witness of tests. Perform tests as indicated and as otherwise noted in other Sections of the 1600 Division.

3.3.2 Conduct field tests in the sequence listed below:

3.3.2.1 Insulation Resistance Tests: Make tests after all wiring is completed and connected ready for the attachment of fixture and/or equipment. Repeat test when all fixtures and/or equipment are connected ready for use. Make tests with an instrument capable of measuring the resistance involved at a voltage of at least 500 volts DC for equipment rated 100 to 500 volts AC, 1500 volts DC for equipment rated 151 to 600 volts AC. Apply voltage continuously for one minute prior to taking reading. Measure insulation resistance between each pair of insulated conductor separately and between each insulated conductor and ground. Make tests at each panelboard distribution panel, and switchboard on every circuit with the circuit protective device open but connected. The minimum acceptable measured insulation resistance for wiring completed and ready for connection of fixtures and/or equipment is:

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ELECTRICAL GENERAL REQUIREMENTS

WIRE SIZE	INSULATION RESISTANCE
#14 & #12 AWG	1,000,000 Ohms
#10 AWG & Larger	250,000 Ohms

3.3.2.2 For wiring completed with all fixtures and/or equipment connected, the minimum acceptable insulation resistance is one-half the tabled values.

3.3.3 Load Balance Test: Make test by energizing all lighting, motors and other electrical equipment simultaneously for a three hour period. Alter fuses, circuit breakers, circuit connections, etc., as required for satisfactory performance. Take voltage and amperage readings on each circuit at all panels.

3.3.4 Check the amperage draw, voltage and direction of rotation of each motor in the presence of the equipment contractor and the Owner's representative. Make all necessary changes to obtain proper rotation, motor terminal voltage, motor protection, etc. Revise heater elements as necessary for proper motor protection. Similarly check all other electrically connected equipment.

Make the test at a time during the day or night that is mutually satisfactory to the Owner at least one week prior to substantial completion. Make all arrangements and notify all parties in writing at least seventy-two hours prior to the test.

3.3.5 Equipment Operation Test - Show by demonstration in service that all circuits are in good operating condition. Cycle all control equipment under load at least five times.

3.3.6 Equipment and apparatus factory tests - Manufacturer's normal quality control tests are acceptable, unless specific factory witnessed tests are specified in other sections.

3.4 CLEANING:

3.4.1 When directed, just prior to final acceptance, clean all equipment including, but not limited to, the following:

SECTION 16011

ELECTRICAL GENERAL REQUIREMENTS

- Lighting fixtures, panelboards, control centers, switchgear, receptacles and switch plates - Remove all tags and labels; leave ready for use - All equipment to be painted, removing all rust, etc., and leave ready for painting - Building, by removing all debris, conduits, wire, insulation, cartons, etc., left as a result of this work.

3.5 UTILITY COORDINATION:

3.5.1 Contractor shall provide and pay for inspection of electrical work by the New York Board of Fire Underwriters or other approved electrical inspection agency prior to connection to the utility service.

3.5.2 Contractor shall coordinate with Niagara Mohawk and the Owner regarding the new building electric service. Contractor must submit a complete set of shop drawings of the new service entrance equipment for the utility's approval.

3.5.3 Contractor shall coordinate with the Owner regarding connections to existing systems and work within existing buildings and equipment.

3.6 WORK WITHIN EXISTING BUILDINGS:

3.6.1 Contractor shall install new service and service panel and shall install new conduit and wire systems within existing building. Contractor shall use care in installation of new work and shall protect existing work and finishes in his work area. Contractor shall immediately notify Owner of any damages to existing equipment or finishes and shall restore damaged items to Owner's satisfaction.

END OF SECTION

product for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures. Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished. The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the Contract.

1.13 MANUFACTURER'S RECOMMENDATIONS: Where installation procedures or any part thereof are required to be in accordance with manufacturer's recommendations, furnish printed copies of the recommendations prior to installation. Installation of the item shall not proceed until recommendations are received. Failure to furnish recommendations shall be cause for rejection of the equipment or material. Obtain manufacturer's recommendations from the Owner for equipment and/or material provided by the Owner.

1.14 MOTORS AND MOTOR CONTROLS FOR MECHANICAL EQUIPMENT: The electrical components of mechanical equipment, such as motors, motor starters, control or push button stations, float or pressure switches, solenoid valves, and other devices functioning to control mechanical equipment, and control wiring and conduit for circuits rated 100 volts or less, are specified in the section covering the associated mechanical equipment, rather than in Division 16, unless otherwise shown. The interconnecting power wiring and conduit, control wiring rated 120 volts (nominal) and conduit, and the electrical power circuits shall be furnished and installed under Division 16.

SECTION 16011

ELECTRICAL GENERAL REQUIREMENTS

1.15 EQUIPMENT FURNISHED BY OTHERS:

CONTRACT NO.	ITEM	FURNISHED INSTALLED	FURNISHED ONLY	WORK BY D

NOTE KEY

1 - Power & Control Wiring & Conduit
2 - Control Wiring & Conduit
3 - Push Button Stations
4 - Starters
5 - Mount Equipment
6 - Disconnect
7 - Power Wiring & Conduit
8 - Timer Switch

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT: All materials, equipment, and devices shall, as a minimum, meet the requirements of UL where UL standards are established for those items, and the requirements of NFPA 70. All items shall be new unless specified or indicated otherwise.

2.2 NAMEPLATES: Fed. Spec. L-P-387. Provide laminated plastic nameplates for each panelboard, equipment enclosure, relay, switch, and device. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 0.125-inch thick, white with black center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the black core. Minimum size of nameplates shall be 1.0 inch by 2.5 inches. Lettering shall be a minimum of 0.25-inch high normal block style.

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ELECTRICAL GENERAL REQUIREMENTS

PART 3 - EXECUTION

3.1 NAMEPLATE MOUNTING: Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.2 PAINTING OF EQUIPMENT:

3.2.1 Factory Applied: Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA ICS 6 corrosion-resistance test, except equipment specified to meet requirements of ANSI C37.20 shall have a finish as specified in ANSI C37.20.

3.3 TESTS:

3.3.1 General: Perform and record all tests in the presence of the Owner's authorized representative and/or the Engineer. Furnish all instruments and personnel. Perform preliminary tests and correct all defective material and/or workmanship prior to witness of tests. Perform tests as indicated and as otherwise noted in other Sections of the 1600 Division.

3.3.2 Conduct field tests in the sequence listed below:

3.3.2.1 Insulation Resistance Tests: Make tests after all wiring is completed and connected ready for the attachment of fixture and/or equipment. Repeat test when all fixtures and/or equipment are connected ready for use. Make tests with an instrument capable of measuring the resistance involved at a voltage of at least 500 volts DC for equipment rated 100 to 500 volts AC, 1500 volts DC for equipment rated 151 to 600 volts AC. Apply voltage continuously for one minute prior to taking reading. Measure insulation resistance between each pair of insulated conductor separately and between each insulated conductor and ground. Make tests at each panelboard distribution panel, and switchboard on every circuit with the circuit protective device open but connected. The minimum acceptable measured insulation resistance for wiring completed and ready for connection of fixtures and/or equipment is:

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ELECTRICAL GENERAL REQUIREMENTS

WIRE SIZE	INSULATION RESISTANCE
#14 & #12 AWG	1,000,000 Ohms
#10 AWG & Larger	250,000 Ohms

3.3.2.2 For wiring completed with all fixtures and/or equipment connected, the minimum acceptable insulation resistance is one-half the tabled values.

3.3.3 Load Balance Test: Make test by energizing all lighting, motors and other electrical equipment simultaneously for a three hour period. Alter fuses, circuit breakers, circuit connections, etc., as required for satisfactory performance. Take voltage and amperage readings on each circuit at all panels.

3.3.4 Check the amperage draw, voltage and direction of rotation of each motor in the presence of the equipment contractor and the Owner's representative. Make all necessary changes to obtain proper rotation, motor terminal voltage, motor protection, etc. Revise heater elements as necessary for proper motor protection. Similarly check all other electrically connected equipment.

Make the test at a time during the day or night that is mutually satisfactory to the Owner at least one week prior to substantial completion. Make all arrangements and notify all parties in writing at least seventy-two hours prior to the test.

3.3.5 Equipment Operation Test - Show by demonstration in service that all circuits are in good operating condition. Cycle all control equipment under load at least five times.

3.3.6 Equipment and apparatus factory tests - Manufacturer's normal quality control tests are acceptable, unless specific factory witnessed tests are specified in other sections.

3.4 CLEANING:

3.4.1 When directed, just prior to final acceptance, clean all equipment including, but not limited to, the following:

SPECIFICATIONS

SECTION 16301

UNDERGROUND ELECTRICAL WORK

PART 1 - GENERAL

1.1 DESCRIPTION:

1.1.1 Under this Section, the Contractor shall furnish all labor, materials and equipment for Underground Electrical Work, as shown on the Plans, as specified, and/or directed.

1.2 REFERENCES: The publications listed below and their latest revisions form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1.2.1 Federal Specification (Fed. Spec.):

RR-F-621C	Frame, Covers, Gratings, Steps, Sump and Catch Basin, Manhole

1.2.2 American Association of State Highway and Transportation Officials (AASHTO) Publications:

HB-12	Highway Bridges, Including Interim Specifications
M 198	Joints for Circular Concrete Sewer and Culvert Pipe Using Flexible Watertight Gaskets

1.2.3 American Concrete Institute (ACI) Publications:

315	Details and Detailing of Concrete Reinforcement
318	Building Code Requirements for Reinforced Concrete

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UNDERGROUND ELECTRICAL WORK

1.2.4 American National Standards Institute (ANSI) Publication:

C2	National Electrical Safety Code (NESC)

1.2.5 American Society for Testing and Materials (ASTM) Publications:

B1	Hard-Drawn Copper Wire
B8	Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
C32	Sewer and Manhole Brick (Made from Clay or Shale)
C260	Air-Entraining Admixtures for Concrete
C309	Liquid Membrane-Forming Compounds for Curing Concrete
D698	Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5-lb (2.49-kg) Rammer and 12-in. (305-mm) Drop
D1556	Density of Soil in Place by the Sand-Cone Method
D1557	Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb (4.54-kg) Rammer and 18-in. (457-mm) Drop
D1682	Breaking Load and Elongation of Textile Fabrics

1.2.6 National Electrical Manufacturer's Association (NEMA) Publications:

RN 1	Polyvinyl-Chloride Externally Coated Galvanized Rigid Steel Conduit and Electrical Metallic Tubing

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UNDERGROUND ELECTRICAL WORK

TC 2	Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80)
TC 3	PVC Fittings for Use With Rigid PVC Conduit and Tubing
TC 6	PVC and ABS Plastic Utilities Duct for Underground Installation
TC 9	Fittings for ABS and PVC Plastic Utilities Duct for Underground Installation
WC 7	Cross-Linked-Thermosetting- Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (ICEA S-66-524)
WC 8	Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (ICEA S-68-516)

1.2.7 National Fire Protection Association (NFPA) Publication:

70	National Electrical Code (NEC)

1.2.8 Underwriters' Laboratories Inc. (UL) Publications:

6	Rigid Metal Conduit
467	Grounding and Bonding Equipment
510	Insulating Tape
514A	Metallic Outlet Boxes
514B	Fittings for Conduit and Outlet Boxes
854	Service-Entrance Cables

SECTION 16301

UNDERGROUND ELECTRICAL WORK

1242-83 Intermediate Metal Conduit

1.3 GENERAL REQUIREMENTS: Section 16011, "Electrical General Requirements", applies to this Section with additions and modifications specified herein.

1.3.1 Overhead Service: Terminate overhead service conductors into buildings at the service entrance fittings or weatherhead outside the building. Installation and connection of service entrance equipment to the overhead service conductor is included in Section 16402, "Interior Wiring Systems". Locate nearby support bracket for overhead wires not less than 18 feet above the finished grade at the building.

1.3.2 Electrical Characteristics: Electrical characteristics for this project shall be 480/227 volts secondary, three phase, 4 wire, wye connected.

1.3.3 Laboratory Tests:

1.3.3.1 Determine soil-density relationships for compaction of backfill material in accordance with ASTM D1557, Method D.

1.4 SUBMITTALS:

1.4.1 Shop Drawings (S) or Manufacturer's Data (M):

Direct Burial Wire (M)

1.4.2 Manufacturer's Instructions:

a. Manufacturer's directions for use of ground megger with proposed method indicated
b. Terminator manufacturer's installation instructions

1.4.3 Certificates of Compliance:

1.4.3.1 Material and Equipment: Provide manufacturer's statement certifying that the product supplied meets or exceeds contract requirements.

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UNDERGROUND ELECTRICAL WORK

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT: Provide materials and equipment listed by UL or approved by Factory Mutual (FM) System when such equipment is listed or approved.

2.1.1 Conduit: Shall be plastic coated rigid hot-dipped galvanized steel or Schedule 80 plastic conforming to the following:

2.1.1.1 Rigid galvanized steel conduit and fittings shall conform to the requirements of UL 6 and UL 1242, for threaded type, respectively, and shall be coated with a polyvinyl chloride (PVC) sheath bonded to the galvanized exterior surface, nominal 40 mils thick, conforming to NEMA RN 1, Type A40, except that hardness shall be nominal 85 Shore A durometer, dielectric strength shall be minimum 400 volts per mil at 60 Hz, tensile strength shall be minimum 3500 psi, and aging shall be minimum 1000 hours in an Atlas Weatherometer.

2.1.1.2 Plastic conduit for direct burial shall be PVC conforming to NEMA TC 2 (conduit) and NEMA TC 3 (fittings), Type EPC-80-PVC.

2.1.1.3 Outlet boxes for use with rigid or flexible steel conduit shall be cast-metal cadmium or zinc-coated if of ferrous metal with gasketed closures and shall conform to UL 514A. Fittings for steel conduit and outlet boxes shall conform to UL 514B.

2.1.2 Plastic Insulating Tape: UL 510.

2.1.3 Wire and Cable:

2.1.3.1 Wire and cable conductor sizes are designated by American Wire Gauge (AWG) and Thousands of Circular Mils (MCM). Conductor and conduit sizes indicated are for copper conductors, unless otherwise noted. Insulated conductors shall bear the date of manufacture imprinted on the wire insulation with other identification. Wire and cable manufactured more than 24 months before delivery to the job site shall not be used.

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UNDERGROUND ELECTRICAL WORK

2.1.3.2 Conductors rated 600 volts and less, including service entrances, shall conform to UL 854, Type USE. Conductor size and number of conductors in each cable shall be as indicated. Cable shall be color coded. Conductor identification shall be provided within each enclosure where a tap, splice, or termination is made. Conductor identification shall be by color-coded insulated conductors, plastic-coated self-sticking printed markers, colored nylon cable ties and plates, or heat shrink type sleeves. Control circuit terminations shall be properly identified. Conductors No. 10 AWG and smaller shall be solid copper. Conductors No. 8 AWG and larger shall be stranded copper.

a. Colors for coding conductors shall be:

240-VOLT SYSTEM	480-VOLT SYSTEM
Neutral - White	Neutral - White
Phase A - Black	Phase A - Brown
Phase B - Red	Phase B - Purple
Grounding Conductor - Green	Phase C - Yellow
	Grounding Conductor - Green

2.1.3.3 Pull Wire: Shall be plastic, having a minimum tensile strength of 200 pounds.

2.1.3.4 Connectors and Terminals: Shall be designed and approved for use with the associated conductor material, and shall provide a uniform compression over the entire contact surface. Solderless terminal lugs shall be used on stranded conductors. For connecting aluminum to copper, connectors shall be the circumferentially compressed, metallurgically bonded type.

2.1.4 Grounding and Bonding Equipment: UL 467. Ground rods shall be copperweld type copper clad steel with diameter adequate to permit driving to full length of the rod, but not less than 3/4 inch in diameter and 10 feet long unless otherwise indicated.

PART 3 - EXECUTION

3.1 INSTALLATION: Underground installation shall conform to ANSI C2 and NFPA 70 except as otherwise specified or indicated.

SECTION 16301

UNDERGROUND ELECTRICAL WORK

3.1.1 Contractor Damage: The Contractor shall promptly repair any indicated utility lines or systems damaged by Contractor operations. Damage to lines or systems not indicated, which are caused by Contractor operations, shall be treated as "Changes" under the terms of the General Provisions of the Contract. If the Contractor is advised in writing of the location of a non-indicated line or system, such notice shall provide that portion of the line or system with "indicated" status in determining liability for damages. In any event, the Contractor shall immediately notify the Engineer of any such damage.

3.1.2 Direct Burial System: Bury cables directly in earth, except under roadways, install cables in conduit. Slope ducts to allow drainage. Trenches in which the cables are placed shall be excavated by hand or with mechanical trenching equipment. Provide a minimum cable cover of 24 inches below finished grade for power conductors operated at less than 600 volts, and 30 inches to the top of the cables for over 600 volts. Trenches shall be not less than 6 inches wide, and shall be in straight lines between cable markers. Bends in trenches shall have a radius of not less than 36 inches. Where two or more cables are laid parallel in the same trench, space cables laterally at least 3 inches apart. If rock is encountered, remove rock to a minimum depth of 3 inches below the cable and fill the space with sand or clean earth free from particles larger than 1/4 inch. Cables shall not be unreeled and pulled into the trench from one end. However, the cable may be unreeled on grade and lifted into position. Provide a plastic warning tape as specified herein.

3.1.2.1 Cables crossing other cables or metal piping shall be separated from the other cables or pipe by not less than 3 inches of well-tamped earth.

3.1.2.2 Cables shall be in one piece without splices between connections except where the distance exceeds the lengths in which the cable is furnished.

3.1.2.3 Bends in cables shall be not less than those specified in NFPA 70 for the type of cable specified.

3.1.2.4 Horizontal slack of approximately 3 feet shall be left in the ground on each end of cable runs, on each side of connection boxes, and at all points where connections are brought above ground. Where cable is brought aboveground, leave additional slack to make necessary connections.

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3.1.2.5 Identification Slabs [Markers]: Provide a slab at each change of direction of the cable, over the ends of ducts or conduits which are installed under paved areas and roadways, and over each splice. Identification slabs shall be concrete, approximately 20 inches square by 6 inches thick, and shall be set flat in the ground so that the top surface projects not less than 3/4 inch, nor more than 1-1/4 inches above ground. The concrete shall have a minimum compressive strength of 3000 psi and shall have a smooth, troweled finish on exposed surface. Inscribe an identifying legend such as "cable", "duct", "splice", or other applicable designation on the top surface of slab before the concrete hardens. Inscribe circuit identification symbols on slabs as directed. The letters or figures shall be approximately 2 inches high, and the grooves shall be approximately 1/4 inch in width and depth. Install the slabs so that the side nearest the inscription on the top shall include an arrow indicating the side nearest the cable.

3.1.3 Underground Duct Without Concrete Encasement: Conduits shall be PVC, Type EPC-80.

3.1.3.1 The top of the conduit shall be not less than 24 inches below grade, shall have a minimum slope of 3 inches in each 100 feet away from buildings and toward manholes and other necessary drainage points, and shall run in straight lines except where a change of direction is necessary. As each conduit run is completed, a testing mandrel not less than 12 inches long with a diameter 1/4 inch less than the inside diameter of the conduit shall be drawn through each conduit, after which a stiff-bristled brush shall be drawn through until the conduit is clear of earth, sand, or gravel particles. Conduit plugs shall then immediately be installed. Ensure a minimum 3-inch clearance from the conduit to each side of the trench. Grade the bottom of the trenches smooth; excavate the bottom for an additional 3 inches; fill with sand, free from particles that would be retained on a 1/4-inch sieve; and tamp level with the original bottom.

3.1.3.2 Under roads, install conduits to extend at least 5 feet beyond the edges of the roads.

3.1.4 Underground Conduit for Service Feeders Into Buildings: Shall be PVC coated rigid steel from the service equipment to a point 5 feet beyond the building and projections thereof. Protect the ends of the conduit by threaded metal caps or bushings; coat the threads with graphite grease or other coating. Clean and plug conduit until conductors are installed.

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3.1.5 Buried Utility Warning and Identification Tape: Provide detectable aluminum foil plastic-backed tape or detectable magnetic plastic tape manufactured specifically for warning and identification of buried cable and conduit. Tape shall be detectable by an electronic detection instrument. Provide tape in rolls, 2 inches minimum width, color coded for the utility involved with warning and identification imprinted in bold black letters continuously and repeatedly over entire tape length. Warning and identification shall be CAUTION BURIED [ELECTRIC] [TELEPHONE] CABLE BELOW or similar. Use permanent code and letter coloring unaffected by moisture and other substances contained in trench backfill material. Bury tape with the printed side up at a depth of 12 inches below the top surface of earth or the top surface of the subgrade under pavements.

3.1.6 Reconditioning of Surfaces:

3.1.6.1 Unpaved surfaces disturbed during the installation of duct or direct burial cable shall be restored to the original elevation and condition. Sod or topsoil shall be preserved carefully and replaced after the backfilling is completed. Replace damaged sod with sod of equal quality. Where the surface is disturbed in a newly seeded area, the disturbed surface shall be reseeded with the same quantity and formula of seed as that used in the original seeding.

3.1.6.2 Unpaved roadways shall be restored as noted on the Contract Drawings.

3.1.7 Cable Pulling: Test existing ducts with a mandrel and thoroughly swab out to remove foreign material before the pulling of cables. Cables shall be pulled down grade with the feed-in point at the highest elevation. Cable lubricants shall be soapstone, graphite, or talc for rubber- or plastic-jacketed cables. Cable-pulling tensions shall not exceed the maximum pulling tension recommended by the cable manufacturer. Do not exceed the specified cable bending radii when installing cable under any conditions, including turnups into switches, transformers, switchgear, switchboards, and other enclosures. If basket-grip type cable-pulling devices are used to pull cable in place, cut off the section of cable under the grip before splicing and terminating.

3.1.7.1 Secondary cable runs, 600 volts and less, shall include an insulated copper equipment grounding conductor sized as required by the rating of the overcurrent device supplying the phase conductors.

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3.1.8 Excavating, Backfilling, and Compacting: Excavate to depths indicated. If hard material is encountered, the provisions of the contract respecting an adjustment for changed conditions shall apply, subject to the requirements of notification thereunder being given. Hard material shall be defined as solid rock; firmly cemented unstratified masses; conglomerate deposits possessing the characteristics of solid rock not ordinarily removed without systematic drilling and blasting; or any boulder, masonry, or concrete (except pavement) exceeding 1/2 cubic yard in volume.

3.1.8.1 Excavated materials not required or suitable for backfill shall be wasted on the project site as directed. Provide sheeting and shoring as necessary for protection of work and safety of personnel. Remove water from excavation by pumping or other approved method.

3.1.8.2 Backfilling shall consist of earth, loam, sand-clay, or sand and gravel, free from large clods of earth or stones over 1 inch in size Backfill materials shall be placed symmetrically on all sides in loose layers not more than 9 inches deep. Each layer shall be moistened, if necessary, and compacted with mechanical or hand tampers to 90 percent compaction.

3.1.8.3 Backfilling Trenches: Place backfill in layers not more than 6 inches thick, and compact each layer. Backfilling shall progress as rapidly as the construction, testing, and acceptance of the work permits. Backfill shall be free from roots, wood scrap material, and other vegetable matter and refuse. Compaction of backfill shall be to 90 percent of ASTM D698 density. The first layer shall be earth or sand, free from particles that would be retained on a 1/4-inch sieve and extending not less than 3 inches above the top of the conduit or cables. The succeeding layers shall be excavated material having stones no larger than would pass through a 4-inch ring. The backfill may be moistened. The backfill shall be level with the adjacent surface, except that in sodded areas, leave a space equal to the thickness of the sod.

3.1.9 Cable Terminating: Protect terminations of insulated power and lighting cables from accidental contact, deterioration of coverings, and moisture by the use of terminating devices and materials. Make terminations by using materials and methods indicated or specified herein or as designated by the written instruction of the cable manufacturer and termination kit manufacturer.

3.1.10 Splices for 600-Volt Class Cables: Splices in underground systems shall be made only in accessible locations such as manholes and hand holes, using a compression connector on the conductor and by insulating and waterproofing by one of the following methods suitable for continuous submersion in water.

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3.1.10.1 Cast-type splice insulation shall be provided by means of a molded casting process employing a thermosetting epoxy resin insulating material which shall be applied by a gravity-poured method or by a pressure-injected method. The component materials of the resin insulation shall be in a packaged form ready for convenient mixing without removing from the package. Do not allow the cables to be moved until after the splicing material has completely set.

3.1.10.2 Gravity-poured method shall employ materials and equipment contained in an approved commercial splicing kit which includes a mold suitable for the cables to be spliced. When the mold is in place around the joined conductors, prepare and pour the resin mix into the mold. Do not allow cables to be moved until after the splicing materials have completely set.

3.1.11 Grounding: Noncurrent-carrying metallic parts associated with electrical equipment shall have a maximum resistance to solid earth ground not exceeding the following values:

Grounded secondary distribution system neutral and noncurrent-carrying metal parts associated with distribution systems and grounds not otherwise covered	25 ohms

When work in addition to that indicated or specified is directed in order to obtain the specified ground resistance, the provisions of the Contract covering "Changes" shall apply.

3.1.11.1 Grounding electrodes shall be cone-pointed ground rods, driven full depth plus 6 inches, installed when indicated to provide an earth ground of the appropriate value for the equipment being grounded.

3.1.11.2 Grounding connections which are buried or otherwise normally inaccessible, and excepting specifically those connections for which access for periodic testing is required, shall be made by exothermic weld or compression connector. Exothermic welds shall be made strictly in accordance with the weld manufacturer's written recommendations. Welds which are "puffed up" or which show convex surfaces, indicating improper cleaning, are not acceptable. Mechanical connectors are not required at exothermic weldments. Compression connector shall be the type which uses a hydraulic compression tool to provide the correct circumferential

pressure. Tools and dies shall be as recommended by the manufacturer. An embossing die code or other standard method shall provide visible indication that a connector has been adequately compressed on the ground wire.

3.1.12 Special Conditions: During the construction of duct banks located in streets, the streets shall remain open to traffic. Plan and execute the work to meet this condition. At locations where duct banks cross railroad tracks and the work requires closing of the tracks, secure permission from the Engineer for each track closure.

3.2 FIELD TESTS: As an exception to requirements that may be stated elsewhere in the Contract, notify the Engineer in writing at least 5 working days prior to tests. Furnish labor, equipment, and incidentals required for testing, except that the Owner will provide electric power required for the tests. Correct defects in the work provided by the Contractor and repeat tests until the work is in compliance with contract requirements. Show by demonstration in service that circuits and devices are in good operating condition. Tests shall be such that each item of control equipment will function not less than five times.

3.2.1 Distribution Conductors 600-Volt Class: After wiring is completed and connected ready for operation, but prior to placing systems in service and before any branch circuit breakers are closed, perform insulation resistance tests in all circuits. Measure the insulation resistance between conductors and between each conductor and ground. Use an instrument capable of making measurements at an applied potential of 500 volts. Take readings after the voltage has been applied for a minimum of 1 minute. The minimum insulation resistance for circuits of No. 12 AWG conductors shall be 1,000,000 ohms. For circuits of No. 10 AWG or larger conductors, a resistance based on the allowable ampacity of the conductor as fixed by NFPA 70 shall be as follows:

WIRE SIZE	INSULATION RESISTANCE
#14 & #12 AWG	1,000,000 Ohms
#10 AWG & Larger	250,000 Ohms

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3.2.2 Ground Rods: Test ground rods for ground resistance value before any wire is connected. Perform ground resistance measurements in normally dry weather, not less than 48 hours after rainfall. Ground resistance shall also be measured for each piece of equipment to the ground electrode. Use a portable ground testing megger to test each ground or group of grounds. The instrument shall be equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground electrode under test. Provide one copy of the ground megger manufacturer's directions, indicating the method to be used.

3.2.3 Compaction: Backfill shall be tested in accordance with ASTM D1556, one test per lift per 2000 square feet.

3.2.4 Test Report:

a. 600-Volt Cables: Identify each cable and test result.

b. Grounding Electrodes and Systems: Identify electrodes and systems for each test, as well as the resistance and soil conditions at the time the measurements were made.

END OF SECTION

SPECIFICATIONS

SECTION 16402

INTERIOR WIRING SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION:

1.1.1 Under this Section, the Contractor shall furnish all labor, materials and equipment for Interior Wiring Systems, as shown on the Plans, as specified, and/or directed.

1.2 REFERENCES: The publications listed below and their latest revisions form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1.2.1 American National Standards Institute, Inc. (ANSI) Publications:

C80.1	Rigid Steel Conduit, Zinc Coated
C80.3	Electrical Metallic Tubing, Zinc Coated

1.2.2 American Society for Testing and Materials (ASTM) Publications:

B1	Hard-Drawn Copper Wire
B8	Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

1.2.3 Federal Specifications (FS):

L-P-387	Plastic Sheet, Laminated, Thermosetting (for Design Plates)
W-C-375	Circuit Breakers, Molded Case, Branch Circuit and Service
W-S-896	Switches, Toggle (Toggle and Lock), Flush Mounted

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1.2.4 National Electrical Manufacturers Association (NEMA) Publications:

FU1	Low Voltage Cartridge Fuses
ICS1	Industrial Control and Systems
ICS2	Industrial Control Devices, Controllers and Assemblies
ICS4	Terminal Blocks for Industrial Use
ICS6	Enclosures for Industrial Controls and Systems
KS1	Enclosed Switches
MG1	Motors and Generators
RN1	Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
ST20	Dry-Type Transformers for General Applications
TC2	Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80)
TC3	PVC Fittings for Use with Rigid PVC Conduit and Tubing
WD1	Wiring Devices

1.2.5 National Fire Protection Association (NFPA) Publication:

70	National Electrical Code

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1.2.6 Underwriters' Laboratories, Inc. (UL) Publications:

1	Flexible Metal Conduit
5	Surface Metal Raceways and Fittings
6	Rigid Metal Conduit
50	Cabinets and Boxes, Electrical
67	Panelboards
83	Thermoplastic-Insulated Wires and Cables
198C	High-Interrupting-Capacity Fuses, Current-Limiting Types
198E	Class R Fuses
198H	Class T Fuses
360	Liquid-Tight Flexible Steel Conduit
467	Grounding and Bonding Equipment
486A	Wire Connector and Soldering Lugs for Use with Copper Conductors
486B	Wire Connectors for Use with Aluminum Conductors
486C	Splicing Wire Connectors
489	Molded-Case Circuit Breakers and Circuit-Breaker Enclosures
498	Attachment Plugs and Receptacles

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506	Specialty Transformers
508	Industrial Control Equipment
510	Insulating Tape
514A	Metallic Outlet Boxes
514B	Fittings for Conduit and Outlet Boxes
514C	Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
719	Nonmetallic-Sheathed Cables
797	Electrical Metallic Tubing
854	Service-Entrance Cables
869	Service Equipment
886	Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations
943	Ground-Fault Circuit Interrupters

1.3 RELATED REQUIREMENTS: Section 16011, "Electrical General Requirements", applies to this Section with additions and modifications specified herein.

1.4 SUBMITTALS: Submit the following:

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1.4.1 Drawings:

a. Panelboards

b. Transformers

c. Disconnects

1.4.2 Field Test Reports:

a. 600-volt wiring test

b. Grounding system test

1.4.2.1 Format: Submit test results for approval in report form.

1.5 QUALITY ASSURANCE: In each standard referred to herein, consider the advisory provisions to be mandatory, as though the word "shall" has been substituted for "should" wherever it appears. Interpret references in these standards to "authority having jurisdiction," or words of similar meaning, to mean Engineer.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT: Materials, equipment, and devices shall, as a minimum, meet requirements of UL, where UL standards are established for those items, and requirements of NFPA 70.

2.2 CONDUIT AND FITTINGS:

2.2.1 Electrical Metallic Tubing (EMT): UL 797, ANSI C80.3.

2.2.2 Plastic-coated Rigid Steel Conduit: NEMA RN1, Type 40 (40 mils thick).

2.2.3 Flexible Metal Conduit: UL 1.

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2.2.3.1 Liquid-tight Flexible Metal Conduit, Steel: UL 360.

2.2.4 Fittings for Metal Conduit, EMT, and Flexible Metal Conduit: UL 514B. Ferrous fittings shall be cadmium- or zinc-coated in accordance with UL 514B.

2.2.4.1 Fittings for Rigid Metal Conduit: Threaded-type. Split couplings unacceptable.

2.2.4.2 Fittings for EMT: Compression type.

2.2.4.3 Fittings for Use in Hazardous Locations: UL 886.

2.3 SURFACE METAL RACEWAY AND FITTINGS: UL 5, two-piece painted steel, totally enclosed, snap screw fastened-cover type.

2.4 OUTLET BOXES AND COVERS UL 514A, cadmium- or zinc-coated, if ferrous metal. UL 514C, if nonmetallic.

2.4.1 Outlet Boxes in Hazardous Locations: UL 886.

2.5 CABINETS, JUNCTION BOXES, AND PULL BOXES: Volume greater than 100 cubic inches, UL 50, hot dip, zinc-coated, if sheet steel.

2.6 WIRES AND CABLES: Wires and cables shall meet applicable requirements of NFPA 70 and UL for type of insulation, jacket, and conductor specified or indicated. Wires and cables manufactured more than 12 months prior to date of delivery to site shall not be used.

2.6.1 Conductors: No. 10 AWG and smaller diameter shall be solid; No. 8 AWG and larger diameter shall be stranded. Conductor sizes and ampacities shown are based on copper, unless indicated otherwise.

2.6.1.1 Minimum Conductor Sizes: Minimum size for branch circuits shall be No. 12 AWG; for Class 1 remote-control and signal circuits, No. 14 AWG; and for Class 2 low-energy, remote-control and signal circuits, No. 16 AWG.

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2.6.2 Color Coding: Provide for service, feeder, branch, control, and signaling circuit conductors. Color shall be green for grounding conductors and white for neutrals; except where neutrals of more than one system are installed in same raceway or box, other neutral shall be white with colored (not green) stripe. Color of ungrounded conductors in different voltage systems shall be as follows:

a. 277/480 volt, 3-phase:

(1) Phase A - brown

(2) Phase B - orange

(3) Phase C - yellow.

b. 120/240 volt, single phase: red and black.

2.6.3 Insulation: Unless specified or indicated otherwise or required by NFPA 70, power and lighting wires shall be 600-volt, Type THWN, except that grounding wire may be Type TW; remote-control, and signal circuits shall be Type TW, THW, or TF. Conductors shall conform to UL 83. Where lighting fixtures require 90-degree C conductors, provide only conductors with 90-degree C insulation or better.

2.6.4 Bonding Conductors: ASTM B1, solid bare copper wire for sizes No. 8 AWG and smaller diameter; ASTM B8, Class B, stranded bare copper wire for sizes No. 6 AWG and larger diameter.

2.7 SPLICES AND TERMINATION COMPONENTS: UL 486A and UL 486B, as applicable, for wire connectors and UL 510 for insulating tapes. Connectors for No. 10 AWG and smaller diameter wires shall be insulated, pressure-type in accordance with UL 486A or UL 486C (twist-on splicing connector). Provide solderless terminal lugs on stranded conductors.

2.8 DEVICE PLATES: Provide UL listed, one-piece device plates for outlets and fittings to suit the devices installed. For metal outlets and fittings, plates on unfinished walls and on fittings shall be of zinc-coated sheet steel or cast metal having round or beveled edges. Screws shall be machine-type with countersunk heads in color to match finish of plate. Use of sectional-type device plates will not be permitted. Plates installed in wet locations shall be gasketed and UL listed for "wet locations".

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2.9 SWITCHES:

2.9.1 Toggle Switches: FS W-S-896, totally enclosed with bodies of thermosetting plastic and mounting strap. Handles shall be brown. Wiring terminals shall be screw-type, side-wired. Switches shall be rated quiet-type ac only, 120/277 volts, with current rating and number of poles indicated.

2.9.2 Disconnect Switches: NEMA KS 1. Switches serving as motor-disconnect means shall be horsepower rated. Provide heavy duty-type switches where indicated, where switches are rated higher than 240 volts, and for double-throw switches.

Fused switches shall utilize Class R fuseholders and fuses, unless indicated otherwise. Provide switches in NEMA 12 enclosure, per NEMA ICS6.

2.9.3 Breakers Used as Switches: For 120- and 277-Volt fluorescent fixtures, mark breakers "SWD" in accordance with UL 489.

2.10 RECEPTACLES: UL 498 and NEMA WD1, heavy-duty, specification grade, grounding-type. Ratings and configurations shall be as indicated. Wiring terminals shall be screw-type, side-wired. Connect grounding pole to mounting strap.

2.10.1 Weatherproof Receptacles: Provide in cast metal box with gasketed, weatherproof, cast-metal cover plate and gasketed cap over each receptacle opening. Caps shall be provided with a spring-hinged flap. Receptacle shall be UL listed for use in "wet locations".

2.10.2 Ground-fault Circuit Interrupter (GFCI) Receptacles: UL 943, duplex type for mounting in standard outlet box. Device shall be capable of detecting current leak of 6 milliamperes or greater and tripping per requirements of UL 943 for Class A GFCI devices.

2.11 PANELBOARDS: UL 67 and UL 50. Panelboards for use as service disconnecting means shall additionally conform to UL 869. Panelboards shall be circuit breaker-equipped. Design shall be such that individual breakers can be removed without disturbing adjacent units or without loosening or removing supplemental insulation supplied as means of obtaining clearances as required by UL. Where "space only" is indicated, make provisions for future installation of breaker sized as indicated. Panelboard locks shall be keyed same. Directories shall be typed to indicate load served by each circuit and mounted in holder behind transparent protective covering.

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2.11.1 Panelboard Buses: Support bus bars on bases independent of circuit breakers. Main buses and back pans shall be designed so that breakers may be changed without machining, drilling, or tapping. Provide isolated neutral bus in each panel for connection of circuit neutral conductors. Provide separate ground bus identified as equipment grounding bus per UL 67 for connecting grounding conductors; bond to steel cabinet.

2.11.2 Circuit Breakers: FS W-C-375 ambient-compensated thermal magnetic-type with interrupting capacity of 10,000 amperes symmetrical minimum. Breaker terminals shall be UL listed as suitable for type of conductor provided. Plug-in circuit breakers unacceptable.

2.11.2.1 Multipole Breakers: Provide common trip-type with single operating handle. Breaker design shall be such that overload in one pole automatically causes poles to open. Maintain phase sequence throughout each panel so that any three adjacent breaker poles are connected to Phases A, B, and C, respectively.

2.11.2.2 Circuit Breaker With GFCI: UL 943 and NFPA 70. Provide with "push-to-test" button, visible indication of tripped condition, and ability to detect and trip on current imbalance of 6 milliamperes or greater per requirements of UL 943 for Class A GFCI devices.

2.12 FUSES: NEMA FU1. Provide complete set of fuses for each fusible switch. Time-current characteristics curves of fuses serving motors or connected in series with circuit breakers or other circuit protective devices shall be coordinated for proper operation. Fuses shall have voltage rating not less than circuit voltage.

2.12.1 Cartridge Fuses, Current Limiting Type (Class R): UL 198E, Class RK-5 time delay-type. Associated fuseholders shall be Class R only.

2.13 TRANSFORMERS: NEMA ST20, general purpose, dry-type, self-cooled, ventilated. Provide transformers in NEMA 1 enclosure. Transformer shall have 220 degrees C insulation system for transformers 15 kVA and greater and shall have 180 degrees C insulation for transformers rated 10 kVA and less, with temperature rise not exceeding 150 degrees C under full-rated load in maximum ambient of 40 degrees C. Transformer of 150 degrees C temperature rise shall be capable of carrying continuously 100 percent of nameplate kVA without exceeding insulation rating. Transformer of 115 degrees C temperature rise shall be capable of carrying continuously 115 percent of nameplate kVA without exceeding insulation rating. Transformers shall have wall mounting brackets and shall have full capacity taps + (2) - 2.5%, - (2) - 2.5%.

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2.14 MOTORS: NEMA MG1. Hermetic-type sealed motor compressors shall also comply with UL 984. Provide the size in terms of HP, or kVA, or full-load current, or a combination of these characteristics, and other characteristics, of each motor as indicated or specified. Determine specific motor characteristics to ensure provision of correctly sized starters and overload heaters. Motors for operation on 480-volt, 3-phase circuits shall have terminal voltage rating of 460 volts. Provide motors designed to operate at full capacity with voltage variation of plus or minus 10 percent of motor voltage rating.

2.14.1 Motor Sizes: Provide size for duty to be performed, not exceeding the full-load nameplate current rating when driven equipment is operated at specified capacity under most severe conditions likely to be encountered. When motor size provided differs from size indicated or specified, make adjustments to wiring, disconnect devices, and branch circuit protection to accommodate equipment actually provided.

2.15 MOTOR CONTROLLERS: UL 508, NEMA ICS1, and NEMA ICS2. Controllers shall have thermal overload protection in each phase. Magnetic-type motor controllers shall have undervoltage protection when used with momentary-contact push button stations or switches and shall have undervoltage release when used with maintained-contact push button stations or switches. When used with pressure, float, or similar automatic-type or maintained-contact switch, controller shall have hand/off/automatic selector switch. Connections to selector switch shall be such that only normal automatic regulatory control devices are bypassed when switch is in "hand" position. Safety control devices, such as low and high pressure cutouts, high temperature cutouts, and motor overload protective devices, shall be connected in motor control circuit in "hand" and "automatic" positions. Control circuit connections to hand/off/automatic selector switch or to more than one automatic regulatory control device shall be made in accordance with indicated or manufacturer's approved wiring diagram. Selector switch shall have means for locking in all positions. For each motor not in sight of controller or where controller disconnecting means is not in sight of motor location and driven machinery location, controller disconnecting means shall be capable of being locked in open position or manual operation. Place nonfused switch which disconnects motor from supply source within sight of motor. Overload protective devices shall give adequate protection to motor windings; be thermal inverse, time limit-type; and include manual reset-type push button on outside of motor controller case. Cover of combination motor controller and manual switch or circuit breaker shall be interlocked with operating handle of switch or circuit breaker so that cover cannot be opened unless handle of switch or circuit breaker is in "off" position. [Minimum short circuit withstand rating of combination motor controller shall be [_____] rms symmetrical amperes.]

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2.15.1 Control Circuits: Control circuits shall have maximum voltage of 120 volts derived from control transformer in same enclosure. Transformers shall conform to UL 506, as applicable. Transformers, other than transformers in bridge circuits, shall have primaries wound for voltage available and secondaries wound for correct control circuit voltage. Size transformers so that 80 percent of rated capacity equals connected load. Provide disconnect switch on primary side. Provide fuses in each ungrounded primary feeder. One secondary lead shall be fused; other shall be grounded.

2.15.2 Enclosures for Starters and Controllers: NEMA ICS6.

2.15.3 Push Button Stations: Provide with "start/stop" momentary contacts having one normally open and one normally closed set of contacts and red lights to indicate when motor is running. Stations shall be heavy duty, oil-tight design.

2.15.4 Pilot and Indicating Lights: Provide transformer, resistor, or diode type.

2.15.5 Terminal Blocks: NEMA ICS4.

2.16 Backboards: Exterior grade plywood, 3/4-inch thick, painted.

2.17 GROUNDING AND BONDING EQUIPMENT: UL 467. Ground rods shall be sectional type, copper-clad steel, with minimum diameter of 3/4 inch and minimum length of 10 feet.

2.18 HAZARDOUS LOCATIONS: Electrical materials, equipment, and devices for installation in hazardous locations, as defined by NFPA 70, shall be specifically approved by Underwriters' Laboratories, Inc., or Factory Mutual for particular "Class", "Division", and "Group" of hazardous locations involved. Boundaries and classifications of hazardous locations shall be as indicated.

2.19 NAMEPLATES: FS L-P-387. Provide as specified in Section 16011, "Electrical General Requirements".

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PART 3 - EXECUTION

3.1 INSTALLATION: Electrical installations shall conform to requirements of NFPA 70 and to requirements specified herein.

3.1.1 Overhead Service: Overhead service conductors into buildings shall terminate at service entrance fittings or weatherhead outside building.

3.1.2 Hazardous Locations: Work in hazardous locations, as defined by NFPA 70, shall be performed in strict accordance with NFPA 70 for particular "Class", "Division", and "Group" of hazardous locations involved. Provide conduit and cable seals where required by NFPA 70. Conduit shall have tapered threads.

3.1.3 Service Entrance Identification: Service entrance disconnect devices, switches, or enclosures shall be labeled or identified as such.

3.1.4 Wiring Methods: Provide insulated conductors installed in conduit, except where specifically indicated or specified otherwise or required by NFPA 70 to be installed otherwise. Provide insulated, green equipment grounding conductor in feeder and branch circuits, including lighting circuits. Grounding conductor shall be separate from electrical system neutral conductor. Provide insulated, green conductor for grounding conductors installed in conduit or raceways. Minimum conduit size shall be 1/2 inch in diameter for low voltage lighting and power circuits.

3.1.4.1 Service Entrance Conduit, Overhead: Rigid steel from service entrance to service entrance fitting or weatherhead outside building.

3.1.4.2 Underground Conduit, Other Than Service Entrance: Plastic-coated rigid steel. Convert nonmetallic conduit, other than PVC Schedule 80, to plastic-coated rigid, steel conduit before rising through floor slab; plastic coating shall extend minimum 6 inches above floor.

3.1.4.3 Existing building, interior; Use EMT conduit for wiring inside the existing building.

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3.1.5 Conduit Installation: Unless indicated otherwise, conduit shall be run exposed. Keep conduit minimum 6 inches away from parallel runs of flues and steam or hot water pipes. Install conduit parallel with or at right angles to ceilings, walls, and structural members where located above accessible ceilings and where conduit will be visible after completion of project.

3.1.5.1 Conduit Through Floor Slabs: Where conduits rise through floor slabs, curved portion of bends shall not be visible above finish slab.

3.1.5.2 Conduit Support: Support conduit by pipe straps, wall brackets, hangers, or ceiling trapeze. Fasten by wood screws to wood; by toggle bolts on hollow masonry units; by concrete inserts or expansion bolts on concrete or brick; and by machine screws, welded threaded studs, or spring-tension clamps on steel work. Threaded C-clamps may be used on rigid steel conduit only. Do not weld conduits or pipe straps to steel structures. Load applied to fasteners shall not exceed one-fourth proof test load. Fasteners attached to concrete shall be vibration- resistant and shock-resistant. Holes cut to depth of more than 1-1/2 inches in reinforced concrete beams or to depth of more than 3/4 inch in concrete joints shall not cut main reinforcing bars. Fill unused holes. In partitions of light steel construction, use sheet metal screws.

3.1.5.3 Directional Changes in Conduit Runs: Make changes in direction of runs with symmetrical bends or cast-metal fittings. Make field-made bends and offsets with hickey or conduit-bending machine. Do not install crushed or deformed conduits. Avoid trapped conduits. Prevent plaster, dirt, or trash from lodging in conduits, boxes, fittings, and equipment during construction. Free clogged conduits of obstructions.

3.1.5.4 Pull Wire: Install pull wires in empty conduits in which wire is to be installed by others. Pull wire shall be plastic having minimum 200-pound tensile strength. Leave minimum 12 inches of slack at each end of pull wire.

3.1.5.5 Locknuts and Bushings: Fasten conduits to sheet metal boxes and cabinets with two locknuts where required by NFPA 70, where insulated bushings are used, and where bushings cannot be brought into firm contact with the box; otherwise, use minimum single locknut and bushing. Locknuts shall have sharp edges for digging into wall of metal enclosures. Install bushings on ends of conduits, and provide insulating type where required by NFPA 70.

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3.1.5.6 Flexible Connections: Provide flexible connections of short length, 6-foot maximum, for recessed and semi-recessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for motors. Provide liquid-tight flexible conduit in wet locations. Provide separate ground conductor across flexible connections.

3.1.6 Boxes, Outlets, and Supports: Provide boxes in wiring or raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures. Boxes for metallic raceways shall be cast-metal, hub-type when located in wet locations, when surface mounted on outside of exterior surfaces, when installed exposed up to 7 feet above interior floors and walkways, or when installed in hazardous areas. Boxes in other locations shall be sheet steel. Each box shall have volume required by NFPA 70 for number of conductors enclosed in box. Boxes for mounting lighting fixtures shall be minimum 4 inches square, or octagonal, except that smaller boxes may be installed as required by fixture configurations, as approved. Provide gaskets for cast-metal boxes installed in wet locations and boxes installed flush with outside of exterior surfaces. Provide separate boxes for flush or recessed fixtures when required by fixture terminal operating temperature; fixtures shall be readily removable for access to boxes unless ceiling access panels are provided. Support boxes and pendants for surface-mounted fixtures on suspended ceilings independently of ceiling supports, or make adequate provisions for distributing load over ceiling support members. Fasten boxes and supports with wood screws on wood, with bolts and expansion shields on concrete or brick, with toggle bolts on hollow masonry units, and with machine screws or welded studs on steel. In open overhead spaces, cast boxes threaded to raceways need not be separately supported except where used for fixture support; support sheet metal boxes directly from building structure or by bar hangers. Where bar hangers are used, attach bar to raceways or opposite sides of box, and support raceway with approved-type fastener maximum 24 inches from box. When penetrating reinforced concrete members, avoid cutting reinforcing steel.

3.1.6.1 Boxes: Boxes for use with raceway systems shall be minimum 1-1/2 inches deep, except where shallower boxes required by structural conditions are approved. Boxes for other than lighting fixture outlets shall be minimum 4 inches square, except that 4-by-2-inch boxes may be used where only one raceway enters outlet.

3.1.6.2 Pull Boxes: Construct of at least minimum size required by NFPA 70 of code-gauge galvanized sheet steel, except where cast-metal boxes are required in locations specified herein. Furnish boxes with screw-fastened covers. Where several feeders pass through common pull box, tag feeders to indicate clearly electrical characteristics, circuit number, and panel designation.

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3.1.7 Mounting Heights: Mount panelboards, circuit breakers, and disconnecting switches so height of operating handle at its highest position is maximum 78 inches above floor. Mount lighting switches 48 inches above finished floor, receptacles 48 inches above finished floor, and other devices as indicated. Measure mounting heights of wiring devices and outlets to center of device or outlet.

3.1.18 Conductor Identification: Provide conductor identification within each enclosure where tap, splice, or termination is made. For conductors No. 6 AWG and smaller diameter, color coding shall be by factory-applied, color-impregnated insulation. For conductors No. 4 AWG and larger diameter, color coding shall be by plastic-coated, self-sticking markers; colored nylon cable ties and plates; or heat shrink-type sleeves. Identify control circuit terminations.

3.1.9 Splices: Make splices in accessible locations. Make splices in conductors No. 10 AWG and smaller diameter with insulated, pressure-type connector. Make splices in conductors No. 8 AWG and larger diameter with solderless connector, and cover with insulation material equivalent to conductor insulation.

3.1.10 Covers and Device Plates: Install with edges in continuous contact. Plates shall be installed with alignment tolerance of 1/16 inch. Use of sectional-type device plates are not permitted. Plates installed in wet locations shall be gasketed.

3.1.11 Grounding and Bonding: In accordance with NFPA 70. Ground-exposed, noncurrent-carrying metallic parts of electrical equipment, metallic raceway systems, grounding conductor in metallic and nonmetallic raceways, and neutral conductor of wiring systems. Make ground connection at main service equipment, and extend grounding conductor to point of entrance of metallic water service. Make connection to water pipe by suitable ground clamp or lug connection to plugged tee. If flanged pipes are encountered, make connection with lug bolted to street side of flanged connection. Supplement metallic water service grounding system with additional made electrode in compliance with NFPA 70. Make ground connection to driven ground rods on exterior of building. Where ground fault protection is employed, ensure that connection of ground and neutral does not interfere with correct operation of fault protection.

3.1.11.1 Grounding Conductor: Provide insulated, green equipment grounding conductor in feeder and branch circuits, including lighting circuits. Grounding conductor shall be separate from electrical system neutral conductor. Provide insulated, green conductor for grounding conductors installed in conduit or raceways.

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3.1.11.2 Resistance: Maximum resistance-to-ground of grounding system shall not exceed 25 ohms under dry conditions. Where resistance obtained exceeds 25 ohms, contact Engineer for further instructions.

3.1.12 Owner-furnished Equipment: Contractor shall rough-in for Owner-furnished equipment shall make connections to Owner-furnished equipment to make equipment operate as intended, including providing miscellaneous items such as plugs, receptacles, wire, cable, conduit, flexible conduit, and outlet boxes or fittings.

3.1.13 Repair of Existing Work: Repair of existing work, demolition, and modification of existing electrical distribution systems shall be performed as follows:

3.1.13.1 Workmanship: Lay out work in advance. Exercise care where cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, or other surfaces is necessary for proper installation, support, or anchorage of conduit, raceways, or other electrical work. Repair damage to buildings, piping, and equipment using skilled craftsmen of trades involved.

3.1.13.2 Existing Concealed Wiring to be Removed: Existing concealed wiring to be removed shall be disconnected from its source. Remove conductors; cut conduit flush with floor, underside of floor, and through walls; and seal openings.

3.1.13.3 Removal of Existing Electrical Distribution System: Removal of existing electrical distribution system equipment shall include equipment's associated wiring, including conductors, cables, exposed conduit, surface metal raceways, boxes, fittings, etc., back to equipment's source as indicated.

3.1.13.4 Continuation of Service: Maintain continuity of existing circuits of equipment to remain. Existing circuits of equipment shall remain energized. Circuits which are to remain but were disturbed during demolition shall have circuits wiring and power restored back to original condition.

3.2 FIELD QUALITY CONTROL: Furnish test equipment and personnel and submit written copies of test results. Give Engineer 5 working days notice prior to test.

3.2.1 Devices Subject to Manual Operation: Each device subject to manual operation shall be operated at least five times, demonstrating satisfactory operation each time.

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3.2.2 Test on 600-volt Wiring: Test 600-volt wiring to verify that no short circuits or accidental grounds exist. Perform insulation resistance tests on wiring No. 6 AWG and larger diameter using instrument which applies voltage of approximately 500 volts to provide direct reading of resistance. Minimum resistance shall be 250,000 ohms.

3.2.3 Grounding System Test: Test grounding system to ensure continuity and resistance to ground is not excessive. Test each ground rod for resistance to ground before making connections to rod; tie grounding system together and test for resistance to ground. Make resistance measurements in dry weather, not earlier than 48 hours after rainfall. Submit written results of each test to Engineer, and indicate location of rods as well as resistance and soil conditions at time measurements were made.

END OF SECTION

SPECIFICATIONS

SECTION 16450

GROUNDING

PART 1 - GENERAL

1.1 DESCRIPTION: Under this Section, the Contractor shall furnish all labor, materials and equipment for Grounding and Bonding of electrical installations as shown on the Plans, as specified and/or directed.

1.2 REFERENCES: The publications listed below and their latest revisions form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1.2.1 National Fire Protection Association (NFPA) Publication:

70	National Electrical Code (NEC)

1.2.2 Underwriters' Laboratories, Inc. (UL) Publications:

83	Thermoplastic-Insulated Wires and Cables
44	Rubber-Insulated Wires and Cables
467	Grounding and Bonding Equipment

1.3 RELATED SECTIONS:

1.3.1 Section 16011, Electrical General Requirements.

1.4 SUBMITTALS:

1.4.1 Submit the following:

1.4.2 Submit test reports in accordance with Section 16011, "Electrical General Requirements".

1.4.2.1 Certified test reports of ground resistance.

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1.4.2.2 Certifications: Two weeks prior to final inspection, deliver to the Engineer four copies of the certification that the material and installation is in accordance with the drawings and specifications and has been properly installed.

PART 2 - PRODUCTS

2.1 GROUNDING WIRES:

2.1.1 General Purpose: UL and NEC approved types, copper, with TW, THW, XHHW or dual rated THHN-THWN insulation color identified green.

2.1.2 Isolated Power System: Type XHHW insulation with a dielectric constant of 3.5 or less.

2.1.3 Size wire not less than what is shown and not less than required by the NEC.

2.2 GROUND RODS:

2.2.1 Copper clad steel, 3/4-inch diameter by 10 feet long.

PART 3 - EXECUTION

3.1 INSTALLATION:

3.1.1 Ground as shown and as hereinafter specified in accordance with the NEC.

3.1.2 System Grounding:

3.1.2.1 Secondary service neutrals ground at the supply side of the secondary disconnecting means and at the related transformers.

3.1.2.2 Separately derived systems (transformers downstream from the service entrance) ground the secondary neutral.

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3.1.2.3 Isolation transformers and isolated power systems shall not be system grounded.

3.1.3 Equipment Grounding:

3.1.3.1 Metallic structures, enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits shall be grounded for personnel safety and to provide a low impedance path for possible ground fault currents.

3.2 PRIMARY EQUIPMENT AND CIRCUITS:

3.2.1 Switchgear: Provide a bare grounding electrode conductor from the switchgear ground bus to a grounding electrode system, metal underground water pipe or driven ground rods for the grounding electrode.

3.2.2 Duct Banks and Manholes:

3.2.2.1 Provide a bare equipment grounding conductor in each duct bank containing medium or high voltage cables. Connect the grounding conductors to the switchgear ground bus, to all manhole hardware, to the cable shielding of medium or high voltage cable splices and terminations, and equipment enclosures.

3.2.2.2 Provide a grounding conductor having at least 50 percent ampacity of the largest phase conductor in the duct bank.

3.2.2.3 Connect the equipment grounding conductor to the ground rod.

3.2.3 Outdoor Fences: Connect outdoor fences around electrical equipment to the grounding electrode system.

3.2.4 Metallic Conduit: Metallic conduits which terminate without mechanical connection to a housing of electrical equipment by means of locknut and bushings or adapters, provided with grounding bushings. Connect bushings with a bare grounding conductor to the equipment ground bus.

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GROUNDING

3.2.5 Lightning Arresters: Connect lightning arrester grounds to the equipment ground bus, or ground rods as applicable.

3.3 SECONDARY EQUIPMENT AND CIRCUITS:

3.3.1 Main Bonding Jumper: Connect the secondary service neutral to the ground bus in the service equipment.

3.3.2 Water Pipe and Supplemental Electrode:

3.3.2.1 Provide a ground conductor connection between the service equipment ground bus and the metallic water pipe system. Jumper insulating joints in the water pipe.

3.3.2.2 Provide a supplemental ground electrode and bond to the water pipe ground, or connect to the service equipment ground bus.

3.3.3 Service Disconnect (Separate Individual Enclosure): Provide a ground bar bolted to the enclosure with lugs for connecting the various grounding conductors.

3.3.4 Switchgear, Switchboards and Unit Substations:

3.3.4.1 Connect the various feeder green grounding conductors to the ground bus in the enclosure with suitable pressure connectors.

3.3.4.2 Connect the grounding electrode conductor to the ground bus.

3.3.4.3 Connect the neutral to the ground bus (main bonding jumper).

3.3.4.4 Connect metallic conduits, which terminate without mechanical connection to the housing, by grounding bushings and ground wire to the ground bus.

3.3.5 Conduit Systems:

3.3.5.1 Ground all metallic conduit systems.

3.3.5.2 Non-metallic conduit systems shall contain a grounding conductor.

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3.3.5.3 Conduit provided for mechanical protection containing only a grounding conductor, bond to that conductor at the entrance and exit from the conduit.

3.3.6 Feeders and Branch Circuits: Install green grounding conductors with feeders and branch circuits as follows:

a. Feeders
b. Branch Circuits
c. Receptacle Outlets
d. Directly Connected Equipment, Appliances and Devices
e. Motors and Motor Controllers
f. Fixed Equipment and Appurtenances
g. Items of equipment where the final connection is made with flexible metal conduit shall have a grounding wire.
h. Additional locations and systems as shown

3.3.7 Boxes, Cabinets, Enclosures and Panelboards:

3.3.7.1 Bond the grounding wires to each pull box, junction box, outlet box, cabinets, and other enclosures through which the ground wires pass.

3.3.7.2 Provide lugs in each box and enclosure for ground wire termination.

3.3.7.3 Provide ground bars in panelboards, bolted to the housing, with sufficient lugs for terminating the ground wires.

3.3.8 Motors and Starters:

3.3.8.1 Provide lugs in motor terminal box and starter housing for ground wire termination.

3.3.8.2 Make ground wire connections to ground bus in motor control centers.

3.3.9 Receptacles are not approved for grounding through their mounting screws. Ground with a ground wire from green ground terminal on the receptacle to the outlet box ground screw.

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3.3.10 Ground lighting fixtures to the green grounding conductor of the wiring system. During renovation, provide the green ground if it is not part of the system, or ground the fixtures through the conduit systems per means acceptable under the NEC. Fixtures connected with flexible conduit shall have a green ground wire included with the power wires from the fixture through the flexible conduit to the first outlet box.

3.3.11 Fixed electrical appliances and equipment shall have a ground lug installed for termination of the green ground conductor.

3.4 CONDUCTIVE PIPING:

3.4.1 Bond all conductive piping systems in the building to the electrical system ground. Bonding connections shall be made as close as practical to the water pipe ground or service equipment ground bus.

3.5 GROUND RESISTANCE:

3.5.1 Grounding system ground resistance must comply with NEC.

3.5.2 Services at power company interface points shall comply with the power company ground resistance requirements.

3.5.3 Make necessary modifications to the ground electrodes for compliance that is needed without additional cost to the Owner, including the provisions of a multi-rod system.

3.6 GROUND ROD INSTALLATION:

3.6.1 Drive each rod vertically in the earth for not less than ten feet in depth.

3.6.2 Where permanently concealed ground connections are required, make the connections by the exothermic process to form solid metal joints. Make accessible ground connections with mechanical pressure type ground connectors.

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3.6.3 Where rock prevents the driving of vertical ground rods, install grounding electrodes in horizontal trenches to achieve the specified resistance.

END OF SECTION