



STANDARD SPECIFICATIONS

LOUISVILLE AND JEFFERSON COUNTY
METROPOLITAN SEWER DISTRICT
700 WEST LIBERTY STREET
LOUISVILLE, KENTUCKY 40203-1911

MSD STANDARD SPECIFICATIONS

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SECTION 1

MSD STANDARD SPECIFICATIONS

GENERAL PROVISIONS

1.1. DESCRIPTION OF WORK

All labor, materials, equipment, tools and services required for the furnishing, installation, construction, video recording, and testing of all sanitary sewer or storm drainage facilities required for this Project shall be furnished, installed, constructed, recorded and tested in compliance with the Contract. These Specifications cover the materials to be utilized in construction, and the installation and construction standards to be required of the Contractor.

1.2. VIDEO RECORDING

Prior to the start of construction, the Contractor shall provide one original walking, narrative continuous **digital-type** video, a minimum 2 to 3 minutes per 100 feet of alignment, of the complete Project as directed by MSD's Construction Inspector. The tape counter value should be keyed to each manhole, drainage structure, or building address, labeled accordingly.

1.3. UNDERGROUND STRUCTURES AND UTILITIES

Every effort will be made to show on the Plans known utilities, structures, drains, etc., adjacent to or to be encountered by construction. The locations shown on the Plans are taken from existing records and are believed to be the best information available. However, it is expected that there may be some discrepancies or omissions in the locations and quantities shown. The Contractor shall verify the locations of all underground structures and utilities in critical areas or as directed by MSD prior to the start of construction. The Contractor shall avoid damaging the existing utilities while verifying their locations. Such information is furnished subject to the limitations set out in MSD's Information to Bidders.

The Contractor shall notify the Kentucky **811 Before Your Dig (BUD)** at 1-800-752-6007, 48 hours in advance of any construction. The Contractor shall notify MSD's Base One (540-6812) prior to any personnel being allowed to enter into an MSD active manhole or sewer. All precautions as delineated in the MSD Health & Safety Rule Book shall be followed.

The Contractor shall be responsible for protection of any structure or utility encountered on the site. The cost of repair, removal, replacement, relocation, etc. of such facilities arising because of carelessness or negligence on the part of the Contractor shall be the Contractor's responsibility.

The Contractor shall make every effort to protect private structures and utility service connections whether in right-of-way/easement or on private property, including sewer facilities.

They may not be shown on the Plans. When these facilities are disturbed or damaged by the Work, the Contractor shall make necessary repairs to the facilities for continuous service prior to the close of the work day, at the Contractor's expense.

Should uncharted or incorrectly charted piping or other utilities be encountered within utility easements or the public rights-of-way, the Contractor shall immediately contact MSD.

Suitable arrangements will be made with the proper agency by MSD and the responsibility for the cost will be determined by MSD. The Contractor shall cooperate and coordinate with the utility companies to keep respective services and facilities in operation. Coordination is the responsibility of the Contractor.

1.4. WORK AROUND LOUISVILLE GAS AND ELECTRIC COMPANY FACILITIES

1.4.1. General. The Louisville Gas and Electric Company shall be given 5 working days advance notice before Work is begun. When revamping of facilities will be required, at least 2 weeks advance notice shall be given the Louisville Gas and Electric Company to allow sufficient time for engineering Work to be completed. On major modifications or relocations, longer notice will be necessary. Coordination is the responsibility of the Contractor. The Contractor shall cooperate and coordinate with the utility companies to keep respective services and facilities in operation.

1.4.2. Electric Facilities

Blasting shall not be done under or near an electric line unless a representative of the Louisville Gas and Electric Company is present.

The Contractor shall not utilize utility poles for physical support of any of his operations. Cables, ropes or support systems shall not be attached to utility poles.

If damage to electric lines should occur, the Contractor shall notify the Louisville Gas and Electric Company immediately by calling 627-3400, Electric Trouble Department.

1.4.3. Gas Facilities

No blasting shall be done within 10 feet of a gas main unless a representative of the Louisville Gas and Electric Company is present.

Special care should be taken not to break or damage gas mains or service lines during construction. If damage does occur to gas mains or service lines the Contractor is responsible for coordinating all repairs and notifying affected property owners before and after repairs.

Damage to a **LG&E facility** by the Contractor shall immediately be reported to Louisville Gas and Electric Company and shall be repaired at the expense of the Contractor. Such repairs shall be limited to that portion of the service line which is in the public right-of-way or

easement.

Extra precaution shall be taken during construction near high pressure mains. If it becomes necessary to expose the Louisville Gas and Electric Company's pipelines as a precautionary measure, advise the Company by calling 589-5511, Gas Trouble Clerk (24 hours).

1.5. GEOTECHNICAL INFORMATION

Borings and soundings may or may not be shown on the Plans. If borings and soundings are not shown, and the Contractor desires to have positive soil information, the Contractor shall make such borings and soundings at the Contractor's expense. Prior to making borings or soundings, the Contractor shall receive approval from the property owner, or if within the road rights-of-way, from the appropriate agency and shall notify MSD's Customer Service of such activity. MSD does not guarantee that the boring information shown in the Bid Documents is accurate or correct. Such information is furnished subject to the limitations set out in the Contract. *See Chapter 17 of MSD's Design Manual for clarification.*

1.6. SURVEYING AND STAKING

1.6.1. General. The responsibilities for the surveying and staking necessary for the construction of the Project shall be as defined herein. MSD will provide all surveying necessary to establish the horizontal and vertical control coordinates, including the setting of monuments meeting MSD standards, and benchmarks for such control on all MSD projects. In all other cases, the Developer's Engineer shall provide for such control on plans.

All surveying control points *on MSD projects* will be furnished by MSD one time only unless otherwise provided in the Contract. The Contractor shall be responsible for protecting and preserving all such surveys provided by MSD, including monuments, benchmarks, survey stakes, reference points, or other survey markers and shall be required to bear the expense of replacing or resetting same if damaged or destroyed. *Should a control point need to be replaced or reset, the Contractor shall pay the Design Engineering firm at their approved hourly rate to perform this work.*

The Contractor will provide all construction survey and staking necessary for layout and construction from the control points. The Contractor, through the field inspector, shall give the **MSD Project Manager** two weeks advance notice prior to the start of survey. The Contractor shall provide temporary benchmarks within 300 linear feet of all proposed structures.

Where new construction connects to existing facilities, it shall be the Contractor's responsibility to check and determine the exact location of the existing facilities. Whenever field conditions are found to vary from those indicated on the Plans, the Contractor shall notify MSD immediately. MSD will investigate such conditions and, if warranted, make revisions or adjustments. The Contractor shall not proceed with that portion of the Work until the investigation is complete and red-lined Plans have been approved by MSD.

1.6.2. Construction Staking. Offset hubs and stakes, one short (12 inch) hub and one tall (36 inch) stake at each location, shall be set at all 100-foot stations for gravity flow sanitary and storm drainage facilities, and at 200-foot stations for all force mains. In paved areas, PK nails and paint shall be used. In addition, offset hubs and stakes shall be provided at line intersections, appurtenances, points where the alignment or grade changes, and a minimum of two offset hubs shall be provided at **all** structure corners.

The stakes shall be strong, sound, straight, and free from knots, dressed on two sides, and pointed. Hubs shall be strong, sound, undressed oak lumber, and pointed. Stakes shall be a minimum of 3/4 inch x 1 1/2 inches when dressed, and hubs shall be a minimum of 2 inches square and 12 inches long. Stake widths, and lengths of both stakes and hubs may vary if so ordered by MSD.

1.6.3. Checking Line and Grade. If requested, the Contractor shall provide MSD with a copy of field book notes and complete cut sheets showing stations, grade stake elevations, required slopes, invert elevations and cut distances for sewer main, structures and pipe stubs.

Additionally, the contractor's surveyor will provide support to MSD when checking and verification is requested. All property service connections (PSC) and pipe stubs with lengths in excess of 5 feet shall have elevations and stations referenced by the Contractor's Professional Land Surveyor. All stubs ends shall be referenced before being covered.

If a laser beam is used to maintain the line and grade, the Contractor shall have it calibrated per manufacturer's recommendation not less than once per year. Calibration seal shall be kept with the instrument on site for review by MSD representative as requested. The Contractor shall use a blower or other acceptable device to vent enclosed conduits as required to prevent refraction.

1.6.4. Final Record Drawings. **On MSD projects, the Final Record Drawings will be prepared by MSD, or the project design engineer/consultant, based on record information provided to MSD by the contractor. At the completion of the project, the contractor will be responsible for providing MSD a set of "Red Line Drawings" and "As-Built Survey Information" as indicated below. The information will be incorporated into the bid plans to become the Final Record Drawings.**

Note - On private development projects, the project design engineer/consultant will be responsible for preparing the Final Record Drawings, subject to the same requirements as a MSD project.

1.6.4.1 Red-Line Drawings

The Contractor shall keep a record of all deviations in location or elevation of any installation from that shown on the Plans. Records shall also be kept of any significant changes in installations from shop drawings. The information will be compiled in a red-lined format on the shop drawings and a copy of the initial bid plan set. Plans shall be available to MSD at any time upon request during construction. No such deviations from the Plans or approved shop drawings shall be made without prior approval by MSD. Should the as-built drawings reflect

that unapproved deviations during the construction process have taken place, MSD shall be notified in writing. If it is determined by MSD that said deviations compromise the intent of the design, the contractor shall be held responsible for reconstruction. **At the completion of the project the as-built information is submitted to MSD. The information should be recorded in a clear and concise format, allowing for an easy transfer.**

1.6.4.2 As-Built Survey Information

The Contractor's Licensed Professional Land Surveyor **will be responsible for**"as-building" the items listed below. The survey information will be compiled in an electronic fashion, compatible with the .dwg format, and submitted to MSD. Location and elevations shall be tied to the project survey control.

The following construction items, at a minimum, should be reviewed and verified to produce the Final Record Drawings:

❖ Alignment Changes

➤ Changes in Location for:

- **Manholes**
- **Catch Basins or Surface Inlets**
- **Headwalls**
- **Retaining Walls**
- **Slope Protection**
- **Channel Linings**
- **Pump Station Wet Wells**
- **Pump Station Valve Vaults**
- **Air Release Valves**
- **Property Service Cleanouts**

➤ Changes in Elevation for:

- **Nearest hundredth**
 - **Inverts**
 - **Rims**
 - **Surface Inlet Grates**
 - **Paved Ditches**
- **Nearest tenth**
 - **Turf Ditches**
 - **Miscellaneous Structures**

❖ Structure Changes

➤ General

- **Manhole collar sizes**
- **All revisions in pipe size, lengths, slopes, and angles**
- **Identify pipe material if different from the plans**
- **For Pump Stations and Wastewater Treatment Plants:**
 - **All revisions in pipe sizes**
 - **All revisions to electrical controls**
 - **All revisions to exhaust and ventilation systems**
 - **Pump modifications**
 - **Changes in elevation for inverts and level controls**
 - **Equipment layout modifications**
 - **Building modifications**
- ❖ **Miscellaneous Changes:**
 - **For Property Service Connections**
 - **Size**
 - **Length**
 - **Depth at R/W or Property Line**
 - **Sewer Station**
 - **End Location, if the PSC is not perpendicular to the sewer**
 - **For changes in Lot or Unit Designations**
 - **Lot Numbers**
 - **Tract Numbers**
 - **Apartment Unit Designations**
 - **Condominium Unit Designations**
 - **Patio Home Designations**

1.6.4.3 Process

Proposed information shall under no circumstances be erased from the original Plans. Plan corrections must be made to ensure a quality image. No red line markings will be accepted for final record drawings. A check mark should be placed beside the original Plan information which has been verified to be correct as constructed. Any unverified data shall show +/- thereby indicating that information has not been verified.

The following stamp will be inserted into each plan sheet after all as-built information has been added.

Final Record Drawing

By _____ Date _____

Contractor _____

Record Drawings have been prepared based on information provided by the Contractor in accordance with the specifications.

1.7. MAINTENANCE AND CONTROL OF TRAFFIC

1.7.1. Permits and Notification. MSD will be responsible for obtaining the necessary ***Louisville Metro Government***, and/or State encroachment permits for work in public rights-of-way as applicable. The Contractor shall obtain all other permits. The Contractor is required to abide by all the conditions of the encroachment permit(s) and they shall be made a part of this Contract.

The Contractor shall notify the ***Louisville Metro Department of Public Works*** or the Kentucky Transportation Cabinet, where applicable, in writing and with a copy to MSD, at least one week prior to beginning any work in the public rights-of-way. Maintenance of traffic (or traffic control) plan shall be supplied by the Contractor, and approved by the appropriate governing agency. The Contractor shall obtain permits on private development projects, stormwater, and non-MSD sanitary sewer facilities.

1.7.2. Traffic Control. At a minimum the Contractor shall provide and maintain traffic control signs, barricades, barriers, warning lights and flaggers as necessary to meet the standards for traffic control, as outlined in the Manual on Uniform Traffic Control Devices, latest revision, or as noted in the permits and the Contract. Additional traffic control measures, including signs, shall be furnished at no additional cost to MSD.

1.7.3. Maintenance of Traffic. Unless otherwise shown in the Bid Documents, all roads and streets, affected by construction, shall be kept clean from mud or debris and open to all traffic by the Contractor. Where so provided on the Plans or as directed by MSD, the Contractor may route the traffic over approved detour routes. The Contractor shall keep the portion of the Project being used by public traffic in such condition that traffic will be adequately and safely accommodated.

The Contractor must maintain proper, sufficient, and continuous ingress and egress to private properties and access to buildings unless otherwise shown in the Contract or where temporary interference to access is authorized by MSD. Provisions shall be made for owners and occupants to reach their premises and for emergency vehicles to have access at all times. The Contractor shall provide access to private properties by bridging, use of steel plates, or other means acceptable to MSD. Where temporary interference is

authorized, it shall be interrupted only for such time as necessary to provide temporary substitutes for surfaces disturbed by the construction and to restore street and sidewalk surfaces after the completion of the Work. The Contractor is to notify each day, all community services which includes contacting TARC, School Districts, U.S. Mail, and central Dispatch of the local Fire Marshall by facsimile when performing Work on the pavement that may in any way impede traffic. When fire hydrants are taken out of service, a facsimile of the location of the fire hydrant must be sent to the local Fire Marshall, Central Dispatch, and a copy given to the inspector on site prior to this occurring.

1.8. AIR POLLUTION CONTROL

1.8.1. General. The Contractor shall perform construction activities in such manner so as to prevent air pollution from occurring as the result of drilling, blasting, grading, hauling, or any other construction activities of any kind in conformity with applicable provisions of the Air Pollution Control Regulations enforced by the ***Louisville Metro*** Air Pollution Control Board.

1.8.2. Open Burning. Open burning will not be permitted on the construction site.

1.8.3. Dust Control. Water or approved chemical additives shall be applied on roadways, stockpiles, graded areas, etc. to prevent and abate fugitive dust resulting from the Contractor's operations. Paved streets and roads shall be kept clean of all earth materials deposited by the Contractor's operations. When water is used for cleaning operations, all affected inlets will be protected to prevent mud, silt and debris from entering the system.

1.8.4. Equipment. The Contractor's equipment shall be maintained to prevent excessive fumes, gases, vapors, noise, or fluids from escaping and creating a nuisance to the public.

1.9. STANDARDS AND SPECIFICATIONS

1.9.1. KTC Standard Specifications and Drawings (latest editions). Reference is made to the Kentucky Transportation Cabinet's (KTC) Standard Specifications for Road and Bridge Construction and the Standard Drawings binder. The Contractor shall secure copies of both documents when performing work which is described therein. Copies may be obtained from:

Kentucky Transportation Cabinet
Manager, Policy and Procedures
Development Branch
112 State Office Building
Frankfort, Kentucky 40622

1.9.2. Latest Revisions. Wherever reference is made to any published standards, codes or standard specifications, it shall mean the latest standard code, specification or tentative specification of the technical society, organization or body to which reference is made. Where specified articles, sections, paragraphs or other subdivisions of the referenced publications are

not stated, the referenced publication shall apply in full.

1.10. WATER SUPPLY AND SANITARY FACILITIES

1.10.1. Water Supply. The Contractor shall provide, at convenient points, including MSD's field office, ample fresh supplies of water of proper quality and quantity for all labor, inspection, and operations required under this Contract. The supply of drinking water shall be contained in a suitable cooler or other approved sanitary container. The Contractor shall also provide paper cups.

1.10.2. Sanitary Facilities. The Contractor shall provide sanitary facilities for the duration of this Contract for all labor and inspection personnel and will comply with the regulations of the local and state health departments. Inspection and Contractor's facilities shall be separate. The sanitary facilities for the MSD inspector shall be a lockable, portable toilet and shall be located at or near MSD's field office when a field office is specified. The Contractor shall clean and maintain these facilities on a weekly basis.

1.11. ENGINEER'S FIELD OFFICE

When specified in the Contract, the Contractor shall furnish, for the exclusive use of MSD, an approved weatherproof, lockable building to be utilized as a field office. It shall be located conveniently on or near the Project, and shall be independent of any buildings used by the Contractor. Adjacent to the field office there shall be two graveled parking spaces for the exclusive use of MSD. The field office shall have approved OSHA steps with handrail. The field office shall have not less than: 200 square feet of usable floor space, 8 feet ceiling heights, 3 windows, a door, and a wooden floor or better. The field office shall be furnished with an instrument locker 2 feet by 3 feet in plan and 5 feet high, with adjustable shelves, a hinged wall table 3 feet by 6 feet, a suitable desk, drafting stool, 2 serviceable swivel office chairs, a coat rack, trash can, fire extinguisher, a fully stocked first aid kit (in accordance with Kentucky Occupational Safety and Health Standards for the Construction Industry Subpart C, Section 1926.50), and a standard 4 drawer lockable file cabinet with key. The building shall be equipped with, electric lighting, adequate heating and air-conditioning, and an integrated telephone answering machine and facsimile, including call waiting and touch-tone service. Facsimile machines shall be either Brother Multi-Function Fax1950 or Sharp Multi-Function Plain Paper Fax - Model UX-1400, or their equivalents.

Contractors, whose main office is outside the Louisville calling area, shall furnish the field office with a toll-free number. All costs of local phone calls, all other utilities and calls to the general Contractor shall be included in that part of the Contract Price attributable to MSD's field office.

The Contractor shall have MSD's field office set up and fully operational within two (2) weeks from the date of execution of the Contract and prior to commencing construction. The field office shall remain on the Work site and be cleaned and maintained weekly until

formal acceptance of the Project. No Work shall be performed until the field office is operational.

All items stored in the field office shall be covered by the Contractor's insurance, including all property of MSD and MSD's employees located within the field office. Any property of MSD and MSD's employees shall be itemized on a list and given to the contractor and MSD for their project files so that those items are covered by the Contractor's insurance.

SECTION 2

MSD STANDARD SPECIFICATIONS

SITE PREPARATION, EROSION PREVENTION AND SEDIMENT CONTROL

2.1. DESCRIPTION OF WORK

2.1.1. Site Preparation. This Work shall consist of the removal and disposal of all rubbish, fences, pavements, structures, all trees, shrubs, brush and herbaceous vegetation not to be protected, and all other obstacles within the rights-of-way/easement limits shown on the Plans. It shall include the protection of trees, shrubs, plants, fences, turfed areas, pavements and structures as identified in the contract documents throughout the construction project.

2.1.2. Erosion Prevention. This Work shall consist of the temporary erosion control measures to be performed during the life of the Project to minimize soil erosion from land surfaces and water conveyances. Measures include temporary **and permanent** soil stabilization, flow diversion, and outlet stabilization.

2.1.2.1. Temporary Soil Stabilization. This Work shall consist of seed bed preparation, furnishing and placing seed, mulch, netting and staples, erosion control blankets, and caring for such areas until acceptance. The Contractor shall remove the netting and staples, 30 to 45 days after installation, or after the grass has become established.

Temporary soil stabilization shall be used in the following circumstances:

- (A) In non-paved areas, rough grading and permanent soil stabilization or temporary soil stabilization shall be maintained within 1,500 linear feet of the active excavation unless more stringent limits are required by the Erosion Prevention and Sediment Control Plan. In no case shall the time between completion of construction activities and the completion of permanent or temporary stabilization exceed 14 calendar days.
- (B) Where construction operations are temporarily suspended for 14 days or longer and permanent soil stabilization is not practical.
- (C) When an immediate cover would be desirable to minimize erosion, siltation, or pollution of any area.

2.1.2.2. Temporary Stabilization of Waterways. This work shall consist of the installation of erosion control blankets as temporary protection for waterways when their construction is completed outside the acceptable work interval for permanent seeding or sodding.

2.1.2.3. Flow Diversion. This Work shall consist of the construction and stabilization of runoff channels and/or berms to divert runoff from undisturbed areas around disturbed areas.

The Work may also consist of the diversion of stream flow around active construction areas during Work across a stream.

2.1.2.4. Outlet Stabilization. The Work shall consist of the installation of measures that slow flow velocities to acceptable levels to prevent erosion of water conveyances (ditches, swales and diversions) and land surfaces.

2.1.2.5. Temporary Stream Crossings. This work shall consist of the installation, maintenance and removal of temporary structures to provide construction and equipment access across streams and the diversion of stream flow around construction activities.

2.1.3. Sediment Control. This Work shall consist of the temporary sediment control measures, such as those included in Section 2.3.3 of these Specifications, to be performed during the life of the Project to control water pollution caused by erosion of exposed soil. Sediment control facilities shall be properly installed and maintained per details, and the Erosion Prevention and Sediment Control Plan. Controls found to be inadequate must **be redesigned and modified in accordance with an approved redline drawing**.

2.1.4. Erosion Prevention and Sediment Control Plan. An EPSC Plan is developed for every MSD Project as part of the Project design. The Plan may be revised, with MSD's approval, to work within constraints imposed by equipment or construction techniques.

2.2. MATERIALS

2.2.1. Topsoil. Topsoil shall meet the requirements set forth in Section 827 of the KTC Standard Specifications.

2.2.2. Temporary Seed. Seed used for temporary seeding may be accepted on the basis of purity and germination values shown on the seed bag. The Work of temporary seeding of erosive earth areas shall be done promptly at the locations and times directed. Rye grain, annual rye or winter wheat seed shall be used for temporary seeding. Rye grain shall not be used in areas to be planted with native vegetation.

2.2.3. Straw Mulch. Refer to Section 9.2.5 of these Specifications.

2.2.4. Wood Cellulose Fiber Mulch. Refer to Section 9.2.6 of these Specifications.

2.2.5. Mulch Anchoring. Refer to Section 9.2.7 of these Specifications.

2.2.6. Stone Bags. Stone bags shall meet the specifications given in MSD Standard Drawing EF-03-02.

2.2.7. Sand Bags. Sandbags shall be **18-1/2-inch x 28-inch woven polypropylene, or other non-photodegradable, bags filled one-half to two-thirds full with sand**.

2.2.8. Silt Fence. Silt fence shall meet or exceed the specifications of MSD Standard Drawing EF-09-02.

2.2.9. Prefabricated Silt Fence. Prefabricated silt fence shall meet or exceed the specifications given in MSD Standard Drawing No. EF-09-02.

2.2.10. Reinforced Silt Fence. Reinforced silt fence shall meet or exceed the specifications of MSD Standard Drawing EF-10-02.

2.2.11. Prefabricated Reinforced Silt Fence. Prefabricated reinforced silt fence shall meet or exceed the specifications given in MSD Standard Drawing No. EF-10-02.

2.2.12. Geotextile Fabrics for Silt Fences. Geotextile fabric shall meet or exceed the specifications given in MSD Standard Drawings No. EF-09-02 and No. EF-10-02.

2.2.13. Hardwood Posts. Hardwood posts shall meet the specifications given in MSD Standard Drawing No. EF-09-02.

2.2.14. Steel Posts. Steel posts shall be “U” shaped or “T” shaped posts that meet the requirements given in MSD Standard Drawing No. EF-10-02.

2.2.15. Steel Reinforcement Mesh. Steel reinforcement mesh shall meet or exceed the specifications for reinforcing mesh given in MSD Standard Drawing No. EF-10-02.

2.2.16. Synthetic Reinforcement Mesh. Synthetic reinforcement mesh shall meet or exceed the specifications for reinforcing mesh given in MSD Standard Drawing No. EF-10-02.

2.3. EXECUTION OF WORK

2.3.1. Site Preparation

2.3.1.1. Rights-of-Way and Easements. The Contractor shall confine his construction activities within the rights-of-way and/or easements shown on the Plans. The Contractor shall be responsible for obtaining written agreements for use of private property outside of MSD acquired easements for such purposes as storage of material and equipment and access to the construction site. The private agreement shall be specific to the responsibilities of both parties and shall provide MSD with indemnification and shall hold MSD harmless. The Contractor shall provide a copy of all such written agreements to MSD immediately upon obtaining same. Access shall not be made through areas or obstructions designated as “Do Not Disturb (DND)” or “Do Not Remove (DNR)” without prior approval by MSD.

2.3.1.2. Temporary Construction Easements. Temporary construction easement shall be used for access to the construction site and temporary storage of materials and/or equipment. The

Contractor shall protect trees within the temporary easement where possible. Where damage to trees is unavoidable, the Contractor will be responsible for compensating property owners, obtaining written agreements with the property owners, and shall indemnify and hold MSD harmless. The Contractor shall provide MSD with a copy of all such written agreements prior to performing the Work. No borrow material can be removed from a temporary construction easement, nor can construction material be buried within a temporary construction easement, without the written consent of MSD and property owner.

2.3.1.3. Limits of Disturbance. The limits of disturbance define the areas in which construction operations are allowed. Construction activities include, but are not limited to; construction traffic, excavation, earth moving activities, stockpiling and staging activities.

2.3.1.4. Existing Obstructions. Locations of obstructions shown on the Plans are approximate. They are shown only for information purposes and are not intended as an accurate location of such obstructions. Obstructions not shown on the Plans but encountered by the Contractor shall be removed as necessary and, if directed by MSD, replaced in their original state or protected by the Contractor at no additional cost to MSD.

2.3.1.5. Protection of Trees and Shrubs. No existing trees or shrubs in rights-of-way and/or easements which are marked "Do Not Disturb (DND)" or "Do Not Remove (DNR)" on the Plans, shall be damaged or destroyed. Where branches of such trees or shrubs interfere with the Contractor's operations, they shall be protected by tying back wherever possible. When possible, put up fencing or other barriers around trees to be protected.

Prior to the start of construction, MSD's Arborist shall identify and flag all trees not previously noted for protection or removal on the Plans, where damage might occur.

Any trees that are in question shall be examined by the Contractors' certified Arborist, before clearing and grubbing or any construction. Any trees that the Arborist determines to be at risk should be marked with caution tape or a certain color of flagging, by the Arborist. The Contractor's Arborist's services shall be provided at no additional cost to MSD.

When working around trees, the Contractor shall make every effort to save as many trees as possible by utilizing the following methods of **construction**.

- Make every effort not to cut or damage any root 2-inches or larger.
- When constructing a trench and roots are encountered, cut 2-inch diameter and larger roots with a clean saw flush with the sides of the trench.
- When roots 2-inches or larger are broken or split, dig out enough of the single trench side to saw through an undamaged portion of the root.
- Use a solution of choline bleach and water or a commercial solution to clean the saw before cutting next tree, to reduce the chance of spreading disease.
- In trenches where roots have been cut, backfill as soon as possible or keep all root ends moist with wet burlap, peat moss or similar material.

- Pile excavated soil on the side of the trench opposite the tree. If this procedure is not possible, place the soil on a plastic tarp, a sheet of plywood or a 4-inch thick bed of mulch outside the drip line of the tree to be protected.
 - Do not dispose of cable scraps, oil cans, wood scraps, machine fluids, paint, left over concrete or any other debris in the backfill.
 - The last 24-inches of backfill shall be compacted to original ground firmness, but no more.
 - Water the backfill, until the last 24-inches of backfill is moist.
 - Do not scrape or gouge any bark on trunks or lower limbs with equipment. Tie back lower limbs when possible.
 - Where equipment is working in confined space near trees, wrap the tree trunk in old tires or snow fence, or place 2-inch x 4-inch studs around the tree trunk and rope or band them in place.
 - Protect valuable trees or groups of trees by erecting a fence outside the dripline.
 - Do not park or operate vehicles and/or equipment within the dripline of a tree unless the Mulch Method or the Bridge Method has been used.
- (A) Mulch Method Root Protection. Place a 12-inch thick layer of **wood chips** around the base of the tree that extends from the trunk beyond the baseline of the tree.
- (B) Bridge Method Root Protection. Place steel plates on railroad ties to bridge construction traffic over the tree's root zone to prevent soil compaction.

When limbs are accidentally broken by equipment, remove the-jagged edge by sawing at the broken limb's junction with the trunk or the next larger limb. Cut as close as possible without cutting into the branch collar, and follow other recommended pruning practices as outlined in "Pruning Trees Near Electric Utility Lines" by Dr. Alex L. Shigo. Do not paint the pruning wound. Remember to clean the saw blade before cutting the limb and before cutting on a another tree.

- Do not store materials within the dripline of a tree.
- Do not add additional soil within the dripline of a tree.
- Do not remove any soil within the dripline of a tree.

If the Contractor's operations will not permit saving certain trees marked "DND" or "DNR" on the Plans, the Contractor shall be wholly responsible for satisfying all claims for restoration or restitution resulting from their damage or removal. If the Work is within public rights-of-way in the City of Louisville, the Contractor shall contact the Arborist/Forester of the City of Louisville before cutting or removing any trees affected by his Work and shall comply with the Forester's requirements. If the Work is within public rights-of-way in Jefferson County, the Contractor shall first contact Arborist/Forester of the Jefferson County Public Works Department before cutting or removing any trees affected by his Work and shall comply with the Forester's requirements. Within the easement, the Contractor shall first advise MSD and then shall replant or replace trees or shrubs with a species and size agreed by the property owners in writing, or the Contractor shall compensate the property owner for the loss. The Contractor shall provide MSD with a copy of all written Agreements, with specific responsibilities detailed, prior to performing any Work, and shall hold MSD

harmless.

If trees and shrubs are moved or pruned, this Work shall be done in accordance with Home and Garden Bulletin No. 83, U.S. Department of Agriculture, "Pruning Shade Trees and Repairing Their Injuries". However, the Contractor shall obtain in writing and provide to MSD the property owner's permission to move or prune trees or shrubs on the property. Trees and shrubs damaged by the Contractor's operations shall be repaired in accordance with said Bulletin No. 83. Any trees whose stumps will not be removed shall be ground out 6-inches below the ground surface. All grindings shall be removed. Backfill with suitable material and revegetate appropriately.

Payment for protecting trees and shrubs shall be the obligation of the Contractor at no additional cost to MSD.

2.3.1.6. Protection of Obstructions Outside Right-of-Way/Easement Limits. The Contractor shall protect and avoid damage to all trees, shrubs, plants, fences, turfed areas, structures and all other objects outside the right-of-way/easement limits shown on the Plans and right-of-way/easement plats from damage due to construction operations. Damage caused by the Contractor shall be repaired or restored at no additional cost to MSD. Particular care shall be used to avoid damage to trees, shrubs, bushes, turfed areas, and private property located adjacent to rights-of-way/easements on private property. No trees, plants, turfed areas, or other objects outside such limits shall be disturbed or damaged without the written permission of the property owner. The Contractor shall provide MSD a copy of all written agreements prior to performing any Work, and shall hold MSD harmless.

2.3.1.7. Special Protection of Obstructions Inside Easement Limits. Wherever the installation of sanitary or storm drainage facilities conflicts with other improvements previously made by other agencies, utility companies, governmental bodies, or adjacent property owners, then the Contractor shall be responsible for their protection and preservation, including necessary removal and storage of such improvement, and subsequent replacement to obtain, to the fullest extent possible, the undisturbed condition.

2.3.1.8. Clearing and Grubbing. Sediment control devices as required by the Erosion Prevention and Sediment Control Plan shall be in place before clearing and grubbing is performed. Those areas contained within the rights-of-way and/or easements shown on the Plans and which will be excavated or used for embankment shall be cleared of trees, stumps, brush, projecting roots, hedges, weeds, logs, and other protruding obstructions, except for trees and shrubs marked "Do Not Disturb". All trees, stumps, roots, brush, hedge, and other protruding obstructions within the rights-of-way/easements which are to be removed shall be cut to within 3 inches of existing ground. The area shall be grubbed to a minimum depth to 6 inches below existing grade to remove grass, roots, and other organic material. This Work shall be done well in advance of earthwork operations in accordance with the Erosion Prevention and Sediment Control Plan.

2.3.1.9. Removal of Obstructions and Pavements. Existing fence material and posts within

the right-of-way/easement limits shown on the Plans and right-of-way/easement plats shall be moved from the construction area and stored in such a manner as to protect them against damage. The Contractor shall be responsible for the condition of the removed fence material and posts. The Contractor shall demolish and remove all structures and structure foundations within the right-of-way/easement limits unless otherwise directed by MSD. Such structure and foundations shall be removed to 24 inches below grade or as directed by MSD. The Contractor shall protect and avoid damage to existing structures when they are to be relocated as directed by MSD. The Contractor shall remove all abandoned vehicles, appliances, and rubbish within the right-of-way/easement limits.

Cuts in all existing pavements shall be made along straight saw cut lines parallel with each edge of the trench or structure. If directed by MSD, cuts in concrete pavements or sidewalks shall be to the nearest construction joint. Cuts in existing curb and gutter shall be made to straight lines perpendicular to the alignment of the curb.

2.3.1.10. Disposal of Debris. All trees, brush, logs, leaves, construction debris, and refuse shall be collected and disposed of in accordance with all applicable codes and ordinances. Debris shall be removed from the site as soon as practical. Unless otherwise provided in the Contract, the Contractor shall make his own arrangements for disposing of such material off-site. All disposal Plans must be approved by MSD. Disposal site shall be on approved site and copy of permits supplied to MSD.

2.3.1.11. Topsoiling. Unless otherwise directed by MSD or shown on the Plans, topsoil shall be stripped from Project areas to be graded and stockpiled for later use at no additional cost to MSD.

- (A) Topsoil Stripping: Strip 4 inches (minimum) of topsoil only from those areas that will be disturbed by excavation, filling, road building, or compaction by equipment. Topsoil stripping is a construction activity. Sediment controls shall be installed prior to the start of topsoil stripping in any area.
- (B) Topsoil Stockpiling: Select stockpile location(s) to avoid slopes, floodplains and natural drainage ways. Do not place stockpiles near waterbodies or traffic routes. Install sediment barriers (e.g. silt fence sediment barrier) as necessary to retain sediment from stockpiles. Protect topsoil stockpiles with temporary stabilization when they will not be utilized for **fourteen (14)** days or more. If stockpiles are not to be used within twelve (12) months, they shall be permanently stabilized to control erosion and weed growth.

2.3.1.12. Temporary Fencing used to Contain Livestock/Domestic Animals. All temporary fencing erected to contain livestock or domestic animals shall be constructed in such a manner as to maintain a level of closure as good or better than that which existed prior to construction. The Contractor shall examine all such temporary fencing daily to ensure that all livestock or domestic animals are sufficiently contained.

2.3.1.13. Replacement of Fences. Any fences disturbed within right-of-way/easement limits

shall be replaced to the satisfaction of the Engineer at no additional cost to MSD. Fences in such poor condition that they cannot be removed and replaced shall be replaced with fence material similar in original quality, size, and appearance to the removed fence, or a written release shall be obtained from the property owner and a copy provided to MSD.

2.3.2. Erosion Prevention

2.3.2.1. Temporary Soil Stabilization

- (A) Preparing the Seed Bed. Areas to be temporarily seeded shall require the preparation of a seed bed only when the soil surface is desiccated, is non-uniform, or contains clods of large stones. Disturbance of the soil surface by whatever means that is practicable, such as disking, to create a 2-inch thick loose and roughened condition capable of retaining the seed and mulch will be required when the soil surface is desiccated or non-uniform. The preparation of a seed bed will not be required when the soil surface is in an acceptable condition from the normal grading operations.
- (B) Seeding. Temporary seeding shall be permitted only during the periods indicated in the table below. In order to stabilize erodible areas with vegetation through the winter, temporary seeding must be completed no later than October 31. Working the soil to cover the seed will not be required. Temporary seeding shall be sown at the approximate rate of 3 pounds per 1000 square feet.

<u>Work Item</u>	<u>Accepted Work Interval</u>
Temporary Seeding with Annual Rye	March 1 through November
Temporary Seeding with Winter Wheat or Rye Grain	September 1 through November

- (C) Protection. All seeded areas shall be promptly protected with straw mulch or wood cellulose fiber mulch. The materials shall be uniformly applied and anchored to the seeded areas in accordance with Section 9.2.7 of these Specifications.
- (D) Dormant Season Stabilization. Areas requiring temporary stabilization during the period of November through February, when seeding is not permitted, shall receive only an application of straw mulch held in place by crimping or netting. The approximate rate of application of the straw mulch shall be 3 tons per acre.

2.3.2.2. Temporary Stabilization of Waterways. Erosion control blankets for temporary stabilization of waterways shall be the equivalent of the temporary blanket specified for permanent stabilization of the waterway. In waterways where erosion control blankets are not specified for permanent stabilization, or a permanent erosion control mat is specified for permanent stabilization, the erosion control blanket for temporary stabilization shall be that specified on the Erosion Prevention and Sediment Control Plan or by MSD. The blankets shall be installed in accordance with Section 9 of these specifications.

2.3.2.3. Flow Diversions. Temporary diversions for runoff from undisturbed areas shall be constructed in accordance with **Exhibit 12-12 in Chapter 12 of the Design Manual**.

- (A) Installation: Temporary diversions shall be constructed according to the sections and on the alignment and grade shown on the Erosion Prevention and Sediment Control Plan. Install diversions in the sequence specified on the Erosion Prevention and Sediment Control Plan or as directed by MSD.
- (B) Inspection and Maintenance: Temporary diversions shall be inspected and maintained in strict accordance with the requirements given in **Exhibit 12-12 in Chapter 12 of the Design Manual**.
- (C) Removal: Remove temporary diversions in accordance with the requirements given in **Exhibit 12-12 in Chapter 12 of the Design Manual** and according to the requirements of the Erosion Prevention and Sediment Control Plan.

2.3.2.4. Outlet Stabilization

- (A) Culvert Outlet Protection. Culvert aprons and headwalls shall be constructed in accordance with Section 5.3.6.2 of these Specifications.

2.3.2.5. Temporary Stream Crossings. All temporary stream crossings shall be **constructed** in accordance with the Kentucky Stream Crossing Permit from the Kentucky **Energy and Environment Cabinet**, Division of Water. Stream banks shall be permanently or temporarily stabilized **as soon as possible, but no later than** 14 days of initial streambank disturbance. Copies of all applicable permits shall be kept at the job site. Temporary stream crossings shall be built in accordance with the approved Erosion Prevention and Sediment Control Plan prior to using the crossing.

- (A) Long-Term Stream Crossings: For locations where a crossing will be used for access, a bridge or a pipe system shall be installed in accordance with Standard Drawing No. ER-02-**02** to prevent personnel, equipment, and material from disturbing the stream with each crossing. Bridges and culverts shall be constructed to the dimensions given in the Erosion Prevention and Sediment Control Plan. Visible build-up of silt and mud in the creek will be cleaned out on a regular basis and appropriate measures shall be taken to stabilize the crossing and prevent further erosion according to Standard Drawing No. ER-02-**02** and the Erosion Prevention and Sediment Control Plan.

Pump-around flow diversion shall be established prior to any construction activity in the stream in accordance with Standard Drawing No. ED-01-**01**. Flow diversion is not required when the stream is dry for the duration of construction activities in the stream.

- (B) Short-Term Stream Crossings: For locations where a crossing is not used for access,

streambank disturbance shall be kept to the minimum required to construct the pipeline stream crossing. Pump-around flow diversion in the stream (in accordance with Standard Drawing No. ED-01-01) shall be established in the stream prior to the start of any construction activities in the stream and shall be maintained until construction and stabilization (permanent or temporary) are complete. Flow diversion is not required when the stream is dry.

2.3.2.6. Surface Roughening. Surface roughening, including tracking, stair-step grading, and slope grooving shall be performed at the locations shown on the Erosion Prevention and Sediment Control Plan in accordance with Standard Drawing Nos. EC-04-01, EC-05-01 and EC-06-01.

2.3.3. Sediment Control

2.3.3.1. General. The Contractor shall exercise every reasonable precaution at all times to prevent water pollution by the deposition of **sediment** in streams, lakes, and reservoirs. **The Contractor** shall conduct and schedule operations so as to avoid or minimize the muddying or siltation of areas adjacent to the construction site including streets, storm sewers, vacant lots, etc. The Contractor shall comply with the applicable provisions of KRS Chapters 220 and 224 of the State Water Pollution Control Laws and other applicable statutes relating to the prevention or abatement of water pollution.

2.3.3.2. Stone Bag Checks. Stone bag checks shall be constructed using stone-filled bags in accordance with Standard Drawing No. EF-12-02.

- (A) Installation: Stone bag checks shall be installed at the locations shown on the Erosion Prevention and Sediment Control Plan prior to the start of construction on areas that drain to the check location.
- (B) Inspection and Maintenance: Stone bag checks shall be inspected and maintained in strict accordance with the requirements given in Standard Drawing No. EF-12-02.
- (C) Removal: Remove Stone bag checks in accordance with the requirements given in Standard Drawing No. EF-12-02. Checks temporarily removed to facilitate construction activities shall be replaced immediately following completion of such activity.

2.3.3.3. Silt Fence. Where called for on the Erosion Prevention and **Sediment Control** Plan or the Project Plans and Specifications, silt fence shall be installed, inspected, maintained, and removed in accordance with the requirements given in Standard Drawing No. EF-09-02.

- (A) Installation: Silt fence shall be installed at the locations shown on the Erosion Prevention and Sediment Control Plan prior to the start of construction on areas that drain to the fence location.

- (B) Inspection and Maintenance: Silt fence shall be inspected and maintained in strict accordance with the requirements given in Standard Drawing No. EF-09-02.
- (C) Removal: Remove silt fence in accordance with the requirements given in Standard Drawing No. EF-09-02. Silt fences temporarily removed to facilitate construction activities shall be replaced immediately following completion of such activity.

2.3.3.4. Reinforced Silt Fence. Where called for on the Erosion Prevention and Sediment Control Plan or the Project Plans and Specifications, reinforced silt fence shall be installed, inspected, maintained, and removed in accordance with the requirements of Standard Drawing No. EF-10-02.

- (A) Installation: Reinforced silt fence shall be installed at the locations shown on the Erosion Prevention and Sediment Control Plan prior to the start of construction activities on areas that drain to the fence location.
- (B) Inspection and Maintenance: Reinforced silt fence shall be inspected and maintained in strict accordance with the requirements given in Standard Drawing No. EF-10-02.
- (C) Removal: Remove reinforced silt fence in accordance with the requirements given in Standard Drawing No. EF-10-02. Silt fences temporarily removed to facilitate construction activities shall be replaced immediately following completion of such activity.

2.3.3.5. Stabilized Temporary Construction Entrances. Stabilized temporary construction entrances shall be constructed in accordance with Standard Drawing No. ER-01-02.

- (A) Installation: Stabilized temporary construction entrances shall be installed at the locations shown on the Erosion Prevention and Sediment Control Plan prior to accessing the construction site.
- (B) Inspection and Maintenance: Stabilized temporary construction entrances shall be inspected and maintained in strict accordance with the requirements given in Standard Drawing No. ER-01-02.
- (C) Removal: Remove stabilized temporary construction entrances in accordance with the requirements given in Standard Drawing No. ER-01-02. Stabilized entrances temporarily removed to facilitate construction activities shall be replaced immediately following completion of such activity.

2.3.3.6. Stone Bag Inlet Protection. Stone bag inlet protection shall be constructed in accordance with Standard Drawing No. EF-03-02.

- (A) Installation: Stone bag inlet protection shall be installed at the locations shown on the Erosion Prevention and Sediment Control Plan prior to the start of construction activities on areas that drain to the inlet, or immediately following the time at which a new inlet can receive runoff from a disturbed area. **The item is not to be used in**

curb-line locations where traffic could be impacted.

- (B) Inspection and Maintenance: Stone bag inlet protection shall be inspected and maintained in strict accordance with the requirements given in Standard Drawing No. EF-03-02.
- (C) Removal: Remove stone bag inlet protection in accordance with the requirements given in Standard Drawing No. EF-03-02. Inlet protection temporarily removed to facilitate construction activities shall be replaced immediately following completion of such activity.

2.3.3.7. Filter Fabric Inlet Protection. Filter fabric inlet protection shall be constructed in accordance with Standard Drawing No. EF-01-02.

- (A) Installation: Filter fabric inlet protection shall be installed at the locations shown on the Erosion Prevention and Sediment Control Plan prior to the start of construction activities on areas that drain to the inlet, or immediately following the time at which a new inlet can receive runoff from a disturbed area.
- (B) Inspection and Maintenance: Filter fabric inlet protection shall be inspected and maintained in strict accordance with the requirements given in Standard Drawing No. EF-01-02.
- (C) Removal: Remove stone bag inlet protection in accordance with the requirements given in Standard Drawing No. EF-01-02. Inlet protection temporarily removed to facilitate construction activities shall be replaced immediately following completion of such activity.

2.3.3.8. Block and Gravel Inlet Protection. Block and gravel inlet protection shall be constructed in accordance with Standard Drawing No. EF-13-01.

- (A) Installation: Block and gravel inlet protection shall be installed at the locations shown on the Erosion Prevention and Sediment Control Plan prior to the start of construction activities on areas that drain to the inlet, or immediately following the time at which a new inlet can receive runoff from a disturbed area.
- (B) Inspection and Maintenance: Block and gravel inlet protection shall be inspected and maintained in strict accordance with the requirements given in Standard Drawing No. EF-13-01.
- (C) Removal: Remove block and gravel inlet protection in accordance with the requirements given in Standard Drawing No. EF-13-01. Inlet protection temporarily removed to facilitate construction activities shall be replaced immediately following completion of such activity.

2.3.3.9. Gravel and Wire Mesh Inlet Protection. Gravel and wire mesh inlet protection shall be constructed in accordance with Standard Drawing No. EF-14-01.

- (A) Installation: Gravel and wire mesh inlet protection shall be installed at the locations shown on the Erosion Prevention and Sediment Control Plan prior to the start of construction activities on areas that drain to the inlet, or immediately following the time at which a new inlet can receive runoff from a disturbed area.
- (B) Inspection and Maintenance: Gravel and wire mesh inlet protection shall be inspected and maintained in strict accordance with the requirements given in Standard Drawing No. EF-14-01.
- (C) Removal: Remove gravel and wire mesh inlet protection in accordance with the requirements given in Standard Drawing No. EF-14-01. Inlet protection temporarily removed to facilitate construction activities shall be replaced immediately following completion of such activity.

2.3.3.10. Temporary Sediment Traps. Temporary Sediment traps shall be constructed in accordance with **Exhibit 12-9 in Chapter 12 of the Design Manual**.

- (A) Installation: Temporary Sediment traps shall be installed at the locations shown on the Erosion Prevention and Sediment Control Plan prior to the start of construction activities on areas that drain to the trap.
- (B) Inspection and Maintenance: Temporary Sediment traps shall be inspected and maintained in strict accordance with the requirements given in **Exhibit 12-9 in Chapter 12 of the Design Manual**.
- (C) Removal: Remove temporary sediment traps in accordance with the requirements given in **Exhibit 12-9 in Chapter 12 of the Design Manual**.

2.3.3.11. Temporary Sediment Basins. Temporary Sediment basins shall be constructed in accordance with **Exhibit 12-8 in Chapter 12 of the Design Manual**.

- (A) Installation: Temporary Sediment basins shall be installed at the locations shown on the Erosion Prevention and Sediment Control Plan prior to the start of construction activities on areas that drain to the basin.
- (B) Inspection and Maintenance: Temporary Sediment basins shall be inspected and maintained in strict accordance with the requirements given in **Exhibit 12-8 in Chapter 12 of the Design Manual**.
- (C) Removal: Remove Temporary sediment basins in accordance with the requirements given in **Exhibit 12-8 in Chapter 12 of the Design Manual**.

2.3.3.12. Diversions for Sediment-Laden Water. Temporary diversions shall be constructed in accordance with **Exhibit 12-12 in Chapter 12 of the Design Manual**.

- (A) Installation: Temporary diversions shall be constructed according to the sections and on the alignment and grade shown in the Erosion Prevention and Sediment Control Plan. Install diversions in the sequence specified on the Erosion Prevention and

Sediment Control Plan or as directed by MSD.

- (B) Inspection and Maintenance: Temporary diversions shall be inspected and maintained in strict accordance with the requirements given in **Exhibit 12-12 in Chapter 12 of the Design Manual**.
- (C) Removal: Remove temporary diversions in accordance with the requirements given in **Exhibit 12-12 in Chapter 12 of the Design Manual** and according to the requirements of the Erosion Prevention and Sediment Control Plan.

2.3.3.13. Rock Ditch Checks. Rock ditch checks shall be constructed in accordance with Standard Drawing No. EB-03-01.

- (A) Installation: Rock ditch checks shall be installed at the locations shown on the Erosion Prevention and Sediment Control Plan prior to the start of construction activities on areas that drain to the ditch.
- (B) Inspection and Maintenance: Rock ditch checks shall be inspected and maintained in strict accordance with the requirements given in Standard Drawing No. EB-03-01.
- (C) Removal: Remove rock ditch checks in accordance with the requirements given in Standard Drawing No. EB-03-01.

2.3.3.14. Vegetated Filter Strips (VFS). VFS are zones of vegetation through which sediment and pollutant-laden runoff are directed before being discharged to a concentrated flow channel. VFS shall be constructed as shown on the Erosion Prevention and Sediment Control Plan.

2.3.3.15. Dewatering. Sediment-laden groundwater that is pumped from bore pits, trenches, or other excavations should be pumped to an appropriate receiving area, including but not limited to sediment basins, sediment traps, or vegetated filter strips, before discharging to a stream or lake. Direct pumping to a stream or lake is **ILLEGAL** and shall be avoided.

2.4. EROSION PREVENTION AND SEDIMENT CONTROL PLAN

2.4.1. General. Construction shall conform to all requirements of the Erosion Prevention and Sediment Control Plan as provided in the Contract Documents.

2.4.2. Certification. For all MSD projects, the Contractor and all Subcontractors shall sign a certification statement, as required by the KPDES General Permit KYR 100000. This statement will be held in MSD's project file.

2.4.3. Revisions. Revisions to the Erosion Prevention and Sediment Control Plan must be approved by MSD. All revisions must be shown on the EPSC Plan.

2.4.4. Spill Prevention, Control, and Countermeasures (SPCC) Plan. The Contractor and Subcontractors shall be responsible for obtaining and implementing SPCC Plans for

petroleum products and hazardous materials stored on the job site as required by National Oil Pollution Prevention (NOPP) Regulations. If petroleum products are stored in containers with capacity in excess of 660 gallons, the storage tanks are regulated by NOPP regulations and an SPCC plan is required.

SECTION 3

MSD STANDARD SPECIFICATIONS

EARTHWORK

3.1. DESCRIPTION OF WORK

This Work shall consist of excavations, backfilling of excavations, construction of embankments, and grading for all types of sanitary and storm drainage facilities, and all other items as may be necessary to complete the earthwork as shown on the Plans, in the Contract, or as directed by MSD.

3.2. MATERIALS

3.2.1. Crushed Stone. Crushed stone used to stabilize and backfill excavations shall be coarse aggregate conforming to Size No. 57 as set forth in Section 805 of the KTC *Standard Specifications (latest edition)* and shall be free from sharp, angular pieces which could, in the judgment of MSD, cause damage to the pipe.

3.2.2. Sand. Sand for backfill placed in accordance with Section 3.3.4.2 (A) herein referred to as Type 1-A backfilling shall be comprised of sand or sand-gravel mixtures containing less than 30 percent passing a No. 40 sieve and less than 5 percent passing a No. 200 sieve. Sand or sand-gravel mixtures shall classify as SW, SP, or GW, and shall have a uniformity coefficient of 4.5 or more, as set forth in ASTM D 2487, Standard Specification for Classification of Soils for Engineering Purposes. Sands which have a coefficient of uniformity less than 4.5 but greater than or equal to 1.5 will be permitted, but placement and compaction shall be in accordance with Section 3.3.4.2.(B). These sands are referred to as Type 1-B backfill.

The Contractor shall provide a Certification of Compliance stating that the sand fully complies with the requirements stated herein. In addition, the Contractor shall provide the results of the sieve analysis, including a graph depicting the percent finer versus particle size and the uniformity coefficient.

Sand used on the basis of Certificates of Compliance may be sampled and tested by the agency designated by MSD at any time and, when found not to be in conformity, will be subject to rejection, whether in place or not. Should the test results show the sand to not meet the requirements stated herein, then the Contractor shall assume the full cost of the testing, removal of the undesirable material, replacement of the materials and other Work resulting from the removal of the undesirable material and replacement by acceptable material.

3.3. Execution of Work

3.3.1. General. Prior to beginning earthwork operations, all necessary clearing, grubbing,

removal of obstructions and pavements, installation of required sediment control facilities shall have been completed in accordance with Section 2 of these Specifications. Rough grading and restoration shall be maintained within a maximum distance of 1,500 L.F. of the active disturbance, with logical limits between structures, unless otherwise approved by MSD.

The Contractor shall at all times be responsible for the condition of the trenches and filled areas. He shall maintain frequent inspection of same, and if at any time before the final acceptance of the Work by MSD, the trenches or filled areas settle or sunken areas appear, he shall be required to refill these sunken areas with suitable material as soon as they are discovered. Barricades are to be closely spaced to provide a nearly continuous protection. All trenches shall be barricaded and caution-lighted or covered with steel trench plates at all times for the protection of the public.

3.3.2. Excavation

3.3.2.1. Classification. Without regard to the materials encountered, all excavation shall be unclassified. It shall be distinctly understood that reference to rock, earth, or any other material on the Plans or in the Contract, whether in numbers, words, letters, or lines, is solely for MSD's information and is not to be taken as an indication of classified excavation or the quantity of either rock, earth, or any other material involved.

The Contractor must draw his own conclusions as to the conditions to be encountered. MSD does not give any guarantee as to the accuracy of the data and no claim will be considered for additional compensation when the materials encountered are not in accord with the classification shown. In the event contaminated materials are encountered, the Contractor shall cease Work and immediately contact the appropriate agencies, including MSD, in accordance with Section 3.3.3.2.

Blasting **and rock removal** shall be performed at a safe distance ahead of the installation of the pipes and structures to prevent damage as the shots are fired. Blasting of rock for property service connections, branches, and stubs shall be performed concurrent with the trench blasting. The rock at the ends of all pipes, branches, stubs and property service connections, shall be shattered by continuing the blasting operations approximately 6 feet beyond the end of the pipe.

For property service connections consent and release **must** be obtained by MSD and **include** approximately one full joint of pipe beyond the manhole or the end of the main line sewer. Sufficient explosive shall be used to shatter the rock to allow for future excavation. To prevent damage to installed sewers or structures, concrete for walls, footings, or encasements shall not be poured in direct contact with bedrock unless otherwise shown on the Plans or directed by MSD.

The blasting of rock under existing pavement, prior to uncovering the rock, may be permitted provided the Contractor assumes full responsibility for all damage to the

existing pavement. MSD reserves the right to require the uncovering of rock prior to blasting if blasting without uncovering proves unsatisfactory.

If the Contractor chooses to shoot rock under pavement without uncovering the rock, the Contractor shall immediately repair humps in the paving which create a traffic hazard. All distortions outside the limits of the trench caused by the blasting shall later be removed and replaced as part of the pavement restoration **at no additional cost to MSD.**

After the blast is fired, the Contractor shall thoroughly scale the excavation. All loose, shattered rock or other loose material which may be dangerous to the workmen, pipe, or structure shall be removed and the excavation made safe before proceeding with the work. The fact that the removal of loose, shattered rock or other loose material may enlarge the excavation beyond the required width will not relieve the Contractor from making such removal and filling the extra space. If rock is excavated beyond the trench width indicated on MSD's Standard Drawings, such unauthorized excavation, or overbreakage, shall be refilled with crushed stone in the pipe zone **and** the remaining backfill will be per section 3.3.4 or Class B concrete in ditches and streams, at no additional cost to MSD. Remove all blasting debris to ensure public and Contractor's safety.

3.3.2.2. Stockpiling Excavated Materials. The Contractor shall be responsible for determining the limits of stockpiles in relation to excavations and maintaining such limits to prevent excessive loads on the sides of excavations or sheeting and bracing systems. Excavated material shall not obstruct crosswalks, sidewalks, street intersections, nor interfere unreasonably with travel on streets by occupants of adjoining property. Gutters or other surface drainage facilities shall not be obstructed. When clear access to fire hydrants, mail boxes, sewer or conduit manholes, and similar utilities or municipal service facilities is required, the Contractor must provide such access. All work shall conform to the Kentucky Occupational Safety and Health Program and Section 29 CFR 1926, Subpart P, "Trenching and Shoring."

3.3.2.3. Wasting Excavated Materials. All materials excavated by the Contractor not used for backfilling trenches, channels, or structure excavations or **not** used in restoration of the ground surface, shall be removed from the site and disposed of by the Contractor at a pre-approved site, unless otherwise specified in the Contract. MSD reserves the right to retain excess excavated materials and direct the Contractor to deliver it to a site specified by the Contract at the Contractor's expense. When the Contractor proposes to waste unsuitable or excess excavated material upon any privately-owned property, written consent from the property owner must be secured in advance and a copy provided to MSD prior to scheduling the work. All filling operations must be approved by MSD Water Management prior to placement of said material. No surplus or unsuitable materials shall be deposited in any stream channel nor in any place where pre-construction surface drainage would be changed without written permission from MSD.

3.3.2.4. Sheeting and Bracing and Trench Boxes. The Contractor shall furnish, place and

maintain adequate sheeting and bracing or trench boxes as may be required to support the sides of the excavation and prevent any movements of earth which could, in any way, diminish the width of the excavation to less than that necessary for proper construction, cause damage to the sewer or structure being constructed or to adjacent structures, utilities, pavements or walks, or cause injury to workmen or others through movement of the adjacent earth banks, or to otherwise damage or delay the work. All work shall conform to the Kentucky Occupational Safety & Health Program and Section 29 CFR 1926, Subpart P, "Trenching and Shoring."

Sheeting and bracing or trench boxes shall be of wood or steel and shall be of adequate strength for excavation. Wherever possible, the sheeting and bracing shall be driven ahead of the excavation to avoid loss of material from behind the sheeting. If it is necessary to excavate below the sheeting, care shall be taken to avoid trimming behind the face along which the sheeting will be driven. Care shall be taken to prevent voids outside the sheeting, but if voids develop, they shall be immediately filled with sand backfill and densified by flushing and jetting with water. Where drop inlets, stacks or other appurtenances are constructed, the trench excavation shall be offset, as required, without additional compensation.

Sheeting left in place shall be cut off at least 18 inches below the ground surface and the cutoff material shall be removed from the excavation. All voids created by cutting off the sheeting shall be immediately filled with sand backfill and densified by flushing and jetting with water. Sheeting and bracing specified to be left in place as shown on the Plans or as ordered by MSD shall be paid for by MSD. Sheeting and bracing left in place at the Contractor's option, shall be at his expense.

All sheeting, bracing, and shoring which is not left in place under the foregoing provisions shall be removed in a manner which will not endanger the completed work or other structures, utilities, sewers, or property whether, public or private. The Contractor shall exercise care to prevent the opening of voids during the extraction process. Any voids created while pulling sheeting and bracing shall be immediately filled with sand backfill and densified by flushing and jetting with water.

3.3.2.5. Trench Dimensions. No more than 300 feet of trench in unpaved areas and 100 feet of trench in paved areas shall be opened at any time in advance of the pipe, nor shall more than 100 feet be left unfilled except by written permission from MSD. In special cases, MSD may limit the distance to which the trench may be open by notifying the Contractor in writing. Excavations for pipe in both earth and rock trenches shall display a width between the minimum and maximum allowable width, below a level 1 foot above the outside top of the pipe, as shown on MSD's Standard Drawings. If the maximum allowable trench width is exceeded, a higher strength classification of pipe may be required, at no additional cost to MSD.

Trench excavations for cast-in-place concrete sewers and structures shall have the minimum width necessary, as determined by the Contractor, for proper and safe

construction. Trenches shall be excavated to a subgrade depth of six inches below the outside of the pipe, unless unsuitable foundation materials are encountered at the subgrade level.

3.3.2.6. Unsuitable Foundation. Unsuitable foundation materials shall consist of soft, spongy earth, mud, unconsolidated fill, organic matter, or any other materials which will not, in the opinion of MSD, provide suitable support. MSD may order extra work performed when the bottom of the excavation is unsuitable. It shall be undercut below the subgrade level, to a depth approved by MSD, and backfilled with crushed stone or other approved backfill material. Class B concrete shall be used to backfill the undercut zones in ditches and streams. At MSD's direction, on MSD funded Projects, payment shall be made for removal or replacement of unsuitable material within the first 2 feet below the subgrade level.

If the unsuitable material is mud or muck caused by the activity of the Contractor or by his failure to provide adequate drainage for the excavation, no payment shall be made for the removal or replacement of such material.

3.3.2.7. Drainage of Excavations. The Contractor shall maintain all excavations free of water. He shall provide all dams, flumes, channels, sumps, or other works necessary to keep the excavation entirely clear of water and shall provide and operate pumps or other suitable equipment of adequate capacity for dewatering the excavations. He shall avoid producing mud in the trench or channel bottom by his operations. If necessary or so directed by MSD, the Contractor shall place crushed stone at his own expense to maintain a firm, dry excavation bottom and base. Pipe bedding, laying, jointing, and the placing of concrete shall be done in a water-free trench or excavation. The water shall be disposed of at the Contractor's expense.

Where the excavation extends below the water table, and lowering of the water table is necessary to prevent excessive inflows and maintain stability within the excavation, dewatering shall be performed. The Contractor shall use well points, sump pumps, or any other method of dewatering as required to lower the water table below the bottom of the excavations in a manner that will prevent saturated soil from flowing into open trenches, shafts, structures and tunnels, and render such excavations firm until the structures to be built therein are completed. The Contractor shall obtain MSD's approval prior to the use of special dewatering equipment other than well points or sump pumps. Dewatering operations are considered incidental to the work and no additional compensation shall be made to the Contractor. The groundwater shall not be allowed to rise until the backfilling operations are complete. The Contractor shall be responsible for preventing pipe flotation.

Prior to beginning the work, the Contractor shall obtain, at his expense, a water withdrawal permit from the Commonwealth of Kentucky, Department of Natural Resources and Environmental Protection Cabinet (KNREPC) in accordance with the following criteria:

(A) Where the average withdrawal rate is more than ten thousand gallons per day (10,000

gal/day), a permit shall be required, except as exempted by KRS 151.140.

(B) Where the withdrawal of water is made at a relatively constant rate each day and the average withdrawal rate is ten thousand gallons per day (10,000 gal/day), or less, no permit will be required.

(C) Where withdrawals are made on an irregular basis at an irregular rate, permits may be required where the Division of Water determines that the water withdrawn represents a significant portion of the available water supply or that collection of withdrawal data is necessary for water resource planning purposes.

The Contractor shall assume all responsibility for claims resulting from damage to any land, wells, structures or improvements due to his dewatering operations.

Prior to any point discharge into a blueline stream or intermittent blueline stream, the Contractor shall obtain necessary permits from the Kentucky Division of Water and provide a copy to MSD. Point discharge operations are considered incidental to the work and no additional compensation shall be made to the Contractor.

3.3.2.8. Blasting and Hoe-Ramming. When blasting is required to excavate rock, the Contractor shall comply fully with the provisions of the Laws and Regulations Governing Explosives and Blasting, as issued by the Kentucky Department of Mines and Minerals, and the Kentucky Occupational Safety and Health Standards for the Construction Industry, Subpart U, Blasting, as issued by the Kentucky Labor Cabinet.

Prior to any blasting or hoe-ramming operations, a pre-blast survey of potentially affected homeowners and properties shall be conducted by the Contractor or his agent. The Contractor shall provide MSD with the name of the agency and person(s) who will be performing the survey. All appointments for surveys shall be made in advance by the Contractor or his agent. MSD will provide the person(s) performing the pre-blast survey an original letter of introduction to identify them to the residents. No copies of the letter shall be permitted.

The property owner(s) will be notified of the above procedure for the pre-blast survey by the Contractor or his agent. The affected property owners will be instructed by the Contractor to only accept an original letter of introduction on MSD's letterhead. The Contractor shall furnish, upon request, all photographs taken and reports made during the pre-blast and post-blast surveys, without any additional cost to MSD.

No blasting or hoe-ramming shall be done unless proper insurance has been secured and is in force. Except with written permission by MSD, no blasting of rock, or hoe-ramming, will be permitted at nights or on Sundays.

During blasting operations, every precaution shall be used for the protection of persons and private and public property. Each blast shall be well covered with mats and other suitable means to confine the rock fragments. Only the minimum amounts of explosives shall be used

to shatter the rock. The Contractor shall monitor the blasts to ensure that excessive charges are not being used. The debris from the blasting operations shall be disposed of properly, in accordance with Department of Mines and Minerals Standards.

3.3.3 Embankment

Non trench-type embankment shall conform to section 206 of the KYTC Standard Specifications

3.3.4 Excavation and Borrow Materials

3.3.4.1. Selected Excavated Material. This material shall consist of earth removed from excavations and used for backfill. It shall be free from rubbish, organic matter, frozen soil, muck, and other perishable, compressible debris which prevent compaction of the material to a dense, uniform state. Rock and other hard, durable fragments shall be limited to the particle sizes described in Section 3.3.4., with adequate fines to fill all voids, and shall be uniformly distributed *throughout* the material.

3.3.4.2. Unsuitable Contaminated Materials. For MSD Projects, MSD-or in some instances the property owner-shall be responsible for any asbestos, PCB's, petroleum, hazardous waste or radioactive material uncovered or revealed at the site, which was not shown or indicated in MSD Project Plans or identified in the Contract to be within the scope of the work and which may represent a substantial danger to persons or property exposed thereto in connection with the Work site. Once a problem is identified, work shall stop until the course of action can be determined by MSD. It shall then be up to MSD to participate in paying additional costs for hauling and disposal at a landfill or appropriate facility or *the* cost of testing as delineated further within these specifications.

MSD SHALL NOT be responsible for any such materials brought to the site by the Contractor sub-Contractor, suppliers, or anyone else for whom the Contractor is responsible.

If unsuitable contaminated materials are encountered, the Contractor shall take the following action:

(A) The Contractor shall immediately stop all work in connection with such hazardous condition and notify the MSD inspector (and thereafter confirm in writing such notice to the MSD Construction Contracts Administrator).

(B) The Contractor shall then be responsible for making notification to "911" (Emergency Response) in the event of discovery of a release of contaminated material.

(C) The Contractor is responsible for making notification to the Kentucky Department for Environmental Protection at (502) 564-2380 or 1-800-928-2380.

(D) The Contractor is responsible for securing the work site to prevent access by unauthorized personnel.

NOTE: The above notices should include the precise location, the suspected material type, and the approximate quantity and concentration if known.

IF MATERIALS ARE HAULED WITHOUT NOTICE TO MSD, IT SHALL BE THE PROPERTY OF THE CONTRACTOR. MSD WILL NOT PAY FOR DISPOSAL OR ASSOCIATED ADDITIONAL COSTS.

The Contractor shall not be required to resume work in connection with such condition until MSD and/or the owner of the property has obtained any required permits for disposal of the unsuitable materials. MSD's engineer shall promptly determine the means and methods to evaluate such condition or take corrective action on a case-by-case basis. This action could involve realignment or other design changes. MSD will provide the Contractor special written notice specifying that the condition is rendered safe for the resumption of work, or specifying any special conditions under which the work may be resumed. The cost of sampling and lab testing will be the responsibility of MSD. MSD will also be responsible for substantiated additional costs for disposal such as receiving fees at the local landfill or additional hauling fees.

The Contractor shall resume such work based on special conditions or MSD may order such portion of the work that is in connection with hazardous condition to be deleted from the work according to the unit price of the Contract. MSD may choose to perform the deleted portion of the work with its own forces or make such provisions as necessary to complete that portion of the Project.

3.3.4.3.. Borrow Material. Borrow material used as backfill or embankment shall be approved for such use by MSD. The Contractor shall not use borrow material from the permanent or temporary construction easement without the written consent of MSD. Prior to its use, the Contractor shall identify the source and provide samples for soil classifications and moisture-density tests. Borrow material shall meet the following requirements:

- (A) Unless otherwise permitted by MSD, borrow material shall not be comprised of soils represented by the following classifications, as determined in accordance with ASTM D 2487: MH, CH, OL, OH, or Pt.
- (B) The borrow material shall be free from rubbish, organic matter, frozen soil, muck or other perishable, compressible debris, which prevent compaction to a dense, uniform state. Rock and other hard, durable fragments shall be limited to particles displaying a maximum dimension of 4 inches, shall not exceed 10 percent of the total volume, and shall be uniformly distributed throughout the material.
- (C) ***The maximum dry density of the borrow material shall meet or exceed 98 pounds per cubic foot in accordance with ASTM D 698, Standard Specification for Test***

***Methods for Moisture-Density Relations for Soils and Soil-Aggregate Mixtures,
Using a 5.5-lb. Rammer and a 12-in. Drop.***

3.3.5. Backfill of Trench Excavations

3.3.5.1. General. Backfilling of trenches, and tunnel shaft excavations shall be accomplished as soon as possible after the pipe is placed or the tunnel is completed. The Contractor shall have the option of using flushed and jetted or compacted backfill materials. The Contractor shall notify MSD 48 hours in advance of all flushing and jetting and/or mechanical compaction operations.

3.3.5.1.1. Compaction. Compaction around structures will be performed by a mechanical compactor when flushing and jetting of sand and earth material is not possible or practical, or when required by the Plans.

3.3.5.2. Within Limits of Existing or Proposed Paved Surfaces. At the Contractor's option, with prior approval by MSD (based on the availability of sand which meets the requirements of Section 3.2.2), backfill within the limits of existing or proposed paved surfaces shall consist of: Type I-A Backfill - sand, flushed and jetted, Type I-B Backfill - sand, combination flushed and jetted and mechanically compacted, or Type III Backfill - selected excavated material and/or approved borrow material - mechanically compacted. In special cases and with the approval of MSD, the Contractor may utilize Type I-A sand backfill - flushed and jetted in the lower portion of the excavation and Type III backfill selected excavated materials - mechanically compacted in the upper portion of the excavation.

- (A) Sand - Flushed and Jetted (Type I-A). After the trench has been completely backfilled with sand, the backfill shall be densified by thoroughly flushing and jetting with water, beginning at the downstream end of the trench and proceeding upstream. Water to be used for flushing and jetting shall be supplied through hoses and pipes having a minimum diameter of 2 inches. The jet pipe shall have a minimum diameter of 1-1/2 inches. Jet pipes used to penetrate the backfill material shall be equipped with a shut-off valve and be of sufficient length to completely penetrate the sand backfill. The jet pipe shall be inserted into the sand backfill at a maximum spacing along the trench of 6 feet and the spacing shall be staggered along the trench area. The jet pipe shall penetrate the sand backfill to within 12 inches of the crushed stone encasement. Care shall be exercised to prevent the jet pipe from penetrating the crushed stone encasement. When the depth of the trench exceeds the length of the jet pipe the flushing and jetting shall be completed in lifts. The pipe shall remain in place until water is observed rising above the backfill throughout the full width of the trench and over a length of the trench equal to one-half the distance between adjacent jet installations. If this condition is not observed within a reasonable period, the Contractor shall increase the water flow or provide additional jet pipes. If the Contractor fails to flush and jet the sand backfill in accordance with the Specifications, the sand backfill shall be excavated and replaced with properly flushed and jetted sand backfill or material compacted in accordance with Section 3.3.4.2.C., at no additional cost to MSD.

The Contractor shall provide all piping, fittings, etc., necessary to deliver the water along the site of the work and shall arrange with the Louisville Water Company, if applicable, for making the necessary taps and metering. All expenses incurred for installing the pipe and hose, together with the cost of the water, shall be borne by the Contractor. Following flushing and jetting and prior to pavement construction, the surface of the sand subgrade shall be thoroughly compacted following the procedures described in Section 3.3.4.2.(B).

- (B) Sand, Combination Flushed and Jetted, and Mechanically Compacted (Type I-B). The trench shall be completely backfilled with sand, and the backfill shall be densified by thoroughly flushing and jetting with water. Flushing and jetting procedures shall be in accordance with Section 3.3.4.2.(A) above. Next, the sand backfill shall be removed to a depth of 3 feet below the pavement surface and stockpiled for later mechanical compaction. The exposed surface shall then be thoroughly compacted. The remainder of the trench shall be backfilled in two lifts of sand (approximately 12-inches thick) up to the pavement subgrade level with each lift being thoroughly compacted. For compaction, the Contractor shall supply a vibratory plate compactor or smooth drum vibratory roller capable of compacting sands to a minimum effective depth of 16-inches. The Contractor shall submit the manufacturer's equipment specifications for proof of this required effective compaction depth. The required number of passes of the roller or plate shall be established at the beginning of compaction operations for the Project by taking nuclear density tests to monitor the density increase with increased passes of the roller or plate. The required number of passes shall be set when no further increase in sand backfill density is measured.
- (C) Earth Materials - Compacted (Type III-A). Selected excavated materials or approved borrow materials containing no rock fragments with a maximum dimension larger than 4 inches shall be carefully deposited in uniform, horizontal layers, not exceeding 6 inches in compacted depth, in a zone located from the top of the cradle or encasement up to a horizontal plane located 2 feet above the exterior top of the pipe. Prior to compaction, each layer shall be level and evenly distributed on both sides of the pipe so as to not disturb, displace or damage the pipe. Each layer shall be thoroughly compacted to a minimum of 95 percent of the standard Proctor density, at moisture content between plus 2 percent and minus 4 percent of the optimum moisture content, as determined by ASTM D 698, utilizing mechanical compaction. Each layer shall be properly compacted before the next succeeding layer is placed. Any lift of fill which pumps under the weight of the compaction equipment shall be rejected, regardless of the field density test results.

The remainder of the trench from the horizontal plane located 2 feet above the pipe up to the ground surface or top of the existing subgrade shall be backfilled with selected excavated materials containing no rock fragments with a maximum dimension larger than 4 inches, or approved borrow materials. The backfill shall be placed in uniform horizontal layers not exceeding 12 inches in compacted depth. Each layer shall be thoroughly compacted to a minimum of 95 percent of the standard Proctor density and a moisture content between plus 2 percent and minus 4 percent of the optimum moisture content, as determined by ASTM D 698,

utilizing mechanical compaction methods. Each layer shall be properly compacted before the next succeeding layer is placed. Any lift of fill which pumps under the weight of the compaction equipment shall be rejected, regardless of the field density test results. Follow guidelines set forth in MSD Specifications Section 3.3.9.3. at no additional cost to MSD.

- (D) Combination Sand (Type I-A) and Earth Backfill (Type III-A). In trench situations where the lower trench dimensions limit the use of mechanical compaction equipment, the existing site conditions limit the effectiveness of the mechanical compaction methods, or where additional backfill material is required to replace unsuitable excavated materials, the Contractor may utilize flushed and jetted sand backfill in the lower portion of the trench and mechanically compacted earth material in the upper portion of the trench with prior approval of MSD. The sand backfill operations shall extend from the top of the cradle or encasement up to a point where mechanical compaction can be properly accomplished in accordance with Section 3.3.4.2.C. The mechanical compaction operations shall extend from the top of the sand backfill up to the ground surface or top of the existing subgrade. Follow guidelines set forth in MSD Specifications Section 3.3.9.3.
- (E) No. 57 Crushed Stone - Compacted. With prior approval from MSD, No. 57 crushed stone may be used as trench backfill within paved areas. The stone shall be carefully deposited in uniform, horizontal layers not exceeding 12 to 24 inches in compacted depth, depending on the type and size of compaction equipment used. The initial lift(s) of stone immediately above the pipe shall be level and evenly distributed on both sides of the pipe. Each layer shall be thoroughly compacted by making a minimum of two passes using a vibratory plate compactor or smooth drum vibratory roller capable of compacting clean stone to a minimum effective depth of the lift thickness selected. The Contractor shall submit the manufacturer's equipment specifications for proof of this required effective compaction depth.

3.3.5.3. Outside Limits of Existing or Proposed Paved Surfaces. At the Contractor's option, except as otherwise specified in Section 3.3.4.4., trench backfill outside the limits of existing or proposed paved surfaces shall consist of earth materials (selected excavated or approved borrow materials) which are flushed and jetted or compacted. The upper one foot of the earth backfill shall be essentially free from rock, gravel or other hard, durable fragments.

- (A) Earth Materials - Flushed and Jetted (Type II Backfill). The lower portion of the trench backfill extending from the top of the cradle or encasement to a horizontal plane located 2 feet above the exterior top of the pipe shall contain no rock or rock fragments with a maximum dimension larger than 1 inch. The remainder of the trench shall be backfilled with selected excavated materials or approved borrow materials containing no rock fragments larger than 1 cubic foot. After the trench has been completely backfilled with selected excavated material or approved borrow material, the backfill shall be densified by thoroughly flushing and jetting with water, beginning at the downstream end of the trench and proceeding upstream. The backfill shall be thoroughly and uniformly sluiced and flooded by introducing water at the top of the trench and by inserting the jet pipe into the backfill at intervals as

specified in Section 3.3.4.2. (A) along the trench. This process shall be continued until the backfill is completely saturated and no further settlement is observed. Hoses, jet pipes and the maximum depth of insertion shall be as specified in Section 3.3.4.2.A. After the backfill in the trench has substantially dried and completed any additional settlement, any settlement below the finish grade shall be refilled with additional earth, and compacted in accordance with (B), below.

- (B) Mechanical Compaction of Earth Materials (Type III-B). Selected excavated materials or approved borrow materials, containing no rock or rock fragments with a maximum dimension larger than 3 inches, shall be carefully deposited in uniform, horizontal layers, not exceeding 6 inches in compacted depth, in a zone located from the top of the cradle or encasement up to a horizontal plane located 2 feet above the exterior top of the pipe. Prior to compaction, each layer shall be leveled and evenly distributed on both sides of the pipe so as not to disturb, displace or damage the pipe. Each layer shall be thoroughly compacted to a minimum of 85 percent of the Standard Proctor density before the next succeeding layer is placed. Any lift of fill which pumps under the weight of the compaction equipment shall be rejected, regardless of the field density test results. Follow guidelines set forth in MSD Specifications Section 3.3.9.3. The remainder of the trench from the horizontal plane located 2 feet above the top of the pipe up to the ground surface shall be backfilled with selected excavated materials or approved borrow material containing no rock fragments larger than 1 cubic foot. The material shall be placed in uniform horizontal layers not exceeding 12 inches in compacted depth. Each layer shall be compacted with a dozer or other heavy, earth-moving equipment traveling back and forth over the material until no further settlement is observed.

3.3.5.4. Between Pipe and Drainage Swale or Ditch. The Contractor shall use Type III - A backfill in pipe trenches where a surface ditch or swale is to be constructed above the pipe. This includes all ditches and swales - paved, sodded, rip-rapped or seeded.

3.3.6. Depositing Backfill Material. All backfilling shall be done in a manner to avoid displacing or damaging the pipe or structure. Any pipe or structure damaged or displaced shall be excavated and repaired or replaced at the Contractor's expense.

3.3.7. Backfill Against Structures

3.3.7.1. Backfill Against Retaining Walls and Box Culverts. Unless shown otherwise on the Plans, backfill shall be selected excavated materials or approved borrow materials. The placement of any backfill shall be delayed until representative test samples of the concrete have attained a compressive strength of 3,500 pounds per square inch and the concrete has been in place at least seven days.

When the back slopes bounding the excavation lie within the slope limits of 6:1 to 1/4:1, the planes of the slopes shall be destroyed by stepping or serrating to prevent wedging action during compaction.

Backfill material shall be placed and compacted in uniform horizontal layers not exceeding 6 inches in thickness, loose measurement. Each layer shall be compacted by means of approved manually-directed mechanical tampers or rollers. Successive blows of the tamper shall overlap no less than one-fourth of the width of the tamper head. Successive passes of the roller shall overlap no less than one-fourth the width of the roller. Each layer shall be dampened when necessary to ensure the maximum density obtainable, as directed. The Contractor shall not permit heavy rolling compaction equipment to operate closer to the back of the culvert or retaining walls than a distance equal to the unbalanced height of the fill at any time. Backfill that will be beneath or within a proposed embankment or pavement area shall be thoroughly compacted to a minimum of 95 percent of the standard Proctor density, as determined by ASTM D 698. Each layer shall be properly compacted before the next succeeding layer is placed. Backfill shall be brought up equally on both sides of the walls to the elevation shown on the drawings to prevent unequal loading.

3.3.7.2. Backfill Against Wet Wells and Deep Structures. Unless otherwise shown on the Plans, backfill shall be selected excavated materials, approved borrow materials, sand, or crushed stone. The backfill shall be brought up evenly on all sides to reduce any unbalanced lateral loading that could cause tilting, or opening of joints between riser sections.

For earth materials, backfill shall be flushed and jetted, or mechanically compacted as set forth in MSD Specifications Section 3.3.4.3. Section (B) and Section 3.3.9.3. when directed by MSD or as required by the Plans.

3.3.8. Embankments. Embankments placed in areas over which sanitary or storm drainage facilities will be constructed, pavements will be constructed, which will be subjected to erosive action of water flowing through adjacent channels or streams, or for the purpose of storm water detention basins, shall be constructed of selected excavated materials or approved borrow materials. Embankment material shall be placed and compacted in uniform horizontal layers not exceeding 12 inches in thickness, loose measurement. Each layer shall be thoroughly compacted to a minimum of 95 percent of standard Proctor density at a moisture content between plus 2 percent and minus 4 percent, as determined by ASTM D 698. Each layer shall be properly compacted before the next succeeding layer is placed. Any lift of fill which deflects under the weight of compaction equipment shall be rejected, regardless of field density test results.

3.3.9. Final Grading. Final grading around and above sanitary sewer or storm drainage improvements shall be shaped to the slope of adjacent undisturbed ground. Sufficient grading operations shall be performed to prevent ponding and to provide natural surface drainage from adjacent areas into storm water inlets, ditches or swales.

3.3.10. Inspection and Testing

3.3.10.1. Inspection Personnel. All flushing and jetting operations shall be performed in the presence of the MSD Inspector assigned to the Project. All backfill operations which

involve mechanical compaction and which are required to meet a specified degree of compaction, shall be performed in the presence of an MSD inspector or an experienced earthwork inspector who represents an Agency designated or approved by MSD to provide earthwork inspection and testing on Projects involving MSD facilities.

3.3.10.2. Laboratory Tests. Selected excavated materials or approved borrow materials shall be sampled and tested for standard Proctor density, optimum moisture content and classification by the Agency approved by MSD. These tests will be required whenever such materials are proposed for use in compacted backfill or embankment and a specified degree of compaction is required. A minimum of one week should be allowed for the Agency to obtain samples and complete the tests.

3.3.10.3. Field Density Tests. Field density tests shall be performed on compacted backfill or embankment materials. MSD must be notified 24 hours in advance. Scheduling of field density tests with an approved Agency shall be performed 24 hours in advance of the backfill operations. Acceptable methods of performing field density tests include the following:

- (A) Nuclear Density Test - ASTM D 2922, Standard Specification for Test Methods for Density of Soil and Soil-Aggregate In-Place by Nuclear Methods (Shallow Depth).
- (B) Sand Cone Test - ASTM D 1556, Standard Specification for Test Method for Density of Soil In-Place by the Sand Cone Method.
- (C) Rubber Balloon Test - ASTM D 2167, Standard Specification for Test Method for Density and Unit Weight of Soil In-Place by the Rubber Balloon Method.
- (D) Drive-Cylinder Method - ASTM D 2937, Standard Specification for Test Method for Density of Soil In-Place by the Universal Cylinder Method.

The frequency that field density tests shall be performed will be in accordance to the following minimum schedule. Additional testing shall be performed when directed by the Inspector or by MSD.

- (A) A minimum of 1 test per 100 cubic yards of material placed and compacted in trenches or 500 cubic yards of material in embankments.
- (B) A minimum of 1 test per lift per 200 feet of material placed and compacted in trenches.
- (C) A minimum of 1 test per lift of material placed and compacted in embankments.
- (D) A minimum of 1 test per shift (day) of compaction operations.
- (E) A minimum of 1 test whenever there is a suspicion of a change in material, moisture content, or degree of compaction control.

When instructed by MSD, the Contractor shall excavate previously untested backfill or embankment material to a particular grade for testing. Backfilled areas which do not pass this test shall be excavated and recompact until they meet the compaction specifications. Areas excavated for testing shall be recompact in accordance with the Project Specifications. The cost of this Work shall be at the Contractor's expense.

3.3.10.4. Payment for Inspection and Testing. When the Contract requires mechanical compaction on MSD Projects, earthwork inspection and testing shall be performed as specified at MSD's expense. When the Contractor has the option of backfilling by flushing and jetting or by mechanical compaction, and he selects to backfill using mechanical compaction, earthwork inspection and testing shall be performed as specified at the Contractor's expense for any Project. The mechanical compaction option shall be approved by MSD prior to placement of backfill and the Testing Agent must be designated in writing.

SECTION 4

MSD STANDARD SPECIFICATIONS

PIPEWORK

4.1. DESCRIPTION OF WORK

This work shall consist of the furnishing, bedding, laying, jointing, backfilling, compaction and testing of all sanitary sewers, force main or drainage pipe shown on the Plans or otherwise required by the Contract. The Contractor shall limit active pipe installation to assure clean up following such work, in accordance with Section 4.3.1. of these Specifications.

4.2. MATERIALS

4.2.1. General. Sanitary sewer, force main or drainage pipe may be any of the following types, unless shown otherwise in the Contract. Pipe strength classes listed are the minimum acceptable classes for each type of pipe. Conditions of the construction may warrant a stronger pipe than listed herein, and the pipe supplied shall be as required by the Specifications or shown on the Plans, subject to the approval of MSD. If the contractor requests a method other than *that of* the Plans and Specifications, and the method requires a stronger pipe *or alternate*, the contractor will incur the additional cost of the stronger pipe needed. Should MSD request a stronger *or alternate* pipe other than specified on the Plans and Specifications, MSD will reimburse the contractor for the stronger pipe. Any pipe found defective, or otherwise not meeting the Specifications shall be rejected and replaced by pipe meeting these Specifications at no additional cost to MSD. MSD reserves the right to randomly test up to 3 sections of pipe for each size furnished, in accordance with ASTM standards. Upon passing the tests, MSD shall reimburse the Contractor for the cost of the testing. The Contractor shall pay for any failed tests.

The Contractor shall furnish three copies of the supplier's certification stating that pipe materials were manufactured, sampled, tested and inspected in accordance with the standards listed in this Section and have been found to meet those requirements.

4.2.2. Sanitary Sewers

4.2.2.1. Concrete Pipe. Reinforced concrete pipe shall meet the requirements of ASTM C 76, Standard Specification for Reinforced Concrete Culvert, Storm Drain and Sewer Pipe. Unless shown otherwise on the Plans or required by the Contract, Class III, Wall B or thicker pipe shall be used. For circular pipe sizes 12-inch through 24-inch diameter, non-reinforced concrete pipe meeting ASTM C14, Class 3 can be used where reinforced concrete pipe Class III is allowed.

Cement used in the manufacture of reinforced concrete pipe shall meet the requirements of

ASTM C 150, Standard Specification for Portland Cement, for Type II cement. All reinforcing cages shall be circular; elliptical reinforcement shall not be permitted unless shown on the Plans or allowed by MSD. Joints shall be sealed **with Type A** - rubber compression or confined O-ring or other MSD approved gaskets. Joints shall meet the requirements of ASTM C 443-**05A**, Standard Specification for Joints for Concrete **Pipe and Manholes**, Using Rubber Gaskets.

Unless otherwise directed by MSD, T-branch and Y-branch fittings shall be manufactured at the pre-cast plant and supplied to the Project site as single units. When field-fabricated branches are permitted, the openings in the pipe shall be properly cast at the time of manufacture.

4.2.2.2. Ductile Iron Pipe and Fittings. Ductile iron pipe shall meet the requirements of ANSI/AWWA C151/A21.51, Ductile Iron Pipe, and Centrifugally Cast in Metal Molds or Sand-Lined Molds for Water or Other Liquids. Unless shown otherwise on the Plans or in the Contract, the thickness class shall be determined based on a working pressure of 150 psi, in accordance with ANSI/ AWWA C150/A21.50, Thickness Design for Ductile Iron Pipe.

Flanged joint ductile iron fittings shall meet the requirements of ANSI/AWWA C110/A21.10, Ductile Iron and Gray Iron Fittings, 3 inch through 48 inch for Water and Other Liquids. Unless shown otherwise on the Plans or in the Contracts, Class 250 fittings with class 53 wall thickness shall be used.

Mechanical, push on and other such joints shall meet the requirements for ductile iron fittings, 3 in. through 16 in., ANSI/AWWA C153/A21.53. Where these short bodied compact fittings are to be fitted to aged existing cast iron pipe of larger diameter than specified in A21 standards, mechanical joint sleeves or bell-and-spigot sleeves shall provide transition.

All pipe and fittings shall be cement-lined in accordance with ANSI/AWWA C104/A21.4, Cement-Mortar Lining for Ductile Iron and Gray Iron Pipe and Fittings, or polyurethane lined over concrete or ductile iron or gray iron pipe and fittings. The polyurethane lining shall be an ASTM Type V, chemical cure, 100% solids, elastomeric and aromatic with no sand fillers or extenders added. It shall be capable of being spray applied to 50 mils nominal thickness in a single application. Minimum lining thickness shall be 40 mils. The polyurethane lining shall be *a seamless* flexible membrane that is corrosion, abrasion, and impact resistant; with a Shore "D" hardness of 60 to 65 at 78°F (25.5°C); a tensile strength of 2,878 psi and elongation of 52% per ASTM D-412; shall be resistant to abrasion as measured by a weight loss of no more than 42 mgs. per ASTM D-1044; and shall have a water vapor transmission rate (WVTR) of no more than 0.016 grams per 100 square inches (254 cm²) per 24 hours (75 mils DFT @ 73°F (22.7°C), 100% RH, per ASTM F-1249-90). Unless otherwise noted on the Plans or in the Special Provisions, all pipes shall be cement lined. Lining thickness per ANSI/AWWA C-104/A21.4 shall be 1/16 in. (min.) for 3 through 12 in. pipe, 3/32 in. for 14 in. through 24 in. pipe, and 1/8 in. for 30 through 54 in.

pipe.

Joints shall be push-on rubber gasket types which meet the requirements of ANSI/AWWA C111/A21.11, Rubber Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings.

When flanged joints are required, they shall meet the requirements of ANSI/AWWA C115/A21.15, Flanged Ductile Iron and Gray Iron Pipe with Threaded Flanges. Mechanical flanged restrained joints may be used when approved by MSD.

All flanged and mechanical joints for ductile iron pipe and fittings shall be made with stainless steel nuts, bolts, etc.

4.2.2.3. Polyvinyl Chloride (PVC) Pipe and Fittings. Unless shown otherwise on the Plans, in the Contract, or stipulated by MSD, the Contractor may, at his option, use any of the following types of PVC pipe:

- (A) PVC pipe meeting the requirements of ASTM D 3034, Standard Specification for Type PSM Poly (Vinyl Chloride)(PVC) Sewer Pipe and Fittings. Unless shown otherwise on the Plans or in the Contract, SDR 35 pipe shall be required.
- (B) PVC pipe meeting the requirements of ASTM F 679, Standard Specification for Poly (Vinyl Chloride) (PVC) Large Diameter Plastic Gravity Sewer Pipe and Fittings. Unless shown otherwise on the Plans or in the Contract, SDR 35 (approximate) shall be required.
- (C) PVC pipe meeting the requirements of ASTM F 789, Standard Specification for Type PS46 Poly (Vinyl Chloride) (PVC) Plastic Gravity Flow Sewer Pipe and Fittings.
- (D) PVC pipe meeting the requirements of ASTM D 1785, Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120. Unless shown otherwise on the Plans or in the Contract, Schedule 40 pipe shall be required. Fittings shall meet the requirements of ASTM D 2466, Standard 4 Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings.
- (E) PVC open or closed profile pipe meeting the requirements of ASTM F 794, Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter.
- (F) Corrugated PVC pipe meeting the requirements of ASTM F 949, Latest Revision, "Poly (Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings".

Polyvinyl Chloride Pipe shall be installed in accordance with these Specifications and ASTM Standards for "Underground Installation of Flexible Thermoplastic Sewer Pipe", D2321 requiring a minimum trench width of not less than the greater of either the pipe outside diameter plus 16 inches or the pipe outside diameter times 1.25 plus 12 inches.

Joints for PVC pipe meeting the requirements of ASTM D 3034, ASTM F 679, ASTM F 789, ASTM F949, and ASTM F 794 shall be gasket, bell and spigot, push-on types which meet the requirements of ASTM D 3212, Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals. Gaskets shall meet the requirements of ASTM F 477, Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe. For 4 inch diameter pipe meeting the ASTM F 949 requirements, double gaskets shall be used at the Tee/ Wye.

4.2.2.4. Polyethylene Pipe and Fittings. Polyethylene pipe shall meet the requirements of ASTM F 894, Standard Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe. The pipe shall be manufactured from material which meets the requirements of ASTM D 1248, Standard Specification for Polyethylene Plastics Molding and Extrusion Materials for Type III, Class C, Category 5, Grade P34 High Density Polyethylene. The pipe class shall be as shown on the Plans or in the Contract. Polyethylene pipe shall not be delivered to the site until MSD has provided approval for the pipe class to be used.

Polyethylene pipe shall be installed in accordance with these Specifications and ASTM Standards for "Underground Installation of Flexible Thermoplastic Sewer Pipe", D2321.

Joints shall be gasket, bell and spigot, push-on types which meet the requirements of ASTM D 3212, Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals. Gaskets shall meet the requirements of ASTM F 477, Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

4.2.2.5. Adapters and Couplings. Connections of sanitary sewer pipes of dissimilar materials or different sizes shall be made with connectors or adapters of the compression or mechanical seal types, and which have been approved by MSD. Bitumastic, butyl resin and mastic types of connections will not be acceptable.

4.2.3. Force Mains

4.2.3.1. Polyvinyl Chloride (PVC) Pipe and Fittings. Unless shown otherwise on the Plans or in the Contract, the Contractor may use any of the following types of PVC pipe.

- (A) PVC pipe meeting the requirements of AWWA C 900, Standard Specification for Polyvinyl Chloride (PVC) Pressure Pipe, 4 inch through 12 inch. The minimum pressure class allowance should be class 150 (DR18). PVC pipe meeting the requirements of AWWA C 905, Standard Specification for Polyvinyl Chloride (PVC) Water Transmission Pipe, Nominal Diameters 14 inch through 36 inch, pressure rated 165 psi (DR25). The minimum pressure class allowed shall be Class 150 (DR18). Joints shall be gasket, bell and spigot, push-on types which meet the requirements of AWWA C 900. Gaskets shall meet the requirements of ASTM F 477, Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

- (B) PVC pipe meeting the requirements of ASTM D 1785, Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, 120. The minimum pressure rating allowed shall be 150 psi.

Joints can be solvent-cement joints on pipes less than 4 inch and shall meet the requirements of ASTM D 2855, Standard Specification for Making Solvent-Cement Joints with Poly (Vinyl Chloride) (PVC) Pipe Fittings. The solvent-cement shall meet the requirements of ASTM D 2564, Standard Specification for Solvent-Cement for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.

- (C) PVC pipe meeting the requirements of ASTM D 2241, Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series). The minimum pressure rating shall be 150 psi.

Joints shall be gasket, bell and spigot, push-on types which meet the requirements of ASTM D 3139, Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals. Gaskets shall meet the requirements of ASTM F 477, Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

4.2.3.2. Ductile Iron Pipe and Fittings. Ductile iron pipe shall meet the requirements of ANSI/AWWA C151/A21.51, Ductile Iron Pipe, and Centrifugally Cast in Metal Molds or Sand-Lined Molds for Water or Other Liquids. Unless shown otherwise on the Plans or in the Contract, the thickness class shall be determined based on a working pressure of 150 psi, in accordance with ANSI/ AWWA C150/A21.50, Thickness Design for Ductile Iron Pipe.

Flanged joint ductile iron fittings shall meet the requirements of ANSI/AWWA C110/A21.10, Ductile Iron and Gray Iron Fittings, 3 inch through 48 inch for Water and Other Liquids. Unless shown otherwise on the Plans or in the Contracts, Class 250 fittings with class 53 wall thickness shall be used.

Mechanical, push on and other such joints shall meet the requirements for ductile iron fittings, 3 in. through 16 in., ANSI/AWWA C153/A21.53. Where these short bodied compact fittings are to be fitted to aged existing cast iron pipe of larger diameter than specified in A21 standards, mechanical joint sleeves or bell-and-spigot sleeves shall provide transition.

All pipe and fittings shall be cement-lined in accordance with ANSI/AWWA C104/A21.4, Cement-Mortar Lining for Ductile Iron and Gray Iron Pipe and Fittings, or polyurethane lined over concrete or ductile iron or gray iron pipe and fittings. The polyurethane lining shall be an ASTM Type V, chemical cure, 100% solids, elastomeric and aromatic with no sand fillers or extenders added. It shall be capable of being spray applied to 50 mils nominal thickness in a single application. Minimum lining thickness shall be 40 mils. The polyurethane lining shall be a seamless flexible membrane that is corrosion, abrasion, and impact resistant; with a Shore "D" hardness of 60 to 65 at 78°F (25.5°C); a tensile strength of 2,878 psi and elongation of 52% per ASTM D-412; shall be resistant to abrasion as measured

by a weight loss of no more than 42 mgs. per ASTM D-1044; and shall have a water vapor transmission rate (WVTR) of no more than 0.016 grams per 100 square inches (254 cm²) per 24 hours (75 mils DFT @ 73°F (22.7°C), 100% RH, per ASTM F-1249-90). Unless otherwise noted on the Plans or in the Special Provisions, all pipes shall be cement lined. Lining thickness per ANSI/AWWA C-104/A21.4 shall be 1/16 in. (min.) for 3 through 12 in. pipe, 3/32 in. for 14 in. through 24 in. pipe, and 1/8 in. for 30 through 54 in. pipe.

Joints shall be push-on rubber gasket types which meet the requirements of ANSI/AWWA C111/A21.11, Rubber Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings. When flanged joints are required, they shall meet the requirements of ANSI/AWWA C115/A21.15, Flanged Ductile Iron and Gray Iron Pipe with Threaded Flanges. Mechanical flanged restrained joints may be used when approved by MSD.

All flanged and mechanical joints for ductile iron pipe and fittings shall be made with stainless steel nuts, bolts, etc.

4.2.3.3. Polyethylene Pipe and Fittings. Polyethylene pipe shall meet the requirements of ASTM F 714, Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Inside Diameter. Materials shall meet the requirements of ASTM D 3350, Standard Specification for Polyethylene Plastic Pipe and Fittings Materials, for Polyethylene Cell Classification PE 345434C. Unless shown otherwise on the Plans or in the Contract, the pressure rating to be used shall be 160 psi (SDR 11).

Joints shall be butt fused joints which meet the requirements of ASTM D 3261, Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.

4.2.4. Drainage Pipe

4.2.4.1. Concrete Pipe. Circular reinforced concrete pipe shall meet the requirements of ASTM C 76, Standard Specification for Reinforced Concrete Culvert, Storm Drain and Storm Pipe. For circular pipe sizes 12-inch through 24-inch diameter, non-reinforced concrete pipe meeting ASTM C-14 Class 3 can be used where reinforced concrete pipe Class III is allowed. Elliptical reinforced concrete pipe shall meet the requirements of ASTM C 507, Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain and Sewer Pipe. Unless shown otherwise on the Plans or in the Contract, Class III pipe shall be used.

Joints shall be sealed with either Type A rubber compression gaskets in conformance with ASTM C443-05a- Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets, or Type B preformed flexible butyl rubber sealant in conformance with ASTM C990-06 - Joints for Concrete Pipe Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealant.

Bituminous mastic joint sealing material shall not be allowed in the construction of

reinforced concrete pipe systems.

4.2.4.2. High Density Polyethylene Corrugated Pipe. Corrugated polyethylene pipe with an integrally formed smooth interior shall meet the requirements of AASHTO M 294, Standard Specification for Corrugated Polyethylene Pipe, 12 to 36 inch diameter, for Type S pipe. Polyethylene pipe shall not be delivered to the site until MSD has provided written approval for the pipe to be used.

The pipe shall have a minimum pipe stiffness at 5% deflection as follows when tested in accordance with ASTM D-2412.

<u>Diameter</u>	<u>Pipe Stiffness</u>
12"	45 psi
15"	42 psi
18"	40 psi
24"	34 psi
30"	28 psi
36"	22 psi

Joints shall be **watertight and** made using split-corrugated couplings manufactured by the pipe manufacturer and exceeding the soil tightness requirements of the AASHTO Standard Specifications for Highway Bridges, Section 23 (2.23.3.).

4.2.4.3. Corrugated Steel Pipe. Corrugated steel pipe and coupling bands shall meet the requirements of AASHTO M 36, Standard Specification for Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains. Pipes shall be fabricated from aluminum-coated steel sheet which meets the requirements of AASHTO M 274, Standard Specification for Steel Sheet, Aluminum-Coated (Type 2) for Corrugated Steel Pipe. The gage of the steel sheet used to fabricate the pipe shall be as shown on the Plans.

Joints shall be made using coupling bands and gaskets meeting the requirements of AASHTO M 36 and AASHTO M 274.

4.2.4.4. Polyvinyl Chloride (PVC) Pipe and Fittings. Polyvinyl chloride pipe shall meet the requirements of Subsection 4.2.2.3. of these Specifications.

4.2.5. Cast-In-Place Pipe

4.2.5.1. Concrete. Concrete for all cast-in-place sewer pipes and collars shall be Class A concrete as specified in Section 6 of these Specifications.

4.2.5.2. Steel Reinforcement. Deformed steel reinforcing bars shall be Grade 60 bars of the sizes, dimensions, spacings and locations shown on the Plans. Steel reinforcement and its storage shall be as specified in Section 6 of these Specifications.

4.2.5.3. Waterstops. Waterstops shall be PVC waterstops of the shape and dimensions as shown on the Plans and meeting the material requirements as specified for waterstops in Section 5 of these Specifications.

4.2.6. Cradles and Encasements

4.2.6.1. Crushed Stone. Crushed stone for cradles and encasements shall be as set forth in Subsection 3.2.1. of these Specifications.

4.2.6.2. Concrete. Concrete for cradles, encasements or caps shall be Class B concrete as set forth in Section 6 of these Specifications.

4.2.7. Marking Tape. Marking tape shall be a composite plastic metallic tape, at least 5 mils in thickness with impervious plastic film on both sides and aluminum foil in center. The minimum tensile strength shall be 185 lbs. The tape shall be at least 3 inches in width, colored green, and shall be permanently printed on both sides "Caution Buried Sewer Below".

4.3. EXECUTION OF WORK

4.3.1. General. Prior to beginning pipe laying operations, the trench shall have been excavated to the subgrade level and unsuitable foundation conditions, when encountered, shall be corrected in accordance with Section 3 of these Specifications. The pipe within the right-of-way shall be supported on a crushed stone cradle or a concrete cradle as shown on the plans, specified herein, or directed by MSD. For concrete pipe installed outside the right-of-way, see Section 4.3.2.2. of these Specifications.

Crushed stone or concrete shall be used to encase the pipe as specified herein or directed by MSD.

4.3.2. Cradle and Encasement. Cradle and encasement shall be of crushed stone or concrete and shall be installed as specified and within the limits shown on the Plans or directed by MSD.

4.3.2.1. Crushed Stone Cradle. Crushed stone cradle shall mean the placement of crushed stone from the subgrade level (6 inches below the outside of the pipe) up to the springline of the pipe. The crushed stone shall be deposited in the trench to grade, allowing for the thickness of the pipe wall. Bell holes shall be dug to relieve the bells of all concentrated loads and to provide uniform support throughout the pipe section. For larger pipes, the crushed stone shall be shoveled and shovel-sliced beneath the haunches of the pipe to assure uniform support. Unless shown otherwise on the Plans or directed by MSD, the following types of pipes shall be supported on a crushed stone cradle.

A. Concrete Pipe

B. Ductile Iron Pipe

4.3.2.2. Soil Bedding/Cradle. For concrete pipe installed outside the roadway right-of-way with 9 feet of cover or less, the crushed stone cradle can be eliminated and replaced with job excavated native soil material. The earth trench bottom foundation should be scarified for the middle third of the pipe O.D. or at the Contractors option a minimum thickness of granular bedding can be provided. For rock foundations provide a standard 6-inch thick granular bedding.

4.3.2.3. Crushed Stone Encasement. Crushed stone encasement shall mean the placement of additional crushed stone above the crushed stone cradle to a level at least 6 inches above the outside top of the pipe **and leveled off between the trench walls**. The additional stone shall be placed in such manner to prevent damage to the pipe. Unless shown otherwise on the Plans or directed by MSD, the following types of pipe shall be encased in crushed stone.

- A. Polyvinyl Chloride Pipe
- B. Polyethylene Pipe
- C. Corrugated Polyethylene Pipe
- D. Corrugated Steel Pipe
- E. Corrugated Polyvinyl Chloride Pipe

4.3.2.4. Concrete Cradle. Where a concrete cradle is required as additional support for a sanitary sewer or storm drainage pipe, or if a sanitary sewer pipe will have less than 2 feet of vertical clearance above an existing or proposed storm drain or utility conduit, a concrete cradle shall be installed. The length of the concrete cradle shall be as shown on the Plans or 2 feet beyond the outside edge of the underlying storm drain or utility conduit. The pipe shall be laid to line and grade, and shall be supported on concrete blocks, bricks or saddles set to prevent both vertical and lateral movement of the pipe. The use of wooden blocks will not be permitted. Concrete shall be placed around the pipe up to the springline of the pipe. Proper bracing shall be provided to prevent displacement or flotation of the sewer pipe during placing of concrete.

4.3.2.5. Concrete Cap. **The length of the concrete cap shall either be as shown on the plans; or 2 feet beyond the outside edge of the storm drain or utility conduit; or 2 feet beyond the point where the sewer pipe attains 30 inches of cover in an easement; or 4 feet of cover in a right-of way or surfaces subject to vehicular traffic, or as directed by MSD.** The sewer pipe shall be laid and supported on a crushed stone cradle, and concrete shall be placed around the pipe and at least 6 inches above the top of the pipe for the full trench width, as shown on MSD's Standard Drawings. Proper bracing shall be provided to prevent displacement or flotation of the sewer pipe during placing of the concrete.

4.3.2.6. Concrete Encasement. Where shown on the Plans or where conditions exist requiring additional pipe protection (stream crossings, ditch crossings, shallow trench or poor soil conditions), pipes shall be encased in concrete, as determined by MSD. The length of the concrete encasement shall be at least 2 feet beyond the point where additional pipe

protection is required, as shown on the Plans, or as directed by MSD. The sanitary sewer or storm drainage pipe shall be laid and supported as required for a concrete cradle, and concrete shall be placed around the pipe 6 inches either side of it and up to at least 6 inches over the top of the pipe. Proper bracing of the pipe shall be provided to prevent movement or flotation of the sewer pipe during placing of concrete. In rock-bottom streams, the encasement shall extend from 6 inches below the pipe up to the original rock level. Encasement shall be required when crossing a blue line stream and shall extend to 5 feet beyond the top of bank on each side of said stream. Concrete encasement is required for plastic pipe with less than **4 feet** of cover in easements and less than **5 feet** of cover in street rights-of-way. Unless otherwise directed by MSD, a 4-inch PVC drain pipe shall be placed in the trench next to the carrier pipe and shall extend through the concrete encasement and 5 feet into the crushed stone encasement on both sides. The drain pipe shall be open on both ends. This will allow unimpeded flow of any groundwater in the sewer trench.

4.3.2.7. Safeloading. Safeloading shall consist of completely filling the designated areas with grout in such a manner to make them safe from collapse or at the Contractor's option, safeloading may be done by filling the designated area with free-flowing **grout of sand or other approved free flowing material**. Appreciable deposits of debris shall be removed from other structures prior to safeloading. The ends of existing culverts shall be plugged by use of bulkheads containing small openings at the tops through which the grout may be pumped at a minimum pressure of 15 pounds per square inch.

4.3.2.8. Thrust Block. ***Concrete Thrust Blocks, or reaction backing, shall be placed at all fittings used for changes of horizontal and vertical direction, at reducers, and at each valve, unless otherwise directed by the Engineer. Thrust blocks shall be installed in accordance with the details illustrated on the plans.***

Thrust blocks shall be placed between solid ground and the fitting to be anchored. The backing shall, unless otherwise shown or directed, be placed such that the pipe and fitting joints will be accessible for repair. Do not encase bolts or nuts.

Class B Concrete shall be used to fabricate Thrust Blocks, in accordance with Section 6.3.4.3 of the MSD Standard Specifications, and have a minimum 28-day compressive strength of 2,500 psi.

4.3.3. Pipe Installation

4.3.3.1. Inspection and Handling. All pipes shall be inspected on delivery and such pipe sections that do not conform to these Specifications and which are not suitable for use shall be rejected and immediately removed from the Work site. Equipment used to handle, lay, and joint pipe shall be so used to prevent damage to the pipe and its jointing materials. All pipe and fittings shall be carefully handled and lowered into the trench. Damaged pipe or jointing material shall not be installed.

4.3.3.2. Pipe Laying and Jointing. The laying of pipe shall begin at the lowest point and proceed upstream with the bell pointing upstream **unless conditions dictate otherwise, in**

which case MSD approval must be obtained. Prior to making pipe joints, all joint surfaces shall be clean and dry and free from gravel or other extraneous materials. All necessary lubricants or adhesives shall be used as recommended by the pipe manufacturer. Suitable means shall be used to force the spigot or tongue end of the pipe the proper distance into the bell or groove end without damage to the pipe and its jointing materials and without disturbing previously laid pipe sections. Special care shall be taken to ensure that the pipe is solidly and uniformly cradled or encased in accordance with these Specifications. No section of pipe shall be brought into position for jointing until the preceding section has been bedded and secured in place.

4.3.3.3. Line and Grade. Each section of pipe shall be checked for vertical and horizontal alignment immediately after being laid. A calibrated survey transit shall be on site and in use at all times during pipe laying operations. All adjustments to line and grade must be made by scraping away or filling in under the barrel of the pipe and not by wedging or blocking up any portion of the pipe or striking the pipe in an effort to drive it down. Curved alignments may be allowed on a case-by-case basis, as approved by MSD, except on gravity sanitary sewers smaller than 48 inches in diameter.

4.3.3.4. Protection of Installed Pipe. As the Work progresses, the interior of the pipe shall be protected from and cleaned of all dirt, cement, extruded joint materials, debris, and other extraneous materials. Whenever pipe laying is stopped for any significant length of time, such as at the end of a workday, the unfinished end shall be protected from displacement, floatation, cave-in, and in-wash of soil or debris. A suitable temporary tight-fitting plug, stopper or bulkhead shall be placed in the exposed end of the pipe.

Water shall not be allowed to rise in the excavation until the joint materials and/or concrete cradle or encasement has hardened and cannot be damaged by the water. Particular care shall be used to prevent disturbance or damage to the pipe and the joints during backfilling or at any other time. Walking or working over the pipe, except as necessary for placing and compacting backfill, or operating compaction equipment directly over the pipe shall be allowed until a minimum of 24 inches of cover over the outside top of the pipe has been placed. Mechanical compaction in this zone shall be with manual pneumatic tampers or other hand-operated methods which will not damage the pipe.

4.3.3.5. Property Service Connections. Property service connections shall be installed at the locations and with the pipe sizes shown on the Plans. Manufactured wye and tee fittings and reducers shall be used for new sewer line installations, unless noted otherwise in the Contract. The property service connection pipe shall be laid on a uniform grade from the sanitary sewer to the property **or easement** line. Where a stack is required, the pipe shall be laid on a uniform grade from the top of the stack to the property **or easement** line. The pipe depth at the property **or easement** line shall be at least 30 inches in easements, and shall be 4 feet below the final street grade, unless shown otherwise on the Plans or directed by MSD. Where no final street grade has been established, the depth of the connection shall be as directed by MSD. For existing sewer lines, property service connections shall be made with MSD approved wye, tee saddles or insert-a-tees only.

In MSD easement or right-of-way, two-way (or double wye) polyethylene cleanout fittings shall be installed at each property service connection unless otherwise directed by MSD.

Four or six-inch corrugated PVC property service connections will not be allowed.

At the upstream end of each property service connection, the Contractor shall install a watertight stopper or cap. For any thermoplastic pipe other than SDR-35, ***a Schedule 40*** adapter shall be installed at the end of each property service connection in the event that the cleanout is not installed. The Contractor shall mark the end of each property service connection with a 2x4 board which extends from the pipe to approximately 3 feet above the ground surface and marked with green paint (Catalog No. 4634 Sewer Green Fluorescent by Rainbow Manufacturing, or approved equal).

4.3.3.6. Stacks. Stacks shall be constructed at the locations and to the height shown on the Plans or directed by MSD. Stacks shall be constructed in accordance with MSD's Standard Drawings.

4.3.3.7. Stoppers and Bulkheads. When the open ends of pipes or fittings smaller than 18 inches in diameter are to be sealed, the openings shall be sealed with stoppers, cemented into place using a rubber gasket between the stopper and bell or socket. Openings 18 inches in diameter or larger shall be sealed with ***concrete*** brick masonry or concrete bulkheads at least 4 inches thick, ***verified or redesigned by a professional engineer to meet pressure requirements.***

All openings into pipes shall be protected from the entrance of earth, water or other extraneous materials. If a temporary bulkhead is constructed to prevent sewage from backing into the excavation or to prevent extraneous material from entering the sewer, the Contractor shall be responsible for reconstructing, repairing or replacing those portions of the existing sewer removed or damaged by this operation.

When an existing bulkhead is to be removed, its removal shall be coordinated with MSD.

During construction, use a mechanical plug, properly braced and tied off, when tying into an existing sewer. The plug shall remain until the sewer lines are accepted by MSD. It is the Contractor's responsibility to remove the plug prior to approval of flow being allowed into the system. The Contractor shall assume full responsibility for any damage or claims due to the installation and removal of the plug.

4.3.3.8. Marking Tape for Force Mains and Property Service Connections. Detectable marking tape shall be as specified in Section 4.2.7 of these specifications, buried approximately 12 inches below the finished grade except under pavement, when it shall be 24 inches into the subgrade over all force mains and property service connections.

4.3.4. Cast-In-Place Pipe

4.3.4.1. General. Cast-in-place pipe construction shall be performed in accordance with the applicable provisions of Section 6 of these Specifications.

4.3.4.2. Construction Joints. When shown on the Plans, concrete shall be placed in the invert and the arch sections of the barrel in two separate operations. A keyed construction joint shall be formed between the invert and arch sections. Transverse construction joints shall be constructed with **key-ways** and at locations shown on the Plans. Waterstops shall be placed at all longitudinal and transverse construction joints in cast-in-place sanitary sewer barrels.

4.3.4.3. Concrete Collar. Where cast-in-place pipes join precast pipe, a concrete collar shall be constructed around the joint, as shown on the Plans **or as directed by MSD**.

4.3.5. Leakage Testing for Sanitary Sewers

4.3.5.1. General. Testing shall not be scheduled until at least 48 hours after verbal contact is made with the project inspector. The Contractor shall perform leakage tests on sanitary sewer pipes and force mains to ensure that installed pipes are not subject to excessive infiltration or exfiltration. Sanitary sewer pipes installed in areas where other underground facilities will be constructed subsequent to the sanitary sewer shall be tested twice; at the completion of the sanitary sewer installation, and following the installation of the other underground facilities. All leakage testing must be performed in the presence of a representative of MSD. No leakage testing shall be performed prior to jetting.

When conducting any leakage test, the Contractor shall provide all meters, weirs, gages, water, equipment and personnel necessary to perform the test as specified. MSD shall provide the inspection personnel, stopwatch, recording forms and calculations to demonstrate if the test passed or failed.

If a pipe installation fails to pass the requirements as specified herein, the Contractor shall repair or replace all defective materials or Workmanship, and conduct additional leakage tests necessary to demonstrate that the repaired section meets the leakage requirements, at no additional cost to MSD. If requested by MSD the Contractor shall submit in writing a method of repair, and must be approved by MSD before repair can begin.

4.3.5.2. Low-Pressure Air Tests. When conducting a low-pressure air test, the Contractor shall securely install and brace all plugs prior to pressurizing the pipe. Personnel shall not be allowed to enter manholes when the sewer pipe is pressurized. Low-pressure air tests shall be conducted in accordance with the following:

- (A) Reinforced Concrete Pipe - ASTM C 924, Recommended Practice for Testing Concrete Pipe Sewer Lines by Low-Pressure Test Method.
- (B) Polyvinyl Chloride Pipe (PVC), Corrugated PVC Pipe, Polyethylene Pipe, Corrugated Polyethylene Pipe - UNI-B-6 Recommended Practice for Low-Pressure

Air Testing of Installed Sewer Pipe. The "half-time" testing method will be accepted for these pipes only if the section of pipe being tested has a zero drop in pressure for half the test time specified for the pipe's length to diameter ratio.

4.3.5.3. Infiltration/Exfiltration Tests for Concrete Pipe. Reinforced concrete pipe may be tested for direct infiltration or exfiltration in lieu of performing low-pressure air tests. Tests shall be performed in accordance with ASTM C 969, Standard Practice for Infiltration and Exfiltration

Acceptance Testing of Installed Precast Concrete Pipe Lines, except that the allowable rate of infiltration or exfiltration shall be 150 gallons per 24 hours per inch diameter per mile of pipe. Regardless of the leakage test results, any spurting or gushing streams of water entering the sewer or manhole shall be sealed at no additional cost to MSD.

4.3.5.4. Hydrostatic Tests for Force Mains. Force mains shall be tested by performing a hydrostatic test. The force main shall be completely filled with water and subjected to an internal pressure of 100 psi or twice the surge plus operating pressure, whichever is greater, not to exceed 125 percent of the maximum pressure rating for the pipe, measured at the downstream end. The pressure shall be held for a period of 2 hours. During the test, leakage from the force main shall be measured. The maximum allowable leakage shall be 1/2 gallon per inch diameter per 1,000 feet of pipe per hour.

4.3.6. Deflection Tests for Storm Sewers and Sanitary Sewers. The Contractor shall test all thermoplastic main line pipe by use of a calibrated mandrel, or other device approved by MSD, to ensure that no pipe deflection has occurred greater than 5 percent of the inside diameter of the pipe. Pipe shall be fully backfilled *and compacted* at least 15 days prior to testing. The Contractor shall test the entire length of the sewer installed. Any pipe section exhibiting greater than 5 percent deflection shall be replaced and retested, at no additional cost to MSD. Should this time frame for testing be waived, and MSD requires a second deflection test after 30 days, it will be at the Contractor's expense.

Deflection testing shall be performed at the time of the first or final air test. If conditions warrant, the MSD inspector may request additional tests to be performed after final restoration.

NOTE: When failure of the second air test requires repair of the main line sewer, an additional deflection test shall be required.

SECTION 5

MSD STANDARD SPECIFICATIONS

STRUCTURES

5.1. DESCRIPTION OF WORK

This Work shall consist of the construction of manholes, inlets, catch basins, junction boxes, headwalls, box culverts and other sanitary sewer or storm drainage structures of the kind and dimensions shown on the Plans. The construction shall be accomplished in accordance with these Specifications and in conformity with the lines, grades, cross-sections, and details shown on the Plans or established by MSD. The Work shall include such labor, material, equipment, removal and abandonment of structures, brick masonry, cast-in-place concrete construction, precast concrete construction, rims and covers, frames and grates, miscellaneous iron castings, and all other items as may be necessary to complete the structures as shown on the Plans.

5.2. MATERIALS

5.2.1. Concrete. Concrete for all cast-in-place sanitary sewer and storm drainage structures shall be Class A concrete as specified in Section 6 of these Specifications.

5.2.2. Steel Reinforcement. Deformed steel reinforcing bars shall be Grade 60 bars of the sizes, dimensions, spacings and locations shown on the Plans. Steel reinforcement and its storage shall be as specified in Section 6 of these Specifications.

5.2.3. Grout. Grout shall consist of a mixture of water and cement or cement with fly ash, or water and one part cement or cement with fly ash to two parts mortar sand as defined in Section 804.05 of the *KYTC Standard Specifications (current edition)*, by volume. The water may be adjusted to produce a mixture of a consistency suitable for job conditions; however, not over 5 1/2 gallons of water shall be used per sack of cement.

5.2.4. Non-Shrink Grout. Non-shrink grout shall be an approved non-shrink, non-staining grout consisting of either a mixture of hydraulic cement, water, fine aggregate, and an approved nonferrous expansive admixture, or a packaged commercial product and shall meet the requirements of Section **601.03.03B3 of the** KTC Standard Specifications.

5.2.5. Precast Structures. Any use of precast structures must be so noted on the Plans, including a typical detail for each type of structure for the Project. Round structures shall conform to ASTM C 478 and square and rectangular structures shall meet the requirements of ASTM C 913.

Structures which require specially designed footings, cut-off walls, etc. will not be

allowed as precast.

Openings in precast structures for pipes shall be the outside diameter of the pipe plus a maximum of 6 inches. In order to use non-shrink grout, the opening shall be the outside diameter of pipe plus 3 inches. (Outside diameter of pipe plus 4 1/2 inches is permissible when tapered hole forms are utilized).

For precast structures (other than those with knockout panels) the opening around the pipe shall either be filled with non-shrink grout for the wall thickness of the structure or the pipe shall be encased with minimum 6 inch collar of concrete from the inside face of the wall to 1'-0" outside the outer face of the wall. The pipe shall be adequately supported to prevent settling while the grout or the concrete encasement is setting up. The inside faces of the structure walls shall be finished with a trowel and wet brush finish.

For circular structures and rectangular structures (other than those with knockout panels) the minimum vertical distance from the holes for the pipes to the top of the structure wall shall be 4 inches. If this vertical distance is less than 12 inches, then additional reinforcing steel shall be furnished for this section. The top slab must be designed for **AASHTO HS-20** loading.

For precast structures with knockout panels, holes for the pipes shall not be cut into the structural members (i.e., top beams and corner columns) and non-shrink grout shall not be allowed to be placed around the pipes. The pipes shall be encased with concrete a minimum 6 inch collar around the outside of pipe or a minimum of 3 inches beyond the hole knocked in the wall, whichever is greater. Also, the concrete encasement shall extend from the inside face of the wall to 1'- 0" outside the outer face of the wall.

Precast structures with knockout panels shall not be used with more than 2 feet of earth cover, as measured from the top of the structure, unless load calculations are supplied.

For rectangular structures where pipe will be installed in adjacent walls (other than those with knockout panels), at least 6 inches of wall (measured from the interior corner) is required on each side of the pipe beyond the precast opening for the pipe. This rule is not applicable for structures which have pipe installed in opposite walls or where one outlet reinforced concrete pipe is utilized.

A wash is required in the bottom of catch basins to provide positive drainage (sloped toward outlet).

Precast structures in roadways other than installed sanitary manholes and wet wells shall have a minimum of two 4" weep holes. There will be a 2 cubic foot burlap or plastic sack filled with No. 57 stone over the weep holes.

5.2.5.1. Precast Manhole Sections. All precast concrete manhole risers, cones, grade rings, flat slab tops, and bases shall conform to the requirements of ASTM C 478, Standard

Specification for Precast Reinforced Concrete Manhole Sections, and MSD's Standard Drawings. All cone and transition sections shall be eccentric in shape. Base and riser sections shall be custom-made with openings to meet indicated pipe alignment conditions. The following applies as to the maximum inside diameter (or horizontal dimension) of pipe to be used with a given size of manhole.

<u>Diameter of Structure</u>	<u>Maximum Size Pipe*</u>
4'-0"	24 inches
5'-0"	36 inches
6'-0"	48 inches

*Outside diameter may be considered on a case-by-case basis for other pipe materials. The minimum distance allowed between precast holes for the pipes shall be 12 inches, or one-half the outside diameter, whichever is larger.

5.2.5.2. Precast Structures (Except Manholes). If precast structures are furnished, the following requirements shall apply. The structures furnished shall be products on the list of approved precast structures on file with MSD. To be considered for addition to the list, five copies of shop drawings shall be submitted for review. The shop drawings shall show details of any variation from MSD's Standard Drawings and shall include any special installation instructions necessary. Specifications for any special materials for joint construction shall be submitted with the shop drawings, and samples of joint materials shall be submitted when requested.

5.2.6. Watertight Sewer Pipe Connections. Watertight sewer pipe connections shall be elastomeric gaskets or couplings manufactured in accordance with ASTM C 923, Standard Specification for Resilient Connectors between Reinforced Concrete Manhole Structures and Pipes, and shall be on MSD's list of approved materials.

5.2.7. Joint Sealants.

Type A - Is a compression rubber gasket in conformance with ASTM C443-05a Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets. Note – in applications where a Type A joint is specified, the receiving structure joint will need to be manufactured such to accept the particular gasket type selected (Example O-Ring, Press-Seal, Forsheda, etc)

Type B - Is a preformed flexible butyl rubber sealant in conformance with ASTM C990-06 - Joints for Concrete Pipe Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealant.

Reference is made to 5.3.4 for applications.

Neither bituminous mastic joint sealing material (brush on type) nor (oil-based) bitumastic asphaltic butyl shall be allowed in the construction of structure joints.

5.2.8. Exterior Joint Wrap.

A six-inch wide strip of polyolefin covered with butyl mastic joint sealant, or a hydrophilic sealant having a 50% expansion factor and being capable of withstanding 25 PSI of pressure shall be placed over all exterior manhole joints, including grade rings. The product will be in accordance with ASTM C877-08. **Standard Specification for External Sealing Bands for Concrete Pipe, Manholes, and Precast Box Sections.**

5.2.9. Waterstops. Waterstops shall be extruded from an elastomeric plastic compound, the basic resin of which shall be polyvinylchloride. The compound shall contain any additional resins, plasticizers, stabilizers, or other materials needed to ensure that when the material is compounded it will meet the physical property requirements shown below:

<u>Physical Property</u>	<u>Required Value</u>	<u>Test Method</u>
Tensile Strength (Die "C")		
Sheet Material	2,000 psi	ASTM D 412
Finished Waterstop	1,700 psi	ASTM D 412
Ultimate Elongation (Die "C")		
Sheet Material	350% Min.	ASTM D 412
Finished Waterstop	300% Min.	ASTM D 412
Stiffness in Flexure	750 psi Min.	ASTM D 747
Accelerated Extraction		CRD C 572
Tensile Strength (Die "C")	1,750 psi	ASTM D 412
Elongation (Die "C")	300%	ASTM D 412
Effect of Alkali (After 7 Days)		
Change in Weight	-0.1 to 0.25%	
Change in Hardness, shore Durometer	+ or - 5%	
Low Temperature Brittleness	-35°	ASTM D 746
Specific Gravity	1.3	ASTM D 792

When required, the Contractor shall submit a manufacturer's certificate stating that all of the physical property requirements specified above for the sheet material have been satisfied. Field splices for waterstops shall be performed by heat-sealing the adjacent surfaces in accordance with the manufacturer's recommendations. Waterstops shall be manufactured with an integral cross-section which shall be uniform within plus or minus 1/8 inch in width, and the web thickness or bulb diameter within plus 1/16 inch and minus 1/32 inch.

5.2.10. Manhole Steps. Manhole steps shall be polypropylene plastic-coated steel bar with treads having anti-skid properties for hand and foot grips. Manhole steps shall be cast, epoxy grouted, or attached by mechanical means into the walls of the manholes in such manner as to conform with ASTM C 478. Steps shall be spaced not more than 12 inches vertically on

centers and shall be so arranged that the lowest rung is no more than 12 inches above the bench, and the top rung is 18 inches below the *bottom of the casting*. The steps shall be arranged out of alignment of the flow channel, and shall be centered on the grate or lid opening.

5.2.11. Castings. Castings shall be of the standard MSD type as detailed on MSD's Castings Standards. Castings shall be of uniform good quality, free from scale, lumps, blowholes, shrinkage, distortions or other defects. They shall be smooth and thoroughly cleaned by shot-blasting. Castings shall meet the requirements of ASTM A 48, Standard Specification for Gray Iron Castings, for Class No. 35-B, Gray Iron. Manhole rims and covers and inlet frames and grates shall be machined or ground at touching surfaces so as to seat firmly and prevent rocking. Any set not matching perfectly shall be removed and replaced at no additional cost to MSD.

5.2.12. Manhole Inverts. Manhole Inverts on 8" **and larger** size lines **shall** have a **minimum 0.10 foot drop** through the structure unless one of the lines exceeds a 10% grade. All grades exceeding 10% on 8" lines and all other pipe sizes shall continue to have their grade ending at the manhole P.I.

5.2.13. Chimney Seals. The manhole chimney section shall be sealed and made watertight using either a mechanically locking internal butyl rubber chimney seal or a chemically bonding chimney seal as identified on the plans. **Installation of the chimney seals shall be performed by manufacturer certified personnel. The chimney-sealing product shall be on the MSD pre-approved product list. The actual product used shall be identified on the shop drawing submittal.**

5.3. EXECUTION OF WORK

5.3.1. Modification to Existing and Proposed Structures

5.3.1.1. Removal. Existing structures to be removed shall be indicated on the Plans or as directed by MSD. MSD reserves the right to retain or reject salvage of any materials encountered. Unless otherwise directed by MSD, all castings and mechanically locking internal chimney seals shall be retained by MSD. All salvage materials retained by MSD shall be delivered to the appropriate storage yard as directed by MSD. All remaining materials shall become the property of the Contractor who will be responsible for disposing of same. The excavation shall be backfilled in accordance with Section 3 of these Specifications.

5.3.1.2. Abandonment. Existing structures to be abandoned in place shall be as shown on the Plans or as identified by MSD. After removing structure frames, covers, grates, mechanically locking internal chimney seals and similar items, all pipes shall be bulkheaded as specified in Section 4 of these Specifications. The walls shall be lowered to 2 feet below final grade if in earth or to 12 inches below subgrade if in pavement. The remaining structures shall be filled with crushed stone or sand. In paved areas or where

directed by MSD, a 12 inch thick plain concrete slab shall be installed over the manhole or structure top such that it extends 12 inches beyond the outside face of the manhole or structure. MSD reserves the right to retain or reject salvage of any materials encountered. All remaining materials shall become the property of the Contractor who will be responsible for disposing of same.

5.3.2. Wastewater Treatment Plant Decommissioning

5.3.2.1. General. The Contractor shall furnish all labor, materials, equipment and incidentals required to eliminate the wastewater facilities, including all demolition and removal Work, for the wastewater treatment plant(s) (WWTP) as specified herein.

The Contractor shall submit to MSD for review and acceptance a written plan and schedule for the elimination of the WWTP(s) including the demolition, removal and disposal Work. This plan and schedule shall include certain elements and milestones specified for the subject WWTP(s). After the Contract is awarded and prior to commencement of the Work, the Contractor shall meet with MSD to discuss the transfer of flow to the new sanitary sewer system and demolition, removal, and disposal plan. The plan shall include a schedule for disconnection of existing utility services and procedures for the careful removal and disposal of building materials and existing sewage, bio-solids, grit and mixed liquor which may be in tanks, lagoons, etc. Included in the plan must be a detailed description of the methods and equipment to be used for each operation and the sequence of operations.

Do not proceed with elimination of the facilities until MSD has given written acceptance of the elimination plan.

Specific guidelines for the removal and disposal of material contained in the various individual treatment units are provided below. These guidelines are intended to provide the Contractor with a method of elimination that will meet the approval of MSD, the Louisville and Jefferson County Board of Health and the Kentucky Natural Resources and Environmental Protection Cabinet, Division of Waste Management (DWM) and Division of Water. The Contractor is responsible for obtaining all demolition permits, including any transportation permits required to transport the material to their appropriate disposal site(s), prior to commencement of Work. Two (2) copies of these permits shall be submitted to MSD prior to commencement of Work.

Modifications to the landfill disposal site's existing permit(s) are required by the Division of Waste Management regarding the disposal of wastewater by-product materials at the landfill. MSD is responsible for preparing the "Application to Accept an Additional Waste Stream" to be submitted to the Kentucky Division of Waste Management (DWM), including obtaining the required laboratory test results required by both DWM and the landfill. A copy of the permit modification letter from DWM to the landfill allowing them to accept the additional waste stream will be provided to the Contractor prior to commencement of Work.

5.3.2.2. Existing Facility Elimination. Unless otherwise directed by MSD, the Contractor shall provide MSD with written notification as stated in the special provisions prior to removing a facility from service.

The Contractor shall utilize the following steps during the process of removing a facility from service. These steps will generally include, but are not limited to:

- (A) Influent Diversion: Discontinue wastewater flow to the existing facility by permanent influent diversion to the newly constructed and approved MSD sanitary sewer system, in accordance with the Contract.
- (B) Supernatant and Mixed Liquor: Carefully remove and transfer the liquor supernatant and mixed liquor to the newly constructed and approved MSD sanitary sewer system in accordance with MSD's directions.
- (C) Equipment: Remove grit and bio-solids from the previously submerged equipment to render the equipment salvageable.
- (D) Three to Five Percent Bio-solids: Bio-solids which remain in liquid holding tanks or lagoons after removal of supernatant and mixed liquor that have no greater than 3% - 5% solids concentration with no additional water added, may be removed and hauled to a septage receiving facility approved by MSD. A waste hauler must be permitted by the Board of Health and registered with MSD in order to dispose of waste at the SRF. It is the Contractor's option and responsibility to make arrangements for disposal of 3% - 5% solids, by volume, in the manner and pay all associated costs and fees; the Contractor may handle this bio-solids component in the same manner described in Paragraph (E) below.
- (E) All Other Bio-solids and Grit: Bio-solids and grit which remain in liquid holding tanks or lagoons shall be dewatered using portable dewatering equipment located on-site. The liquid by-product from the dewatering process can be returned to the newly constructed and approved MSD sanitary sewer system. The Contractor shall use shovels, brooms and/or other appropriate methods to assure that residual grit and/or bio-solids are removed from corners and hard to reach areas of holding tanks and treatment vessels. For lagoons, the Contractor shall remove all grit and bio-solids down to residual earth or synthetic liner, and stabilize the earth/liner area with hydrated lime to a pH of 10.0 or greater. The dewatered bio-solids material shall then be transported to an approved landfill site.

The Contractor shall be aware that the landfill receiving the dewatered material may randomly sample the material at the landfill and perform filter laboratory testing. If the dewatered material does not pass this test, the landfill will reject the material and not allow its disposal at the landfill. In addition, any evidence of free water in the material will also result in its rejection by landfill personnel. In either case, additional dewatering of the rejected material will be the Contractor's responsibility prior to acceptance and disposal at the landfill.

The Contractor shall have a maximum of 30 days to dewater and/or remove all bio-solids and grit from the facility beginning at the time of wastewater influent flow diversion. During this 30-day time frame, the Contractor is responsible for controlling odors emanating from the facility.

- (F) Utility Disconnection: Disconnect the existing utility services in accordance with the appropriate utility company's recommendations. Utility disconnection shall not occur until all bio-solids and grit materials have been dewatered and/or removed from the facility.

Once the facility is taken out of service, and the steps outlined in Sections (A) through (F) are complete, the Contractor shall provide written notification to MSD that the facility is prepared for equipment salvage. Unless otherwise directed by MSD, the Contractor shall then vacate the facility site for a period of time as specified in the special provisions to allow equipment salvage by MSD or the Owner.

The Contractor is encouraged to supplement any information about the WWTP site, components and waste constituents provided by the Contract, with his own on-site evaluation.

The Contractor shall be responsible for obtaining all demolition and transportation permits, their attendant costs, and all costs associated with pre-bid investigation, removal and disposal of the sanitary wastewater bio-solids and grit material.

5.3.2.3. Existing Facility Demolition and Closure. At the end of the salvage period, the Contractor shall remobilize at the site, stabilize any remaining residual solids with hydrated lime to a pH of 10.0 or greater and proceed with demolition. For the liquid holding tanks that have been stabilized and are to be left-in-place, the Contractor shall break holes in the bottom of the below grade structures for groundwater pressure relief and demolish/remove the structure(s) to a minimum of 3 feet below finished grade. The remaining void spaces within the structures shall be backfilled with a sand material to 3 feet below finished grade, and then backfilled with select topsoil fill material to finish grade as shown on the Contract. The above-grade structures located at the WWTP facilities and not identified on the Drawings or in the Specifications as "To Remain" or "Do Not Disturb" shall also be demolished/removed to a minimum of 3 feet below finished grade and backfilled as described above. For lagoons, the Contractor shall backfill the entire lagoon area with select fill material, as approved by MSD, and mechanically compact the material to 90% Standard Proctor maximum dry density in accordance with Section 3 of these Specifications. All disturbed areas shall be graded to provide positive drainage; and shall be seeded, fertilized and mulched in accordance with Section 9 of these Specifications.

5.3.3. Connections. The Contractor shall verify the exact locations and elevations of existing structures or sewers prior to construction and any differences between actual and plan locations and elevations shall be brought to the attention of MSD before proceeding with the Work. If a bulkhead opening of adequate size, or a stub of proper size, elevation,

location and direction exists, the connection shall be made as required for normal pipe laying.

For *all* sanitary sewer pipes an opening *shall be core drilled* in the structure to permit inserting the pipe at the required elevation, direction, and slope. The circumference of the opening shall *allow* approximately two inches of space between the inserted pipe and the structure. Care shall be used to avoid unnecessary damage to existing concrete or brick masonry. All loose material shall be removed from the cut surfaces and the cut surfaces shall be completely coated with non-shrink grout. Before setting the pipe, a sufficient thickness of grout shall be placed at the bottom and sides of the opening for proper bedding of the pipe. After setting the pipe, all spaces around the pipe shall be solidly packed and filled with non-shrink grout which shall be neatly pointed up on the inside to present a smooth joint, flush with the inner wall. When making connections to existing stubs, approved pipe adapters shall be used.

For all drainage pipe, an opening may be saw cut and provided with approved connectors. Modifications to the existing invert shall be made as needed to provide a smooth plastered channel to accommodate the flow from the new pipe. When reconstruction of a manhole is required, entry into the manhole shall be at the elevation indicated on the Plans or at the invert of the manhole. Entries shall not be allowed on top of the wash unless otherwise directed.

5.3.4. Manholes and Wet Wells.

5.3.4.1 General. Manholes shall be neatly and accurately built in accordance with the Plans and MSD's Standard Drawings. Precast manhole and wet well bases, when used for sanitary sewer manholes and wet wells, shall be supplied with watertight sewer pipe connections. When the manhole base slab will consist of cast-in-place concrete for existing sewer lines, the sewer pipe and the lower precast barrel section shall be in place and supported by concrete blocks prior to placing concrete for the slab. All rough openings between pipes and precast sections shall be thoroughly and completely filled with non-shrink grout, applied so that there will be no leakage around pipes. The grout shall be finished smooth and flush with the interior and exterior manhole or wet well wall surfaces. When the manhole base slab will consist of cast-in-place concrete for new construction, pipe to manhole connections in the precast barrel section shall be done at the manufacturing plant. Field modifications will be allowed to precast structures if approved by MSD Inspection. When core drilling is not possible, saw cutting shall be performed when modifying an existing structure.

Manhole inverts shall consist of Class A concrete, placed to conform to the shapes indicated on MSD's Standard Drawings. Inverts shall include both channel and wash sections with channels so constructed as to create the least resistance to flow. A smooth, uniform dense finish shall be required. Inverts may be either precast or cast-in-place.

5.3.4.2. Joints

Joint sealant materials shall be of the sizes recommended by the manufacturer to provide watertight seals between precast manhole sections. When requested, the Contractor shall furnish information showing that the sizes of the joint sealants being supplied meet the manufacturer's recommendations.

Storm Manholes

Either a Type A Gasket or Type B Sealant, as described in 5.2.7, shall be used in storm structures. Exterior Joint Wrap is not required.

Sanitary Manholes and Wet Wells

Joints between precast sections shall be sealed in a **two-way fashion consisting of a Type B sealant, described in 5.2.7., and an exterior joint wrap described in 5.2.8.**

Reference is made to MSD's Manhole standard drawings for additional reference.

For wet well joints, the same **two-way** sealing system **described for sanitary manholes** shall be used. For non-circular valve vaults and wet wells, the sealing system shall consist of a double strip of butyl rubber mastic sealant conforming to ASTM C990 under Section 6.2.1., and a 6-inch wide strip of polyolefin covered with butyl mastic exterior wrap joint sealant. The butyl rubber mastic sealant shall be placed approximately 1 to 2 inches apart, centered on the structure shoulder. Refer to section 10.2.17 Wet Well of these specifications for further information on wet wells and pump stations.

5.3.4.3. Future Connections and Drop Inlets. When indicated on the Plans, provisions for future sewers shall be provided at manholes by providing 12 inch long stubs of the sizes, lines and grades shown. The upstream ends shall consist of the bell or spigot ends, and they shall be sealed with removable stoppers or bulkheads. If the specified length of any stub is exceeded, it shall be at no additional cost to MSD, unless the extra length is ordered by MSD. Drop inlets shall be constructed at manholes where indicated on the Plans as per MSD standard drawings. Inside drops are not allowed on new facilities and must have prior MSD approval on existing structures. Manhole barrel sections shall be supplied with openings for upper and lower inlet pipes. The annular spaces between the inlet pipes and the manhole walls shall be filled with non-shrink grout. Grout shall be finished smooth and flush with the adjoining interior and exterior manhole wall surfaces. Encasement of the outside drop pipe shall be with Class B concrete. In case of precast, concrete encasement shall be doweled with reinforcing steel and shall extend a minimum of 2 L.F., or to the undisturbed soil.

For the purposes of property service connection reference and manhole identification, each manhole shall be sequentially numbered with a number provided by MSD. The Contractor shall stamp the numbers into the north edge of the rim of each manhole as shown on the approved Plans. Numbers shall be 3/8 inch high block numerals clearly visible without removing the manhole lid.

5.3.4.4. Frames and Chimney Seals. Manhole frames shall be placed in the positions shown on the Standard Drawings and shall be set to the correct elevations or adjusted to match final grade. Manhole adjusting rings shall only be used to make final elevation corrections and are not required otherwise. Use the least number of standard size rings as required for proper grade. If the concrete adjusting ring height will equal or exceed 12 inches, use 1-ft. barrel sections. Frames shall be set concentrically with the precast concrete collars and sealed between the two with a strip of butyl resin (Type B). The remaining annular space shall be filled with grout so that the spaces between the collars and the bottom flanges of the frames shall be completely filled and made watertight. A frame shall not be disturbed until the grout has hardened to adequate strength.

Chimney Seals shall be installed in accordance with the Manufacturer's Specification for installation. The Installer shall be certified by the product manufacturer and proof of such certification shall be provided to MSD prior to installation of chimney seals. In addition, the installer shall carry a copy of his/her certification at all times during installation. Chimney Seals shall be installed after the binder course is placed when the manholes are constructed in roadways and after rough grading in all other areas.

MSD reserves the right to visually inspect and/or water test all chimney seal installations to ensure that the seal has not been damaged or compromised during final site restoration and/or paving. The contractor at no additional cost to MSD shall correct any defects identified by these inspections and tests.

The water test method shall be either a Static Head Test or Gravity Test as defined below. The test method shall be selected by the Inspector and may vary from manhole to manhole.

Static Head Test - A 1-foot tall section of PVC pipe with external diameter matching the internal diameter of the manhole frame shall be temporarily sealed to the frame. Sandbags or an approved alternative shall be used to form a 6 inch tall ring around the PVC pipe allowing a 6 inch annular space between the PVC pipe and the outer ring. The annular space shall then be filled with water to a height of 6 inch and the water level maintained for 10 minutes. The inspector shall observe the sealed area during the test for leakage. The installation shall be deemed unacceptable if any visible, continuous stream of water leaking from the sealed area is observed.

Gravity Test – The gravity test may be used as an alternative to the static head test on mechanically locking seals. The test shall be performed by introducing approximately 1 gallon of water directly behind the seal and extension, if used. The installation shall be deemed unacceptable if MSD or its representative observes any visible, continuous stream of water leaking from the sealed area.

The following restrictions apply to the use of Chemical Chimney Seals:

- (A) Shall not be used when wet weather is expected before the product is sufficiently cured to withstand water contact per the manufacturer's recommendations.

- (B) Shall not be used to bridge gaps greater than ½-inch.
- (C) Shall not be used with HDPE grade adjustment rings.
- (D) Shall not be used on concrete or grout that has not cured for at least 30 days.

5.3.4.5. Testing. All manholes installed for a project shall be subject to vacuum testing in accordance with ASTM C1244. Vacuum testing shall be conducted in the presence of the MSD inspector after Chimney Seal installation. Chemical Chimney Seals shall not be subject to vacuum testing until the product has sufficiently cured to withstand vacuum pressures. Manholes shall be capable of holding a vacuum of 5 psi (10-inches of Mercury) without dropping more than 0.5 psi (1 inch of Mercury) for the times stated below:

	Depth (ft)											
Diameter (in)*	8	10	12	14	16	18	20	22	24	26	28	30
	Times (s)											
48	20	25	30	35	40	45	50	55	59	64	69	74
60	26	33	39	46	52	59	65	72	78	85	91	98
72	33	41	49	57	67	73	81	89	97	105	113	121

*Refer to ASTM C1244 –99 for required test times on manholes with other diameters

Minimum test times for typical MSD manhole diameters (ASTM C1244)

Vacuum testing of manholes exceeding 15 feet in depth shall take groundwater into consideration and the vacuum pressure for testing shall be reduced by 0.5 psi (1 inch of Mercury) for every five feet of groundwater depth above the outgoing pipe. The contractor shall determine the groundwater elevation immediately prior to vacuum testing. Manholes that do not pass the initial vacuum test shall be repaired and retested at no cost to MSD. A 100% pass rate shall be achieved.

Exfiltration tests will not be allowed for manhole acceptance testing unless directed otherwise by MSD or its representative. When required, exfiltration tests shall be performed in accordance with ASTM C 969, Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines. The maximum allowable exfiltration rate shall be 0.1 gallons per foot diameter, per foot of head, per hour. If the exfiltration rate exceeds this value, the Contractor shall make repairs as required including re-testing, at no additional cost to MSD.

5.3.5. Small Structures. Inlets, catch basins, drains, junction structures, and other small structures shall be neatly and accurately built in accordance with the Plans and MSD's Standard Drawings. The structure shall be either of cast-in-place concrete or of precast concrete, provided the precast sections have been approved by MSD. Square and rectangular structures shall meet the requirements of ASTM C913 and round structures shall be made in accordance with ASTM C478. Inlet and outlet pipes shall be cut off flush with the inside

surfaces of the wall. Pipe bells shall not be allowed inside the structure wall. The pipes shall intersect at the structure so that the invert channel between the inlet and outlet pipes can be smoothly formed. Invert channels shall be of Class A concrete and shall conform to the shapes indicated on the Plans, MSD's Standard Drawings, or as otherwise directed. The invert channels shall be so constructed as to cause the least possible resistance to flow. The shapes of the invert channels shall conform uniformly to inlet and outlet pipes. Smooth and uniform finishes will be required. All inlets, and junction structures deeper than 4 feet, as measured from the top of the rim or frame to the invert of the structure, shall be provided with steps unless otherwise shown on the Plans or directed by MSD.

Steps shall be spaced not more than 12 inches vertically and shall be so arranged that the lowest rung shall not be more than 12 inches above the bench, and the top rung shall be 18 inches below the ***bottom of casting***. The steps shall be arranged out of alignment of the flow channel, and shall be centered horizontally of the grate or lid opening.

All cast-in-place structures shall be built using Class A concrete. The structures shall be built on prepared foundations and conform to the dimensions and shapes shown on the Plans and MSD's Standard Drawings. The construction shall conform to the methods, forms, placement, protection, and curing for concrete as specified in Section 6 of these Specifications.

Any required reinforcement shall be of the kind, type, and size and shall be located, spaced, bent, and fastened as shown in the Plans and MSD's Standard Drawings. Installed concrete reinforcing shall be approved by MSD before any concrete is placed.

Connections for inlet and outlet pipes shall conform to the sizes, alignments, and elevations shown on the Plans. The sealing around pipes for small sanitary sewer structures shall conform to Subsection 5.2.6. of these Specifications.

Waterstops shall be required at construction joints for cast-in-place sanitary sewer structures. Waterstops shall be installed and securely held in place during concreting, in accordance with the manufacturer's recommendations.

Precast sections may be used in the construction of small structures provided that such sections are on MSD's approved list for precast structures.

No sledge hammer modifications are allowed to precast structures. Saw cuts should be utilized when modifying an existing structure.

When shown on the Plans, cast iron grates and lids shall be attached to the frames, or to the concrete in the event there are no frames, with chains of sufficient lengths to permit moving for clean out and maintenance purposes.

5.3.6. Concrete Box Culverts, Retaining Walls and Headwalls

5.3.6.1. Footings. Footings shall be constructed to the elevations shown on the Plans, but such depths may be increased when it is determined by MSD that the increases are necessary to provide sufficient bearing or to prevent undermining. Footing elevations should only be raised when solid rock is encountered at elevations above those shown.

5.3.6.2. Precast Concrete Box Culverts. Precast concrete box culverts shall be submitted to Louisville MSD for approval on a job by job basis. Precast Box Culverts shall be manufactured in accordance with ASTM C1433 Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers. Follow the requirements of the KTC Standard Specifications Section 611- Precast Reinforced Concrete Box Culvert Sections. The precast box culverts shall be built neatly and accurately in accordance to the plans and specifications of the project.

The outside faces of all footings of concrete headwalls for pipe, box, or arch culverts shall be formed to full depths of the footings. Whenever the natural foundation material is insufficiently stable to support the structure or whenever it is anticipated that high water may cause excessive erosion around the footings, MSD may order extra Work performed as necessary to provide the structure with adequate support or protection.

5.3.6.3. Culvert Inverts, Aprons, Curtain Walls, and Headwalls. All culverts, except those founded on solid rock, shall be constructed with a substantial concrete slab through the invert or stream bed. This slab shall terminate at each end of the culvert in apron walls, curtain walls, or cutoff walls carried to a depth that will eliminate danger of undermining. Inverts for concrete culverts shall be paved with a reinforced concrete slab, unless otherwise directed.

Apron or cutoff walls shall, in general, be carried down at both ends to the depths shown, but may be ordered to additional depths necessary to prevent undermining. The outside faces of inlet and outlet concrete aprons or cutoff walls for single span or multiple span culverts shall be formed for the full depths of the aprons or cutoff walls.

MSD may direct the space between wings to be paved. In this event, the apron walls will extend in a straight line between the ends of the wings, or at such locations as may afford the best protection.

When headwalls for pipe culverts are located at the shoulder of a road, the tops of the headwalls shall be parallel to the shoulder line for both line and grade. When shown on the Plans, the KTC Standard Drawings for pipe culvert headwalls list dimensions from the face of concrete to steel reinforcement as clear distances and dimensions for bar spacings as center to center of bars.

Otherwise, MSD's Standard Drawings shall be used for determining the sizes and reinforcing steel requirements. Precast concrete pipe headwalls shall conform to the

requirements of Subsection 5.2.5. of these Specifications.

Surfaces shall be finished in accordance with the requirements of Section **601.03.18 of the** current edition of the KTC Standard Specifications or as directed by the Engineer.

5.3.6.4. Retaining Walls. Gravity type or non-reinforced retaining walls shall be constructed of Class B concrete and shall be constructed as shown on the Plans. Reinforced concrete retaining walls shall be constructed of Class A concrete and shall be constructed as shown on the Plans.

5.3.6.5. Placing Concrete. Concrete shall be placed as specified in Section 6 of these Specifications. The base slab or footing shall be placed and allowed to harden before the remainder of the structure is constructed. When shown on the Plans or directed by MSD, suitable provisions shall be made for bonding the walls to the base by means of longitudinal keys formed by insertion and subsequent removal of beveled timbers. Base slabs, footings, and apron walls shall be constructed as monolithic units, when practicable. When construction joints are necessary, they shall be placed at right angles to the culvert barrel or retaining wall and suitable provision shall be made for bonding adjacent sections by means of keys formed by beveled timbers.

Before concrete is placed in the walls, the footings shall be thoroughly cleaned of all debris, or other extraneous material and the surface carefully chipped and roughened in accordance with the method of bonding construction joints, as specified under Section 6 of these Specifications.

In the construction of all box culverts having a clear height of 5 feet or more, concrete in the side walls shall be placed and allowed to set before the top slab is placed.

For culverts having a clear height of less than 5 feet, the culvert may be poured monolithic when the Contractor so desires. When this method of construction is used, any necessary construction joints shall be vertical and at right angles to the axis of the culvert.

Each wingwall shall be constructed as a monolithic unit. Construction joints, where unavoidable and when not shown, shall be horizontal.

5.3.6.6. Placing Fill. Backfill or embankment shall not be placed against culverts, retaining walls, and headwalls until permission is given by MSD. Backfill and embankment shall be constructed as specified in Section 3 of these Specifications.

5.3.7. Adjusting Manholes and Catch Basins. All frame height and alignment adjustments shall be subject to field inspection by MSD and be subject to correction as directed by MSD.

Concrete brick (conforming to ASTM C-55 for Type II Grade 5) may be used when adjusting the casting no more than 4 inches.

Precast concrete riser rings may be used when the casting is raised more than 4 inches or when total combined height of existing and proposed exceeds 4 inches. If the concrete riser ring height will exceed 12 inches, use 1-ft. barrel sections. Use the least number of standard size rings as required for proper grade.

No wood shims, wood blocks or shot rock shall be used to adjust or reset the frame height.

In asphalt pavement, the excavated area around the manhole or catch basin that is raised shall be backfilled with a minimum of 8 inches Class "A" concrete to a level 2 inches below the new top of grate or lid elevation. The remaining 2 inches shall be paved with bituminous surface.

Prior to raising manhole or catch basin frames, the Contractor, Design Engineer, and MSD representative shall inspect for damaged frames and grates or lids. Damaged frames, grates or lids shall be replaced by the Contractor at no expense to MSD unless item was damaged prior to start of construction.

SECTION 6

MSD STANDARD SPECIFICATIONS

CONCRETE

6.1. DESCRIPTION OF WORK

Concrete shall consist of a mixture of Portland cement, fine aggregate, coarse aggregate, and water, with air entrainment as specified, combined in the proportions and mixed to the consistency specified, and shall be formed or cast to dimensions indicated on the Plans or as directed by MSD. The Contractor shall provide materials, material proportions, equipment, and construction methods that will ensure that concrete produced meets the requirements of these Specifications.

6.2. MATERIALS

6.2.1. Portland Cement Concrete

6.2.1.1. Portland Cement. Portland cement shall meet requirements set forth in ASTM C 150, Standard Specification for Portland Cement, for Type I or Type II cement, and the requirements set forth in ASTM C 595, Standard Specification for Blended Hydraulic Cements, for Type IP cement.

6.2.1.2. Water. Water used in mixing or curing Portland cement concrete shall meet the requirements set forth in Section 803 of the KYTC Standard Specifications (**latest edition**).

6.2.1.3. Fine Aggregates. Fine aggregates shall meet the requirements set forth in Section 804 of the KYTC Standard Specifications (**latest edition**).

6.2.1.4. Coarse Aggregates. Coarse aggregates shall meet the requirements set forth in Section 805 of the KYTC Standard Specifications(**latest edition**).

6.2.1.5. Air-Entraining Admixtures. Air-entraining admixtures shall meet the requirements set forth in ASTM C 260, Standard Specification for Air-Entraining Admixtures for Concrete, except the chloride content shall not exceed one percent by weight.

6.2.1.6. Chemical Admixtures. Chemical admixtures shall meet the requirements set forth in ASTM C 494; Standard Specification for Chemical Admixtures for Concrete, except the chloride content shall not exceed one percent by weight.

6.2.1.7. Fly-Ash. Fly ash shall meet the requirements set forth in ASTM C 618, Standard Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete, for Class F Fly Ash. The loss on ignition shall not exceed 3.0 percent, except 4.0 percent will be permitted when the uniformity requirements of ASTM C 618 are met.

6.2.2. Concrete Reinforcement

6.2.2.1. Steel Bars. Steel reinforcing bars shall be deformed bars meeting the requirements of ASTM A 615, Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement. All bar reinforcement shall be Grade 60 bars. When epoxy coated steel reinforcing bars are used, epoxy coated tie wire shall be required.

6.2.2.2. Welded Steel Wire Fabric. Welded steel wire fabric shall meet the requirements set forth in ASTM A 185, Standard Specification for Steel Welded Wire Fabric for Concrete Reinforcement.

6.2.2.3. Polypropylene Fibers. Fibers shall be 100 percent polypropylene fibers specifically designed for use as concrete reinforcement and shall contain no reprocessed olefin materials. No textile waste materials or other textile products will be allowed. The polypropylene fibers shall meet the following requirements:

	MIN.	MAX.
Melt Temperature	320 F	
Specific Gravity	0.87 -	0.93
Tensile Strength	70 -	110 ksi.
Fiber Fineness	Less than 100 Denier	
Fiber Length	3/4 inch	
Dosage Rate	2 Lbs/Cy	

6.2.3. Curing and Finishing Materials

6.2.3.1. Concrete Curing Materials. Concrete curing materials shall meet the requirements set forth in Section 823 of the KYTC Standard Specifications (**latest edition**), for type 1D Clear, Class B.

6.2.3.2. Masonry Coating Materials. Masonry coating materials shall meet the requirements set forth in Section 828 of the KYTC Standard Specifications (**latest edition**).

6.3. EXECUTION OF WORK

6.3.1. Care, Storage, and Handling of Concrete Materials. Aggregates, cement, and fly ash shall be furnished, stocked and handled at the plant in accordance with the requirements set forth in Section 601.03 of the KYTC Standard Specifications (**latest edition**).

6.3.2. Admixtures. Chemical admixtures to improve workability, retard and/or accelerate the time

of set shall be used where specified or directed. When not specified or directed for use, these admixtures may be used only upon written permission. Determination of quantities of water-reducing and retarding admixture required to produce the desired results shall be the responsibility of the Contractor. The Contractor shall also establish the quantity of air-entraining admixture necessary to produce a concrete mixture having a net air content, by volume, of 5.5 plus or minus 1.5 percent.

6.3.3. Proportioning. Proportioning of concrete mixtures shall be in accordance with Section 601.03.03 of the KYTC Standard Specifications (**latest edition**). For concrete exposed to sewage, the mixture shall contain the necessary proportions of Type II, Type IP, or Type I cement and fly ash to ensure a maximum Tricalcium Aluminate content of 8 percent of the total weight of cementitious materials.

6.3.4. Class of Concrete. The following classes of concrete shall be as specified in Section 601.03.03 of the KYTC Standard Specifications (**latest edition**) and shall be used in the types of construction designated, unless shown otherwise on the Plans, in the Contract, or directed by MSD. Concrete of all classes and for all uses above grade shall be air-entrained.

6.3.4.1. Class AA Concrete. Class AA concrete shall be used in structural concrete. It shall have a minimum 28-day compressive strength of 4,000 psi, a minimum slump of 2 inches and a maximum slump of 4 inches. For fiber reinforced concrete, a tolerance of ± 1 inch shall be allowed outside the minimum and maximum specified.

6.3.4.2. Class A Concrete. Class A concrete shall be used in cast-in-place sewers, headwalls, catch basins, manholes, small retaining walls, culverts, sidewalks, curbs, driveways, pavements, paved ditches and paved channel linings. It shall have a minimum 28-day compressive strength of 3,500 psi, a minimum slump of 2 inches and a maximum slump of 4 inches. For fiber reinforced concrete, a tolerance of ± 1 inch shall be allowed outside the minimum and maximum.

6.3.4.3. Class B Concrete. Class B concrete shall be used in concrete encasements, caps, cradles, stacks, gravity retaining walls and for all non-reinforced concrete deposited as fill for cavities or voids and mass footings. It shall have a minimum 28-day compressive strength of 2,500 psi, a minimum slump of 3 inches and a maximum slump of 5 inches. For fiber-reinforced concrete, a minimum slump of 2 inches and a maximum slump of 6 1/2 inches is allowed.

6.3.4.4. Class M1 Concrete. Class M concrete shall be used for high early strength in driveways and sidewalks, when required by the Special Provisions or the plans. It shall meet the requirements for Class M1 concrete set forth in Section 601.03.03 of the KYTC Standard Specifications (**latest edition**).

6.3.4.5. Flowable Fill. Flowable fill shall be used as required by the Special Provisions or the plans. It shall meet the requirements for flowable fill set forth in Section 601.03.03 of the KYTC Standard Specifications (**latest edition**).

6.3.5. Batching and Mixing

6.3.5.1 General. The concrete shall be batched and mixed in the quantities required for immediate use. Unless otherwise specified or directed, all concrete shall be manufactured by ready-mixed methods.

6.3.5.2. Ready-Mixed Concrete. Ready-mixed concrete shall be manufactured and supplied in accordance with ASTM C 94, Standard Specification for Ready-Mixed Concrete, Alternate No. 3. The placement shall commence within 60 minutes of batch to trucks as indicated on ticket. The interval between delivery of separate batches placed continuously in the Work shall not exceed 20 minutes unless otherwise permitted by MSD. Batch tickets with batch weight shown, shall be provided to MSD when requested.

6.3.5.3. Hand-Mixed Concrete. Hand mixing will not be permitted, except in case of emergency or in case of isolated small units such as pipe headwalls and then only by permission of MSD. When hand-mixing is permitted, proportioning by volume will be allowed and mixing shall be done only on water-tight platforms. The sand shall be spread evenly over the platform and then the cement spread upon it. The sand and cement shall then be thoroughly mixed while dry by means of shovels until the mixture is of a uniform color, after which it shall be formed into a crater and water added in an amount necessary to produce mortar of the proper consistency. The total water content shall not exceed that specified in Section 601.03.03, of the KYTC Standard Specifications (**latest edition**). The material on the outer portion of the crater ring shall then be shoveled to the center and the entire mass turned and sliced until a uniform consistency is produced.

The coarse aggregate shall then be added to the mortar and the entire mass turned and re-turned at least 6 times and until all coarse aggregate particles are thoroughly coated with mortar and the mixture is of a uniform color. Hand-mixed batches shall not exceed 1/2 cubic yard.

6.3.6. Forms

6.3.6.1. General. All forms shall be mortar-tight, true to the dimensions, lines, and grades of the structure, and of sufficient strength to prevent appreciable deflection during placing concrete. Aluminum or aluminum alloy forms will not be permitted except when provision is made to prevent their direct contact with the concrete, or be detrimental to masonry coating if the surface will be coated.

The inside surfaces of forms shall be cleaned of all dirt, mortar, and foreign material. Forms, which will later be removed, shall be thoroughly coated with form oil, prior to use. The form oil shall be commercial quality form oil or other equivalent coating which will permit ready release of the forms and will not discolor the concrete, or be detrimental to masonry coating if the surface will be coated.

Concrete shall not be deposited in forms until all work connected with constructing the forms

has been completed, all materials required to be embedded in the concrete have been placed for the unit to be poured, and MSD has inspected forms and materials. Such Work shall include removal of all dirt, chips, sawdust, water, and other foreign material from the forms.

Forms for all concrete surfaces, which will not be completely enclosed or hidden below the permanent ground surface, shall conform to the requirements herein for forms for exposed surfaces. Interior surfaces of underground sewers and structures will be considered to be completely enclosed surfaces.

Forms for exposed concrete surfaces shall be designed and constructed so the formed surfaces of concrete do not undulate excessively in any direction between studs, joists, form stiffeners, form fasteners, or wales. Plywood forms shall be at least 3/4 inch thick and shall be placed with the face grain perpendicular to the studs or joists, unless the Contractor furnishes calculations showing that excessive deflection or stresses will not occur when the grain is parallel to the studs or joists. The clear span between supporting studs or joists shall be placed no more than 20 times the thickness of the form facing and in no case shall the deflection exceed 1/360 of the clear span. Should any form or forming system, even though previously reviewed prior to use, produce a surface with excessive undulations, its use shall be discontinued until modifications satisfactory to MSD have been made.

All exposed surfaces of each element in a concrete structure shall be formed with the same forming material or with materials which produce similar surface texture, color, and appearance.

Forms for exposed surfaces shall be faced with form panels. A form panel shall be considered to be the continuous section of form facing material, unbroken by joint marks, against which concrete is placed.

Form panels for exposed surfaces shall be plywood conforming to the requirements of U. S. Product Standard PS-1 for Exterior B-B (Concrete Form) Class I Plywood or any material other than plywood which will produce a smooth uniform concrete surface substantially equal to that which would result from use of such plywood. Only form panels in good condition, free of defects, such as scars, dents, or delaminations, shall be used for exposed surfaces.

Form panels for exposed surfaces, in general, shall be furnished and placed in uniform widths of 3 feet or more and in uniform lengths of 5 feet or more, except where the dimensions of the member formed are less than these dimensions. Panels shall be arranged in symmetrical patterns conforming to the general lines of the structure. Form panels on each side of the panel joint shall be precisely aligned, by means of supports or fasteners common to both panels, to result in a continuous, unbroken concrete plane surface.

Forms for exposed surfaces shall be constructed with chamfer strips no less than 3/4 inch by 3/4 inch attached to prevent mortar runs and to produce smooth, straight chamfers at all sharp edges of the concrete.

Form fasteners consisting of form bolts, clamps, or other devices shall be used as necessary to

prevent spreading of the forms during concrete placement. The use of ties consisting of twisted wire loops to hold forms in position will not be permitted.

Metal ties or anchorages within the form shall be constructed to permit their removal to a depth of at least one inch from the face without injury to the concrete. All fittings or metal ties shall be of such design that upon their removal the cavities, which will remain, will be the smallest possible size. Cavities, regardless of their position in the completed construction, shall be rammed and filled with mortar and the surface shall be sound, smooth, even, and uniform in color.

For narrow walls where access to the bottom of forms is not readily attainable otherwise, the lower form boards shall be left loose so they may be removed for removal of all chips, dirt, sawdust, or other extraneous material immediately prior to placing concrete.

Forms which are intended for re-use shall be maintained in good condition to ensure accuracy of shape, strength, rigidity, water-tightness, and surface smoothness. Forms that are unsatisfactory in any respect in the opinion of MSD shall not be used and shall be removed immediately from the job site.

6.3.6.2. Removal of Falsework and Forms. In determination of the time for removal of falsework and forms, consideration shall be given to the location and character of the structure, weather, and other conditions influencing hardening of the concrete and materials used in the mixture. Removal of falsework and forms shall be done in accordance with the KYTC *Standard Specifications (latest edition)*, Sections 601.03.14 and 601.03.15 unless otherwise directed by MSD.

Forms shall be removed with care so as not to damage the surface of the concrete structure and shall be the sole responsibility of the Contractor.

6.3.7. Concrete Reinforcing

6.3.7.1. Protection of Steel Reinforcing. Proper care shall be used in handling and storing steel reinforcement or epoxy coated steel reinforcement to prevent bending, excessive rusting, or coating with objectionable substances. Steel reinforcement, when incorporated in the Work shall be reasonably free from dirt, paint, oil, grease, loose/thick rust, and other foreign substances, and when deemed necessary, shall be cleaned to the satisfaction of MSD.

6.3.7.2. Bending Steel Reinforcing Bars. Steel reinforcing bars shall be bent cold. Bars shall be bent accurately to the dimensions and shapes shown on the Plans and to within tolerances designated in the CRSI Manual of Standard Practice. Bars shall be bent in the shop before shipment and shall not be bent in the field, unless otherwise directed by MSD.

6.3.7.3. Placing and Fastening. All steel reinforcement shall be accurately placed in positions shown and firmly held in position during placement and hardening of concrete. All steel reinforcement, shall be spaced to within a tolerance of plus or minus 1/2 inch and placed to within a tolerance of plus or minus 1/4 inch of specified clearance from the face of concrete.

Dimensions shown from the face of concrete to bars are clear distances. Bar spacings are from center to center of bars. Bars shall be tied at all intersections, except where spacing is less than one foot in both directions, then alternate intersections shall be tied. Epoxy coated steel reinforcement shall be tied with coated tie-wire.

Distances from forms shall be maintained by means of stays, blocks, ties, hangers, or other approved supports. Supports for holding reinforcement from contact with the forms shall be approved precast blocks composed of mortar or approved metal chairs. The tips of metal chair supports, which are in contact with the surface of the concrete, shall be plastic-coated steel. The steel placed in reinforced concrete slabs shall also be securely tied down to prevent any possibility of steel rising above the specified elevation during placing, vibrating, and finishing the concrete.

The top mat and bottom mat of bars shall be separated by precast mortar blocks or by other equally suitable devices. The use of pebbles, pieces of broken stone or brick, metal pipe, and wooden blocks shall not be permitted as separators. Reinforcement in any member shall be securely placed and then inspected and approved before the placing of concrete begins. Concrete placed in violation of this provision may be rejected.

6.3.7.4. Splicing. No splicing of reinforcement will be permitted, except those splices of the types and at the locations shown, without written permission from MSD. Acceptable splices may include lapped splices, welded splices, mechanical splices, or other positive connection splices shown on the Plans or directed by MSD.

Lapped splices, shall have lengths of not less than 40 times the nominal diameters of the reinforcement being spliced, unless otherwise shown on the Plans. Lapped splices in areas not designated on the Plans shall be made at points of low tensile stress, and the bars being spliced shall be rigidly clamped or wired together in an approved manner.

Rolls of welded steel wire mesh shall overlap each other by 2 cells, to maintain a uniform strength, and shall be securely fastened at the ends and edges.

Welded splices shall be in conformance with the AWS Reinforcing Steel Welding Code, current edition. Bars to be welded shall be butted and welded so as to develop, in tension, at least 125 percent of the specified yield strength of the bars. Welded splices will not be permitted unless shown on the Plans or approved by MSD.

6.3.7.5. Fiber Reinforcing. When fiber reinforcing is required by the Plans or Contract, the polypropylene fibers shall meet article 6.2.2.3 requirements. The fibers shall be added after other ingredients have been placed in the mixer and prior to leaving the batch plant. Each batch delivery ticket shall indicate the amount of fibrous concrete reinforcement material per cubic yard added to each batch of concrete. Wire mesh reinforcement shall not be used in conjunction with fiber reinforcement.

6.3.8. Placing Concrete

6.3.8.1. General. Unless other provisions are agreed upon, the contractor shall give MSD inspector 48-hour advance notice before concrete placement.

Concrete shall be delivered to its final position of placement within the time required for delivery after mixing in accordance with ASTM C 94 and within the required time interval between delivery of batches as specified in Section 6.3.5.2. Forms and reinforcement shall be moistened with water immediately before placing the concrete.

All equipment used for handling and/or placing concrete shall be such that it will accommodate concrete of the proportions and consistencies as specified. No adjustments in mixture proportions will be made to accommodate equipment, which is not capable of handling concrete of specified proportions and consistencies. Equipment used to transfer concrete from truck mixers or agitators shall be of adequate design and/or dimensions to deposit concrete of the specified slump.

Water shall be completely removed from all excavations before concrete is deposited. When it is necessary to deposit concrete under water, placement shall be in accordance with the requirements specified under Section 601.03.09, Part B of the KYTC Standard Specifications **(latest edition)**. MSD's approval must be obtained prior to placing concrete under water.

In general, concrete shall not be placed unless otherwise shown on the Plans or directed by MSD.

The method and manner of placing concrete shall be such as to avoid segregation or separation of aggregates or displacement of reinforcement. The use of long chutes, troughs, belts, and pipes for conveying concrete from the point of delivery to the forms will be allowed only upon written permission. When such conveyers are allowed and the quality of concrete or methods of placing or working it therein are not satisfactory, the Contractor shall discontinue their use and equip his plant so that concrete will be placed in a satisfactory manner. Troughs, pipes, or chutes used as aids in placing concrete shall be arranged and used in such a manner that ingredients of the concrete are not separated.

Where steep slopes are required, the chutes shall be equipped with baffle boards or be in short lengths that change the direction of movement. All chutes, troughs, and pipes shall be maintained clean and free from coating of hardened concrete by thoroughly flushing with water after each run or when out of operation for more than 30 minutes. Water used for flushing shall be discharged clear of concrete in place. The troughs, pipes, and chutes shall be either metal or metal-lined and shall extend as nearly as possible to the point of deposit. Aluminum or aluminum alloy troughs, pipes, or chutes will not be permitted.

Dropping concrete in excess of 5 feet without the use of pipe or tremies, or depositing a large quantity at any point and running or working it along the forms will not be permitted. The discharge end of the pipe shall be maintained as close to the point of deposit as is feasible.

Concrete placing shall be such to entirely fill but not bulge or distort the forms or to disturb their alignment.

Special care shall be exercised to fill each part of the forms by depositing concrete as near its final position as possible, to work the coarser aggregate back from the face and to force concrete under and around reinforcing bars without displacing them. After concrete has taken its initial set, care shall be exercised to avoid jarring the forms or placing any strain on ends of projecting reinforcement.

Concrete shall be compacted either by vibration as described herein or with approved spading tools. When vibration or spading is used, it shall be distinctly understood that formation of honeycombs, voids, or air pockets against the forms will not be allowed.

Vibration shall be internal. Vibrators shall be of types and designs capable of transmitting vibration to the concrete at frequencies to adequately consolidate the concrete. Vibration shall be of sufficient intensity and duration to cause flow or settlement of the concrete and complete compaction, but shall not be used to cause concrete to flow over long distances in the forms. The Contractor shall provide and use a sufficient number of mechanical vibrators to ensure that compaction can be started immediately after concrete has been deposited in the forms. The mechanical vibrator shall not be attached to the forms or reinforcing steel or applied to the surface of the concrete. The vibrator shall be applied to the concrete immediately after deposit of the concrete and shall be moved throughout the mass, thoroughly working the concrete around the reinforcement, embedded fixtures, and into angles and corners of the forms.

Vibration shall be of such duration to accomplish thorough compaction and complete embedment of reinforcement and fixtures, but shall not be unduly prolonged to cause segregation or **the excess buildup of paste** at the surface of the lift being consolidated. Forms shall be designed to provide for requirements of vibration.

Concrete shall be placed in continuous horizontal layers, the thickness' of which shall not exceed 12 inches, unless otherwise specified for different types of structures. In any given layer, consecutive batches shall be placed and compacted before the preceding batch has taken its initial set. Each layer of concrete shall retain a rough surface in order to secure efficient bonding with the next layer. A succeeding layer placed before the underlying layer has set shall be compacted in a manner that will entirely break up and obliterate the tendency to produce a cold joint between layers.

The operations of depositing and compacting concrete shall be conducted to form a compact, dense, and impervious mass of uniform texture having smooth faces on exposed surfaces. When any section of concrete is defective, it shall be removed and satisfactorily replaced or repaired as directed.

6.3.8.2. Weather Limitations and Protection. Concrete shall be maintained at a minimum temperature of 45°F for three calendar days after placement and at a minimum temperature of

40°F for an additional four calendar days. When required, the Contractor shall submit a written outline of the method to be used for protecting concrete. The Contractor shall designate one of his employees to be responsible in order that he may be contacted by MSD in unexpected situations. MSD reserves the right to discontinue concrete placement when the means of protection and/or method of placement do not produce satisfactory results.

In cold weather, 40°F or below, all water and/or aggregate shall be heated so the temperature of the mixed concrete shall be no less than 50°F or more than 90°F at the time of placement.

When artificial heat is used, means shall be provided to maintain adequate moisture in the air within the enclosure. Surfaces of all concrete shall be maintained in a moist condition. When artificial heat is used, the temperature of concrete near the source of heat shall not exceed 80°F, and the temperature of concrete remote from the source of heat shall not be less than that designated (45°F or 40°F) for the time of curing after placement. When stoves or salamanders are used, adequate provisions shall be made for fire protection.

In hot weather, efforts shall be made to maintain temperature of the mixture below 90°F. The temperature of the concrete mixture immediately before placing shall be between 50°F and 90°F. When the ambient air temperature is above 90°F, the forms, reinforcing steel, and other surfaces which will come in contact with the mixture shall be cooled to below 90°F by means of a water spray or other approved methods. Excess water shall be allowed to drain or shall be removed from the forms before concrete is placed.

The Contractor shall assume all risks connected with placing concrete under these conditions and permission given by MSD to do the Work will in no way relieve the Contractor of responsibility for proper results. Should concrete placed under such conditions prove unsatisfactory, it shall be removed and replaced with satisfactory concrete and no allowance will be made for removing and replacing the defective concrete.

6.3.9. Joints

6.3.9.1. General. Unless authorized by MSD, all joints in non-road situations will be “tooled”. The saw cutting of control and construction joints will not be allowed.

6.3.10. Curing Concrete

6.3.10.1. General. All surfaces, which are to receive a masonry coating finish, shall be wet-cured. All other concrete, shall either be wet-cured or shall be cured by application of a membrane forming compound.

At any time MSD determines concrete on the Project is not being properly cured, all or any concreting operations on the Project may be suspended.

At any time during the curing period when the atmospheric temperature is 45°F or less, the concrete shall be protected so as to satisfy the temperature requirements specified in Subsection

6.3.8.2. of these Specifications.

6.3.10.2. Wet Curing. Concrete shall be cured for a period of at least seven calendar days, beginning immediately after placement and finishing, by the frequent application of water to all surfaces so as to keep them continuously damp during the full seven-calendar-day curing period. Exposed concrete surfaces shall be protected from drying by application of a double thickness of wet burlap or similar material and the burlap or other approved material shall be kept continuously wet for a period of seven or more calendar days.

When the structure or any portion thereof is enclosed and artificial heat is provided for protection, the requirement of moisture for curing will not be waived. When steamlines are used for heating, the pipe shall be left loose so as to permit the escape of sufficient steam into the housing in order to maintain a moist atmosphere at all times. When stoves or salamanders are used, vessels containing water shall be maintained on each stove or salamander to maintain a moist atmosphere at all times.

6.3.10.3. Membrane Curing. The membrane forming curing compound shall not be diluted or altered prior to use, but shall be thoroughly agitated immediately prior to use. When the compound is too viscous for application, it shall be warmed in a water bath to approximately 100°F prior to application.

The compound shall be uniformly applied to a surface by use of an approved pressure sprayer. Curing compound may be applied in one application provided uniform and satisfactory coverage is achieved. If MSD directs that two applications are required because one application is not satisfactory, then each application shall be at the rate of one gallon per 300 or less square feet. The first application shall be started as soon as practicable after the final finish and as directed by MSD and the second application shall be started as soon as the first application is finished. The total actual application rate shall be at least one gallon per 150 square feet actual coverage.

Curing compound shall not be applied to construction joints, reinforcing steel, or surfaces, which are to receive a masonry coating. When curing compound is applied to surfaces upon which the compound is not permitted for use, it shall be removed by sandblasting.

The curing compound shall be protected and maintained in an acceptable condition for a period of at least seven calendar days. Surfaces upon which the curing compound is damaged before the end of the seven-calendar-day curing period shall be moistened and resprayed with curing compound.

6.3.11. Surface Finish

6.3.11.1. General. Unless otherwise indicated on the Plans, the surface finish that shall be applied to various parts of concrete structures shall be as follows:

Ordinary Surface Finish
Masonry Coating Finish

Floated Surface Finish

Ordinary Surface Finish shall be applied to all concrete surfaces. Unless otherwise specified in the Contract, and provided requirements are satisfactorily met, ordinary surface finish shall be considered as a final finish on all surfaces not required to have a Masonry Coating Finish or a Floated Surface Finish.

6.3.11.2. Ordinary Surface Finish. During concrete placement, care shall be taken that methods of compaction used will result in a smooth surface of even texture free from honeycombs, water, and air pockets, and that the coarse aggregate is forced away from the forms in order to leave a mortar surface.

As soon as the concrete has set sufficiently, the forms shall be carefully removed and all metal ties, anchorages, or tie wires used within the forms to hold them to correct alignment and location shall be removed as specified in Subsection 6.3.6.2. of these Specifications. Immediately following removal of forms, all fins and irregular projections shall be removed from all surfaces, except those not to be exposed in the completed Work. On all surfaces, cavities and depressions resulting from removal of form ties and all other holes, honeycomb spots, broken corners or edges, and other defects shall be thoroughly cleaned, saturated with water, and carefully pointed and trued with a mortar of the same cement and fine aggregates mixed in the same proportions as used in the class of concrete being finished. The mortar used shall not be more than 30 minutes old and the mortar patches shall be cured as specified for the structures.

After the mortar has thoroughly hardened, it shall be finished with a carborundum stone to obtain a uniform and smooth surface the same color and texture as in the surrounding concrete. When required, honeycomb areas shall be chipped out before pointing. All open and filled contraction and expansion joints in the completed Work shall be carefully tooled and free of all mortar and concrete. The joint filler shall be exposed for its full length with clean true edges.

The objective of these requirements is to obtain smooth and even surfaces of uniform color and texture without unsightly bulges, patched areas, depressions, and other imperfections. The degree of care in building forms and the character of materials used in form work, and the care with which concrete is placed will be factors in determining whether additional finishing of concrete will be required.

6.3.11.3. Masonry Coating Finish. After the concrete surfaces of members designated to have a Masonry Coated Finish have been inspected and accepted as having a satisfactory Ordinary Surface Finish, the concrete surfaces shall be cleaned of all dust, foreign matter, and form oil, and an approved Masonry Coating Finish shall be applied.

All surfaces to receive a masonry coating shall be thoroughly cleaned and free of oil, form oil, grease, dust, dirt, mud, curing compound, release agents, loose patching mortar, or any other substance deleterious to bonding. The ordinary surface finish to which the masonry coating is to be applied shall be approved by MSD before application of the masonry coating.

All surfaces to receive a masonry coating shall be checked for the presence of dust by wiping a dark cloth across the surface of the concrete. If a white powder can be seen on the dark cloth, the concrete shall be cleaned by wire brushing, grinding, or water blasting and then allowed to thoroughly dry before the masonry coating is applied. The surface will be rechecked for the presence of dust after cleaning.

All surfaces to receive a masonry coating shall be checked for the presence of oily conditions by sprinkling or fogging water on the surface of the concrete. If the water stands in droplets without spreading out immediately, this indicates the surface is contaminated with an oily substance, and cleaning, using a detergent and water followed by thorough rinsing with water, will be required. The surface will be rechecked for the presence of oily conditions after cleaning.

All surfaces to receive a masonry coating shall be thoroughly dry before coating is applied, unless the coating manufacturer specifically recommends the surface to be wet. Surfaces will not be considered dry unless an absorbent paper pressed tightly against the surface does not show any trace of moisture.

Coating application shall be suspended any time the ambient temperature or the temperature of the concrete does not comply with the coating manufacturer's recommendations.

Prior to application of the materials, the Contractor shall furnish MSD with copies of the coating material manufacturer's brochures or booklets. Masonry coating materials shall be applied in strict conformity with the manufacturer's written instructions, except that in each instance the concrete surface shall be prepared to the satisfaction of MSD before application of the material is started and the material shall be applied at a uniform rate of 50 plus or minus 10 square feet per gallon.

Any portions of the coating which are not clean, uniform in color, texture, thickness, tightly bonded, or which are damaged prior to final acceptance of the Project shall be satisfactorily repaired or removed and replaced with an acceptable finish and coating.

Care shall be exercised to secure a neat uniform appearance and to prevent the coating from being dripped, sprayed, or otherwise deposited upon concrete or steel surfaces not designated to receive the coating. Any objectionable deposits or material shall be removed and the surfaces repaired to the satisfaction of MSD.

6.3.11.4. Floated Surface Finish. Horizontal surfaces that do not receive the Masonry Coating Finish shall be finished by placing an excess of materials in the form and removing or striking off such excess with a wooden template, forcing coarse aggregate below the mortar surface. After the concrete has been struck off as described, the surface shall be thoroughly worked and floated by hand with a wooden float leaving a fine grained, smooth-sanded surface.

Sidewalks and driveways shall receive a broom finish, prior to beginning the curing process.

6.3.12. Sampling and Testing

6.3.12.1. Personnel. Structural concrete, such as foundations and any pour larger than 5 cubic yards, shall be sampled and tests will be performed throughout the work at the minimal frequencies indicated or more often as necessary to determine whether concrete supplied is of the quality specified. Tests will be performed by the Agency designated by MSD to provide concrete testing on Projects involving MSD facilities, according to procedures outlined below. On private developments and other than MSD advertised Projects, the testing company must be designated in writing and be approved by MSD prior to concrete placement. If the concrete plant is designated, MSD may elect to pay for samples to be taken from the same mix in order to run tests in parallel.

The technician who samples and tests concrete shall have demonstrated a knowledge and ability to perform the necessary test procedures equivalent to the minimum guidelines for Certification of Concrete Field Testing Technicians, Grade I in accordance with the American Concrete Institute.

6.3.12.2. Sampling Fresh Concrete. Concrete shall be sampled in accordance with the procedures set forth in ASTM C 172, Standard Specification for Sampling Freshly Mixed Concrete.

6.3.12.3. Slump Test. Slump tests shall be performed in accordance with the procedures set forth in ASTM C 143, Standard Test Method for Slump of Portland Cement Concrete.

6.3.12.4. Air Content. The air content shall be determined by the volumetric or pressure methods in accordance with the procedures set forth in ASTM C 173, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method, or ASTM C 231, Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.

6.3.12.5. Test Cylinders. Concrete test cylinders shall be made and cured in accordance with the procedures set forth in ASTM C 31, Standard Practice for Making and Curing Concrete Test Specimens in the Field. Unless otherwise specified, four test cylinders shall be molded for each set. Cylinders to be used for determining form removal time shall be stored at the site as near to the concrete being represented as possible.

6.3.12.6. Compressive Strength Tests. The compressive strength of test cylinders shall be determined in accordance with the procedures set forth in ASTM C 39, Standard Test for Compressive Strength of Cylindrical Concrete Specimens.

6.3.12.7. Frequency of Tests. Unless otherwise directed by MSD, a minimum of one set of **4** test cylinders shall be made daily for each 50 cubic yards or portion thereof placed in each structure. Two cylinders shall be tested at 28 days to check the adequacy of the concrete mix. The remaining cylinders may be tested, as needed, to meet the provisions of Section 601.03.14 of the KYTC Standard Specifications (**latest edition**), if early form removal is desired.

Slump and air content tests shall be made at the time of concrete placement as often as is necessary for control checks and acceptance purposes, and always when compressive strength specimens are made. If the measured slump or air content falls outside the specified limits, a

check test shall be made immediately on another portion of the same sample. In the event of a second failure, the concrete shall be considered to have failed the requirements of these Specifications. The first and last 1/4 cubic yard discharged from the mixer are exempt from the slump and air content requirements of these Specifications.

SECTION 7

MSD STANDARD SPECIFICATIONS

TRENCHLESS PIPE INSTALLATION

7.1. GENERAL

This Work shall consist of the installation of sanitary and storm sewer pipe by one of the following methods when the open cut method cannot be used.

- **Tunneling**
- **Boring and Jacking**
- **Horizontal Directional Drilling**
- **Pipe Bursting**

The design plans will identify appropriate pipe installation method and required information to allow bidding. The CONTRACTOR will have the option to offer a different method of trenchless pipe installation than that proposed, subject to approval and acceptance by MSD. When an alternate method is proposed by the CONTRACTOR he will be responsible for the final design calculations. A plan of operation and list of proposed materials will be submitted for MSD approval. Structural calculations will be required for all components, including but no limited to: casing and carrier pipe, tunnel liner plates, the working pits sheeting and shoring, electrical facilities, ventilation, and communications. All design calculations and plans must be signed and sealed and submitted by a professional engineer licensed in the Commonwealth of Kentucky.

7.1.1 Maintenance of Traffic. Where pipe is required to be installed under railroads, highways, streets, or other facilities by trenchless installation construction shall be made in such a manner that will not interfere with the operation of the railroad, street, highway, or other facility, and shall not weaken or damage any embankment or structure.

7.1.2. Utilities. The CONTRACTOR will need to coordinate all excavations in advance with Kentucky 811 – Before you Dig (BUD). If any utility above or adjacent to the construction is endangered or has been damaged because of the trenchless operations or movements of earth caused by such operations, the owner of same shall be notified immediately and shall be given access to the Work to carry out all necessary repairs to such utilities. If any sewers are damaged, it shall be the responsibility of the CONTRACTOR to make the necessary repairs.

The CONTRACTOR shall be responsible for protection of utilities, sewers, and drains against damage by his Work. If any public or private property is endangered, or has been damaged as a direct result of the trenchless operations, it shall be repaired at the CONTRACTOR's expense. All cost and expense to the CONTRACTOR for carrying out the above requirements shall be at no additional cost to the MSD.

7.1.3. Dewatering. Prior to commencing, the CONTRACTOR shall furnish and operate all necessary pumping equipment of ample capacity and make all necessary provisions to keep tunnels, shafts and pits free of water during construction and to satisfactorily dispose of such water. During placing of concrete, drainage and pumping shall be so arranged that concrete is placed in the dry and that no water will flow over the concrete until it has hardened. Refer to Spec Section 3.3.3.8 Dewatering of Excavations.

7.1.4. Line and Grade. Line and grade shall be checked frequently by the CONTRACTOR's Professional Land Surveyor and not less than once per day. Results from these checks shall be provided to MSD. The CONTRACTOR also shall assist MSD in checking line and grade as often as MSD deems necessary to ensure that proper tolerances in line and grade are being met.

Trenchless sections of sewers shall be completely installed prior to construction of adjoining sections. If permitted by MSD, minor adjustments in the line and/or grade of the adjoining sections shall be allowed to compensate for slight deviations from the Plan line and grade of the installed sections.

7.1.5 Availability. The PRIME CONTRACTOR shall be on site during all phases of the work. The CONTRACTOR shall have a local or 1-800 cellular phone or pager active at all times.

7.1.6. Working Hours. Work hours must be approved by MSD as part of the construction schedule submittal. Tunnel construction operations may progress for 24 hours a day, except on Sundays. When Work is done at night, the CONTRACTOR shall provide adequate safety precautions such as watchmen, barricades, lights, etc., and any mechanical equipment used in the construction operations shall be of a type that produces a minimum amount of noise to avoid creating a nuisance.

7.1.7 Material of Pipe. Designer shall dictate on plans pipe material used for trenchless installations, refer to MSD Section 4 Pipework for specifications.

7.2 TUNNELING

7.2.1 DESCRIPTION OF WORK

Tunneling shall involve the installation of steel liner plates or rib and lagging systems to provide support to the tunnel walls and/or protective shield for carrier pipe. Excavation of material for installation of tunnels shall be performed manually or by mechanical tunnel boring machines (TBM).

7.2.2 MATERIALS

7.2.2.1. Steel Tunnel Liner Plates. The base metal for steel plates shall conform to the chemical requirements of ASTM A 569, Standard Specification for Steel, Carbon (0.15 Maximum, Percent), Hot-Rolled Sheet and Strip, Commercial Quality. The flat plate (before cold forming) shall conform to the following minimum mechanical properties:

Tensile Strength	42,000 psi
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Yield Strength	28,000 psi
Elongation, 2 inches	30%

Nominal plate dimensions shall provide the sectional properties shown in the current edition of the AASHTO Standard Specifications for Highway Bridges. Thickness tolerances shall conform to Paragraph 14 of AASHTO M 167, Standard Specification for Structural Plate for Pipe, Pipe-Arches, and Arches. Steel liner plates shall be of additional thickness or protected by coatings and other means when required in the Contract for resistance to abrasion or corrosion. **Four-flanged liner plates will be required unless the design requires the use of two-flanged plates.**

7.2.2.2. Bolts and Nuts. Bolts and nuts used with lapped seams shall be no less than 5/8 inch in diameter. The bolts shall conform to ASTM A 449, Standard Specification for Quenched and Tempered Steel Bolts and Studs, for plate thicknesses equal to or greater than 0.209 inch and A-307, Standard Specification for Carbon Steel Externally Threaded Standard Fasteners, for plate thickness less than 0.209 inch. The nut shall conform to ASTM A 307, Grade A.

Bolts and nuts used for 4-flanged plates shall be no less than 1/2 inch in diameter for plate thicknesses to and including 0.179 inch and no less than 5/8 inch in diameter for plates of greater thickness. The bolts and nuts shall be quick acting coarse thread and shall conform to ASTM A 307, Grade A.

7.2.2.3 Cement Grout. Cement grout for filling voids outside the tunnel liner plates, unless shown otherwise on the Plans, shall consist of a mixture of water and one part Type 1 Portland Cement to two parts mortar sand (as specified in Section 804.05 of the most current edition *of the* KTC Standard Specifications), by volume, or KTC 1:2 Proprietary Grout Mix #1093. The water shall be adjusted to produce a mixture of consistency suitable for pumping, with a minimum slump of 5 inches and a maximum slump of 9 inches. Provisions shall be made for releasing of air and filling with grout. A pressure of 10 to 15 PSI (23.0 to 35.0 feet of head) shall be used. Cement grout for filling the voids between the carrier pipe and tunnel liner shall be a mixture suitable for grouting and shall be approved by MSD prior to its use.

7.2.3 EXECUTION OF WORK

7.2.3.1. Submittals and Approvals. Tunnel support systems shall be with steel liner plates, ribs and lagging, steel casing pipe or other systems approved by MSD. The CONTRACTOR shall furnish a detailed Tunneling Plan for review by MSD. The Plans shall contain a description of the tunneling method and equipment proposed, tunnel support system, shop drawings, details and cross-sections, a schedule of operations, and the proposed work hours. Tunnel construction shall not commence until MSD has reviewed the submittal and provided approval of the Plan. MSD's approval shall in no way relieve the CONTRACTOR of his sole responsibility for the execution of this Work or any liability. When tunnel construction shall be beneath a Railroad right-of-way, the Tunneling Plan shall also be subject to the approval of the Railroad.

7.2.3.2. Safety. All Work shall conform to applicable Subsections of the Kentucky Occupational Safety and Health Standards for the Construction Industry and 29 CFR, Part 1926, Subpart S, "Tunneling".

7.2.3.3. Tunnel Shafts. Shafts shall be constructed at the locations shown on the Plans. If not shown on the Plans, shafts shall be constructed at locations selected by the CONTRACTOR, subject to approval by MSD. Temporary construction shafts shall be of adequate size and properly constructed and equipped to meet all requirements of safety to personnel and to the Work. All shafts shall be barricaded, lighted, fenced, and properly guarded from the beginning of the excavation until the completion of the construction requiring the shaft. A substantially constructed ladder shall be provided in each shaft and shall be kept in safe, good repair, clean, and clear of debris.

Provisions shall be made at each shaft so that plumb lines suspended on the centerline of the sewer at each end of the shaft will hang freely from the surface.

7.2.3.4. Tunnel Construction. The CONTRACTOR shall carry out the Work of tunneling and supporting the tunnel face, roof, walls, and floor so that there will be no fall, flow, caving, or heaving of earth or other materials into the tunnel excavation. If there should be any fall or movement of earth into the tunnel at any time, the CONTRACTOR shall proceed with the Work with all necessary precautions and in such a manner as will ensure the safety of life and of all sewers, utilities and public and private property above and adjacent to the tunnel.

The CONTRACTOR shall furnish, place and maintain all sheeting, bracing or lining required to support the tunnel floor, roof, sides, and face until the pipe and its bedding, jointing, encasement and backfilling have been completed. All liners shall remain in place. Care shall be used in trimming the surfaces of the excavated section and in placing the liners or sheeting and bracing so that the required minimum clearance between the outside of the pipe and the final position of the liners, sheeting and bracing in the tunnel will be attained without any deviation in sewer alignment. Sheeting or lining must be placed and held tightly against the trimmed earth surface of the excavated section so that complete filling of voids may be achieved between the earth and the lining or sheeting placed against it. No part of the lining, bracing, or flanges of steel liner plates shall project closer to the outside top of the pipe than 12 inches, or to the outside bottom of the pipe than 4 inches, unless shown otherwise on the Plans.

7.2.3.5. Prevention of Loss of Earth Materials. Cavities or spaces between the actual surfaces of excavation and the tunnel liner plates or sheeting, shall be completely filled with cement grout. Grout shall be placed under pressure through grout nipples in the steel liner plates or grout holes in sheeting. The grout holes shall be at minimum 10 feet centers and the grout placed in such sequence as to ensure the complete filling of all cavities and spaces and of carrying loads uniformly from the undisturbed material to the tunnel lining or sheeting. Grouting shall be done at frequent intervals simultaneously with the tunnel construction and immediately whenever a loss of material occurs. In no case should the tunnel be left ungrouted if Work is to be stopped or suspended for any extended period of time.

At the end of each working day, or whenever a delay in the tunneling is anticipated, the CONTRACTOR shall construct a bulkhead to prevent the caving of soil at the working face. The bulkhead shall be required unless MSD specifically grants permission to omit the bulkhead.

Wherever unstable conditions are encountered and the CONTRACTOR is unable to proceed without loosening earth or creating voids outside the tunnel lining, the CONTRACTOR shall pre-solidify the soil around the area to be excavated by freezing the soil or injecting an approved chemical that will permit the tunnel excavation to proceed without any loss of earth material, or other method approved by MSD. Before any stabilization of earth materials is begun, the CONTRACTOR shall obtain approvals. Stabilization shall be performed at no additional cost to MSD.

7.2.3.6. Installation of Carrier Pipe. All pipe used in tunnels shall be of the type shown on the Plans or in the Contract and shall be of the size and strength class required.

After the tunnel section is excavated, lined, and braced, the carrier pipe shall be placed on and supported by steel rails, a concrete pad, or other approved supports. The supporting system shall assure line and grade and shall allow sufficient space below the pipe for placing concrete. Care shall be used to avoid damage to the pipe or to the liner plates. The carrier pipe shall be rigidly braced to prevent its displacement when the annular space is backfilled.

The space between the carrier pipe and sides of the roof of the tunnel shall be completely filled with grout or with pea gravel or No. 9 crushed stone by pneumatic backstowing. The grout or granular material shall be uniformly placed and compacted to fill all spaces between the outside of the pipe and inside surface of the sheeting or lining. **Refer to MSD Standard Detail GB-01-00 for installation requirements.**

Temporary shafts shall be completely abandoned. Unless otherwise specified in the Plans or Contract, all sheeting, bracing, and similar items may be removed unless the CONTRACTOR requests and receives authorization from MSD to leave it in place. No payment will be made for such items left in place at the Contractor's option.

7.3 BORE AND JACKING

7.3.1 DESCRIPTION OF WORK

Bore and Jacking shall be performed mechanically through the soil by a horizontal auger mounted inside the casing pipe or by a tunnel boring machine (TBM). The casing pipe shall be jacked simultaneously with boring operations until casing pipe is in final position, at which point the carrier pipe can be installed.

7.3.2 MATERIALS

7.3.2.1. Steel Casing Pipe. Steel casing pipe shall conform to ASTM A 139 Grade B, Standard Specification for Electric-Fusion (ARC) Welded Steel Pipe. For 30 inch and greater diameter casing pipe, a minimum clearance of 12 inches (total) must be provided between pipe bells and the inside of the casing pipe, except as otherwise stated in these specifications, or as shown on the Plans. On a case-by-case basis a smaller diameter casing will be allowed if the 12-inch minimum clearance and design grade can be achieved. All storm drains, 8 inch or greater gravity sewers, and 10 inch or greater force mains shall use a 30 inch minimum diameter casing pipe. A 12 inch diameter casing pipe shall be used for 6 inch or less gravity sewers and 8 inch or less force mains.

The minimum pipe wall thickness will be 3/8". The actual pipe wall thickness shall be determined by the contractor based on the static and dynamic loads from traffic loading and anticipated ramming forces for the selected pipe and driven pipe lengths. Pipe lengths shall be determined by the contractor.

7.3.2.2. Cement Grout. Cement grout for filling voids outside 30 inch or larger casing pipe, unless shown otherwise on the Plans, shall consist of a mixture of water and one part Type 1 Portland Cement to two parts mortar sand (as specified in Section 804.05 of the most current edition *of the* KTC Standard Specifications), by volume, or KTC 1:2 Proprietary Grout Mix #1093. The water shall be adjusted to produce a mixture of consistency suitable for pumping, with a minimum slump of 5 inches and a maximum slump of 9 inches. Provisions shall be made for releasing of air and filling with grout. A pressure of 10 to 15 PSI (23.0 to 35.0 feet of head) shall be used. Cement grout for filling the voids between the carrier and casing pipe shall be a mixture suitable for grouting and shall be approved by MSD prior to its use.

7.3.3 EXECUTION OF WORK

7.3.3.1. Submittals and Approvals. Boring and jacking support systems shall be with steel casing pipe or other systems approved by MSD. The CONTRACTOR shall furnish a detailed Boring and Jacking Plan for review by MSD. The Plans shall contain a description of the Boring and Jacking method and equipment proposed, boring and jacking support system, shop drawings, details and cross-sections blocking system, a schedule of operations, and the proposed Work hours. Boring and Jacking construction shall not commence until MSD has reviewed and approved the submittal. MSD's approval shall in no way relieve the CONTRACTOR of his sole responsibility for the execution of this Work or any liability. When boring and jacking construction shall be beneath a Railroad right-of-way, the Boring and Jacking Plan shall also be subject to the approval of the Railroad.

7.3.3.2. Boring and Jacking Equipment and Construction. When required by the Plans, sewers shall be constructed within steel casing pipe which have been jacked or pushed into bored holes. The holes shall be bored from the low or downstream end, unless site conditions dictate otherwise and MSD provides approval.

The access pit shall be of sufficient size to provide ample working space for the boring and jacking equipment, guide rails, reaction blocks, bracing, spoil removal, and sections of pipe as required. Provisions shall be made for the erection of guide rails in the bottom of the pit by providing a crushed stone base where applicable. The CONTRACTOR shall be responsible for providing stable foundation and wall supports during boring operations.

The boring and jacking machine to be used shall be in good mechanical condition and capable of advancing the bore hole within the required limits of accuracy. The CONTRACTOR shall push the casing pipe as the bore progresses. All cutting heads shall be removable without retracting the casing pipe. Backstops and guide rails shall be of sufficient strength and rigidity to support the thrust of the boring and jacking machine without displacement. Guide rails shall be accurately laid to line and grade and maintained in this position until completion of the boring and jacking operation. A smooth casing pipe of sufficient strength and diameter shall be forced into the bored hole to provide a tight fit against the earth sides of the bore hole. The casing pipe shall be of

minimum diameters as specified in Section 7.3.2.1. of these specifications. Joints between sections of the casing pipe shall be welded with a continuous circumferential weld. Following installation, the casing pipe shall be carefully inspected to ensure that the carrier pipe can be properly placed.

During placement of the carrier pipe in the casing, the carrier pipe shall be blocked or otherwise supported to secure the proper flow line elevations throughout its full length and to ensure that backfilling at the bottom, sides and top of the pipe can be done without any displacement or floating. The carrier pipe shall be placed in the casing pipe only by such method that will keep the pipe joints in compression. Any method tending to disjoint the pipe while being placed will not be permitted. When the casing pipe is 30" or larger, the spaces between the casing and the outside of the casing pipe shall be filled solidly with cement grout placed under pressure, after the entire casing pipe is in place. Grout meeting the requirements of Section 7.3.2.3. shall be pumped at a pressure between 10 and 15 PSI (23.0 to 35.0 feet of head). Provisions shall be made for the removal of all air and complete filling of the voids with grout mixture. Before placing grout inside the casing pipe, the exterior of the casing pipe shall be grouted on 10 feet centers and the carrier pipe shall be carefully inspected for uniformity of grade along its alignment and any required corrections shall be made. Particular attention shall be given to ensuring that the pipe will be solidly supported by the selected backfill at its bottom and sides. The method of injection of grout under mechanical pressure shall be approved by MSD. Grout shall be placed by filling the casing pipe, through 4 inch diameter holes placed on 10 feet centers, beginning at the downstream end and proceeding upstream. The space between the carrier pipe and sides of the casing pipe shall be completely filled with grout or with granular material by pneumatic backstowing, in accordance with the methods described in Section 7.2.3.6. **Refer to MSD Standard Details GB-01-00.**

Boring and jacking will be allowed for force main pipe, sanitary sewer, property service connections, and storm drains. In each of these instances, four linear feet of green marking tape, as specified in Section 4.2.7. of these specifications, shall be placed at the edge of pavement on each side.

When unforeseen obstructions or conditions require abandonment of a partially completed bore hole, plug end of pipe by filling with grout. Then the CONTRACTOR shall backfill the abandoned bore hole and start a new hole. The CONTRACTOR shall receive no compensation for any expenses incurred by any unsuccessful attempt.

7.4. HORIZONTAL DIRECTIONAL DRILLING

7.4.1 DESCRIPTION OF WORK

Horizontal Directional Drilling (HDD) is a trenchless excavation method which is accomplished in three phases. First, drilling a small diameter pilot hole along a designed directional path. Second, enlarging the pilot hole to a diameter suitable for installation of the pipe. Third pulling the pipe into the enlarged hole. HDD shall be accomplished using a horizontal drilling rig with ancillary tools and equipment.

7.4.2 MATERIALS

7.4.2.1 HDD Equipment. HDD equipment shall have adequate thrust, pullback, and torque capabilities to successfully complete the installation. The equipment shall have a tracking guidance system which will accurately locate the drilling head and pilot hole during drilling of the pilot hole. The equipment shall be capable of measuring drill string axial and torsional loads, and of measuring drilling fluid discharge rate and pressure.

7.4.2.2 Drilling Fluid System. Drilling fluid system shall be capable of mixing and delivering the drilling fluid to the drill head or the reamer in the volumes and pressures required. CONTRACTOR shall maximize recirculation of drilling fluid surface returns. CONTRACTOR shall provide solids control and fluid cleaning equipment of a configuration and capacity that can process surface returns and produce drilling fluid suitable for reuse.

Drilling fluid shall be used during the installation of the pilot hole, enlarging of the pilot hole, and installation of the pipe. The composition of all drilling fluids proposed for use shall be submitted to MSD for acceptance. No fluid will be accepted or utilized that does not comply with permit requirements and environmental regulations. Drilling Fluid shall completely fill annular space between outside of installed pipe and reamed bore hole.

7.4.3 EXECUTION OF WORK

7.4.3.1. Submittals and Approvals. The CONTRACTOR shall furnish a detailed Bore Plan for review by MSD. The Plans shall contain a description of the HDD method and equipment proposed, deflection and radiuses of the pilot bore, finish grade, existing utilities with minimum vertical and horizontal clearance, shop drawings, a schedule of operations, and the proposed Work hours. HDD construction shall not commence until MSD has reviewed and approved the submittal. MSD's approval shall in no way relieve the CONTRACTOR of his sole responsibility for the execution of this Work or any liability. When HDD construction shall be beneath a Railroad right-of-way, the Bore Plan shall also be subject to the approval of the Railroad.

7.3.3.2. Horizontal Directional Drilling Equipment and Construction. CONTRACTOR shall perform surveying for layout of installation. The entire drill path shall be accurately surveyed with entry and exit stakes placed in the appropriate locations. If CONTRACTOR is using a magnetic guidance system, the drill path shall be surveyed for any surface geo-magnetic variations or anomalies.

Prior to beginning the work, the Contractor shall prepare a Bore Plan for each segment drilled. The Bore Plan shall show finished grade, deflection and radiuses of the pilot bore, all existing utilities with minimum vertical and horizontal clearance. The proposed clearance shall exceed the guidance system accuracy tolerance by a minimum of 100 percent. Submit Bore Plan to MSD for review and acceptance prior to beginning boring of the pilot hole.

CONTRACTOR shall position and anchor drill unit as required. Proper setbacks shall be provided to allow for installation of the pipe at the location indicated on the Drawings and to avoid excessive steep entry and exit angles for the pilot hole and the installed pipe.

CONTRACTOR shall make necessary provisions for operation of the tracking, locating, and instrumentation systems.

Boring of Pilot Hole.

Installation of pilot hole shall be done using a steerable drilling head. Pilot hole shall be drilled along the path shown on the accepted Bore Plan to tolerances listed herein. In all cases, property line restrictions shall take precedence over the listed tolerances. Regardless of the tolerance achieved, no pilot hole will be accepted if it will result in any and/or all of the pipeline being installed in violation of property line restrictions. Additionally, concern for adjacent utilities and/or structures shall take precedence over the listed tolerances. Listing of tolerances shall not relieve CONTRACTOR from responsibility for safe operations or damage to adjacent utilities and structures.

Alignment of the pipe shall be as shown on the Drawings, Bore Plan, and within the listed tolerances. If curves are allowed by MSD, the joint deflections and/or bend radius of the pipe shall not exceed the recommendation of the pipe manufacturer.

Monitor location of drill head as required to install pilot hole to indicated lines and grades, but in no instance shall the interval between locating the drilling head exceed 15-ft in length along the alignment.

Pilot hole shall be free from abrupt changes in line or grade that could result in unacceptably high loadings on the drill pipe or the pipe during installation.

Pre-reaming of the Pilot Hole

Subsequent to MSD acceptance of pilot hole, CONTRACTOR may, at his option, pre-ream the pilot hole as necessary for installation of the pipe.

Pre-reaming operations shall be conducted at the discretion of the CONTRACTOR. The CONTRACTOR shall insure that a hole sufficient to accommodate the pull section of pipe has been produced. Any damage to the pipe resulting from inadequate pre-reaming shall be the responsibility of the CONTRACTOR. All provisions of the specification relating to simultaneous reaming and pulling back operations shall also pertain to pre-reaming operations.

Use of pre-reaming shall be at the option of the CONTRACTOR, however, lack of pre-reaming shall not result in excessive installation loads on the pipe.

Reaming and Pullback of the Pipe

The CONTRACTOR shall utilize a reamer to enlarge the pilot hole to sufficient size for installation of the pipe without imposing excessive installation loadings on the siphon pipe.

Grippers used on the pipe shall not damage adjacent sections of the pipe. Sections of the pipe utilized by the grippers shall be removed from the pipe after installation of the pipe. Pulling head, reamer, and swivel assembly shall be acceptable to the pipe manufacturer.

The CONTRACTOR shall handle and support the pull section of pipe so as to prevent damage to the pipe and minimize pullback forces. Pull section of pipe shall be supported as it proceeds during pull back so that it moves freely and the pipe is not damaged.

The pull section of the pipe shall be installed in the reamed hole in such a manner that external pressures are minimized and an appropriate counter-balancing internal pressure is maintained. Any damage to the pipe resulting from external pressure during installation shall be the responsibility of the CONTRACTOR. If required, the siphon pipe shall be filled with water prior to entering the ground to insure that adequate internal pressure is maintained at all points to counter balance external collapse pressures. The CONTRACTOR shall submit pipe filling procedure proposed for use to MSD for review and acceptance.

The CONTRACTOR shall continuously monitor the pulling loads imposed upon the pipe. The maximum allowable tensile load imposed on the siphon pipes shall not exceed the recommendation of the pipe manufacturer. If necessary, the CONTRACTOR shall at his own expense, stop the pullback of the pipe, remove the section of pipe installed with the enlarged pilot hole, and pre-ream the pilot hole as required to allow installation of the siphon pipe without exceeding the allowable pullback forces.

7.5 PIPE BURSTING

7.5.1 DESCRIPTION OF WORK

Pipe bursting is a system by which the burster unit splits the existing pipe while simultaneously installing a new Polyethylene Pipe of the same or larger size pipe where the old pipe existed, then reconnecting existing service laterals, TVI of the polyethylene pipe, and completion of the installation in accordance with contract documents.

The CONTRACTOR shall provide all materials, labor, equipment, and services necessary for bypass pumping of sewage flows, cleaning and television inspection of sewer, installation of liner, reconnection of sewer service connections, and final television inspection and testing of pipe system. This specification represents the minimum requirements and specifications for Pipe Bursting. The CONTRACTOR shall abide any manufacturer's specifications that exceed these specifications

7.5.2 MATERIALS

7.5.2.1. Polyethylene Pipe The polyethylene pipe shall be high-density polyethylene pipe and meet the applicable requirements of ASTM F714 Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter, ASTM D1248, and ASTM D3550. Sizes of the insertion shall be such to renew the sewer to its original or greater flow capacity. All pipe shall be made of virgin material. No rework except that obtained from the manufacturer's own production of the same formulation shall be used. The minimum wall thickness of the pipe shall meet the following:

MINIMUM WALL THICKNESS	
Depth of Cover (feet)	Minimum SDR of Pipe
0.0 – 16.0	19
>16.1	17

The interior of the pipe shall be a light reflective color to allow better viewing for TVI.

7.5.2.2 Materials Testing. Tests for compliance with this specification shall be made as specified herein and in accordance with the applicable ASTM Specification. A certificate with this specification shall be furnished, upon request, by the manufacturer for all material furnished under this specification. Polyethylene plastic pipe and fittings may be rejected to meet any requirements of this specification.

7.5.2.3 Pipe Bursting Equipment. The pipe bursting tool shall be designed and manufactured to force its way through existing pipe materials by fragmenting the pipe and compressing the old pipe sections into the surrounding soil as it progresses. The bursting unit shall generate sufficient force to burst and compact the existing pipe line. The pipe bursting tool shall pull the polyethylene pipe with it as it moves forward and prevent collapse of the hole ahead of the polyethylene pipe. The bursting action of the tool shall increase the external dimensions sufficiently, causing breakage of the pipe at the same time as expanding the surrounding ground. The action shall not only break the pipe, but create a sufficient void to enable forward progress. The polyethylene pipe, attached to the sleeve or rear of the burster, shall also move forward. The CONTRACTOR shall protect the manholes to withstand forces generated by equipment and bracing used for pipe bursting. Shoring of insertion pits and other confined entry areas must be accomplished using a separate system from that used to protect manholes and existing sewer lines.

7.5.3 EXECUTION OF WORK

7.5.3.1 Submittals and Approvals. All CONTRACTOR Project Submittals shall be submitted to MSD within 14 days of Notice to Proceed issuance. All submittals must be approved by MSD prior to the start of construction. The CONTRACTOR will be required to submit a Bypass Pumping Plan that shall include shop drawings showing bypass pumping locations with sufficient detail to assure that the work can be accomplished without sewage spill. A Sample Customer Notification. A Traffic Control Plan including shop drawings and signage in accordance with MUTCD guidelines. Manufacturer's technical data sheets showing complete information of material composition, physical properties, storage and handling procedures, dimensions, joining procedures, gaskets, service connection saddles, end seal material, and other appropriate information. The CONTRACTOR shall provide certified test results of the properties of the polyethylene plastic pipe to the ENGINEER. A Bursting System Installation Specification. A Construction Plan including the following submittals; handling procedures, insertion locations, material storage location, installation procedures, reconnection of sewer service connections, sampling procedures, project schedule, erosion control plan, and cleanup plan.. When pipe bursting construction shall be beneath a Railroad right-of-way, the Construction Plan shall also be subject to the approval of the Railroad. All submittals shall identify the specification section(s) they address.

7.5.3.2. Qualifications. The CONTRACTOR shall be certified by the particular Pipe Bursting system Manufacturer such that the company is a fully trained user of the pipe bursting system. The CONTRACTOR shall submit certification of worker training for use of pipe bursting equipment and installation of pipe as specified by the manufacturer. Polyethylene pipe jointing shall be performed by personnel trained in the use of thermal butt-fusion equipment and recommended methods for new pipe connections. Personnel directly involved with installing the new pipe shall receive training in the proper methods for handling and installing the polyethylene pipe. Training shall be performed by a qualified representative.

7.5.3.3 Project Documentation. The CONTRACTOR shall make a walk through digital video prior to the start of construction and another immediately after the completion of the project. These digital videos shall document the condition of the entire project area. The project name, contract number, and the date and time of filming shall be clearly identified in the videos. The location within the project area shall be clearly identified as filming progresses. The CONTRACTOR shall take seven pre-rehab digital photos per 100 feet of sewer main detailing the project area. The CONTRACTOR shall provide the digital photos on a CD/DVD along with an index that provides the following information; corresponding photo number, contract number, street address as appropriate, record drawing number, CONTRACTOR name, location by station, and date. Digital videos and digital photos shall be submitted to the MSD INSPECTOR at the earliest possible date. Upon completion of application, the CONTRACTOR shall update the final as-built drawings to reflect the actual work performed and shall submit the completed as-built drawings to MSD or its representative at the completion of the project.

7.5.3.4 Public Notification. 72 hours prior to disruption of service the CONTRACTOR shall notify property owners, public, residents, and all who may be affected using a notification form approved by MSD. The CONTRACTOR shall disrupt customer sewer service for no longer than 24 hours. If the service will be disrupted more than 24 hours, the CONTRACTOR must notify the homeowner and provide on site bypass pumping as required at no additional cost to MSD until the service is restored.

7.5.3.5 Pipe Bursting Equipment and Construction. The CONTRACTOR shall transport, handle, and store pipes, fittings, and other materials as recommended by the manufacturer. If new pipes and fittings become damaged before or during installation, it shall be repaired as recommended by the manufacturer or replaced as required by the ENGINEER at the CONTRACTOR's expense, before proceeding further.

The CONTRACTOR shall carry out operations under this section in strict accordance with all applicable OSHA Standards. Particular attention is drawn to those safety requirements involving work with entry into a confined space. It shall be the CONTRACTOR's responsibility to comply with OSHA Standards and Regulations pertaining to all aspects of the work.

It shall be the responsibility of the CONTRACTOR to TVI the sewer pipe immediately before pipe bursting to locate all active service line connections. If Pre-Installation TVI inspection reveals a sag in the existing sewer that is greater than one-half the diameter of the existing pipe, it shall be the CONTRACTOR's responsibility to install the replacement pipe to result in an acceptable grade without the sag. The CONTRACTOR shall take any necessary measures to eliminate these sags by pipe replacement, digging a sag elimination pit and bringing the bottom of the pipe trench to a uniform grade in line with the existing pipe invert or by other measures that shall be acceptable to the ENGINEER.

Bypass pumping shall consist of furnishing, installing, and maintaining all power, primary and standby pumps, appurtenances and bypass piping required to maintain existing and peak hourly flows and services. The CONTRACTOR shall submit a plan for bypass pumping in accordance with MSD standards and Special Provisions. The CONTRACTOR shall be aware that homes in the area may have sump pumps connected to the sanitary sewer. The bypass pumping plan shall include an emergency response plan to be followed in

the event of a failure of the bypass pumping system or sump pump activity during the rehabilitation process.

Bypass pumping shall be done in such a manner as to not damage private or public property, or create a nuisance or public menace. The pumped sewage shall be in an enclosed hose or pipe that is adequately protected from traffic, and shall be redirected into the sanitary sewer system. Dumping or free flow of sewage on private property, gutters, streets, sidewalks, or into storm sewers is prohibited. The CONTRACTOR shall be liable for all cleanup, damages, and resultant fines in the event of a spill. The CONTRACTOR shall take all necessary precautions to ensure that no private properties are subjected to sewage backup or spill.

Existing property service connections conflicting with the proposed construction shall be adjusted by the CONTRACTOR. Property service connections that are not in service and are visibly plugged shall be lined through and not re-instated unless directed otherwise by the MSD INSPECTOR. All property service connections that are lined through shall be documented as follows; CONTRACTOR's name, MSD INSPECTOR's name, upstream and downstream manhole, property address, distance from upstream manhole and clock reading. The documentation shall be submitted to the MSD INSPECTOR prior to inversion of the liner.

The CONTRACTOR shall be liable for all damages resulting from CONTRACTOR's work.

The CONTRACTOR shall be responsible for viewing MSD's TVI video documentation prior to bidding. The CONTRACTOR is responsible for bidding necessary repairs to allow pipe bursting and pipe installation in accordance with manufacturer specification on any line segment scheduled for pipe bursting in the unit cost for pipe bursting.

Sections of polyethylene replacement pipe shall be assembled and joined on the job site above the ground. Jointing shall be accomplished by the heating and butt-fusion method in strict conformance with the manufacturer's printed instructions.

The butt-fusion method for pipe joining shall be carried out in the field by certified operators with prior experience in fusing polyethylene pipe with similar equipment using proper jigs and tools per standard procedures outlined by the pipe manufacturer.

These joints shall have a smooth, uniform, double rolled back bead made while applying the proper melt, pressure, and alignment. It shall be the sole responsibility of the CONTRACTOR to provide an acceptable butt-fusion joint. All joints shall be made available for inspecting by the ENGINEER before insertion. The replacement pipe shall be joined on the site in appropriate working lengths near the insertion pit.

The joint shall be allowed adequate cooling time before the removal pressure. The fused joint shall be watertight and have a tensile strength equal or greater than that of the pipe. All defective joints shall be cut out and replaced at the CONTRACTOR's expense.

Any section of the pipe with a gash, blister, abrasion, nick, scar, or other deleterious fault greater in depth than 10% of the wall thickness shall not be used and must be removed from site. A defective area of pipe may be cut out and the remaining sections may be joint fused in accordance with manufacturer specifications. In addition, any section of pipe

having other defects such as concentrated ridges, discoloration, excessive spot roughness, pitting, variable wall thickness, or any other defect of manufacturing or handling as determined by the MSD or their representative shall be discarded and not used.

The replacement pipe shall be installed with a tight fitting seal with the existing or new manhole. A Fernco CMA Water Stop Gasket or approved equal shall be placed circumferentially on the replacement pipe and encased with a cementitious non-shrink grout to prevent inflow at the manhole.

The top half of the pipe shall be neatly cut off and not broken or sheared off, at least four inches away from the manhole walls. The channel in the manhole shall be a smooth, continuation of the pipe(s) and shall be merged with other lines or channels, if any. Channel cross-sections shall be 'U' shaped with a minimum height of half to three fourths of the pipe diameter for 15 inches and larger. The side of the channels shall be built up with mortar/cement, as specified, to provide benches at a maximum of 1 in 12 pitch towards the channel.

The replacement pipe shall be sealed as specified above before proceeding to the next manhole section and all manhole sections shall be inspected individually for replacement pipe cutoff, benches and sealing.

All sewer service connections shall be identified and located prior to the pipe insertion to expedite reconnection. Upon commencement, pipe insertion shall be continuous and without interruption between manholes, except as approved by the ENGINEER. Location of the service shall be made by inspection of the pre-construction TVI documentation and other proven methods. Upon completion of the insertion of the new pipe, the CONTRACTOR shall expedite the reconnection of services to customers.

Sewer service connections shall be connected to the new pipe by means of a fusion saddle, insert a tee, or approved equal using approved methods and compatible materials as recommended by the manufacturer. Any connection not satisfactory to MSD shall be repaired in accordance with the manufacturer's recommendations at no additional cost to MSD.

After the existing sewer is completely replaced, The CONTRACTOR shall furnish all equipment and personnel to conduct an acceptance test. The test shall be conducted under the supervision of MSD.

Prior to reinstating property service connections or sealing the pipe in place at the manholes, the CONTRACTOR shall perform a low pressure air test to test the integrity of the pipe.

The pipe shall be plugged at each manhole with pneumatic plugs. The plug design shall be such that they will hold against the air pressure without the use of blocking or bracing. One plug shall have three air hose connections: one for inflating of the plug, one for reading the air pressure inside the sealed line, and one for introducing air into the sealed line.

Air pressure shall be introduced into the sealed line until the internal air pressure reaches 4.0 psig greater than the average back pressure resulting from any ground water that may be over the pipe. At least two minutes shall elapse to allow the pressure to stabilize. The time required for the internal pressure to decrease from 3.5 to 2.5 psig greater than the

average back pressure shall not be less than the time shown for a given pipe diameter in the following table:

Carrier Pipe Diameter (inches)	Minimum Elapsed Time (minutes)
6	3
8	4
10	5
12	6
15	7
18	8
21	9
24	11
30	14
36	17

In the absence of back-pressure due to groundwater, the test pressure shall be equal to $\frac{1}{2}$ psi per vertical foot of pipe depth or 3 psi, whichever is greater.

The CONTRACTOR shall provide MSD with a digital video showing the completed work including the restored conditions after all testing and work is complete

SECTION 8

MSD STANDARD SPECIFICATIONS

ROADWAY CONSTRUCTION AND REHABILITATION

8.1. DESCRIPTION OF WORK

8.1.1. General. This Work shall consist of milling and paving operations necessary to restore all existing pavements which were damaged or removed by the Contractor's operations and construction and paving operations necessary to provide new bituminous concrete pavement. Existing pavements shall be restored to conditions at least equal to their conditions before construction. Complete resurfacing or road construction shall be performed when required in the Special Provisions. The Contractor shall notify MSD 48 hours prior to placement of binder, base or surface so areas that are to be paved can be approved by MSD.

8.1.1.1. City, County, and State Paved Surfaces. Streets, alleys, sidewalks, curbs, and gutters which are wholly or partially removed, damaged or disturbed by the Contractor's operations, shall be promptly restored to the appropriate Agency's standards or as detailed in the Special Provisions.

8.1.1.2. Other Roadway Surfaces. Other roadway surfaces not constructed or maintained by an identified agency which are wholly or partially removed, damaged, or disturbed by the Contractor's operations, shall be restored with like or better materials to a condition as good as or better than existed prior to the beginning of the work, so that movement of traffic, both vehicular and pedestrian, through the restored way shall be as free, safe, and unimpeded as before.

8.1.2. Maintenance or Indemnity Bond. The Contractor shall provide a Maintenance or Indemnity Bond in the amount set forth in the Special Provisions to cover the cost of all claims, loss or damage and expenses of reconstruction or additional Work occurring because of settlement of backfill in the trenches under paved surfaces.

8.1.3. MSD Road Construction Standards. All new pavements at MSD owned or maintained facilities shall be constructed in accordance with the provisions in these Specifications. Included are the construction activities associated with the preparation of the subgrade, the placement and compaction of the aggregate base material, and the placement and compaction of pavement materials. Also included are the submittals required, and the test and inspection procedures required for acceptance of the finished product.

8.2. MATERIALS

8.2.1. Asphalt Mixtures.

The contractor will utilize the specified mixture identified in the design documents.

Unless otherwise noted, materials and the preparation of mixes shall meet the requirements as set forth in Sections 403.02 and 403.03.03 of the KYTC Standard Specifications. The KYTC has adopted the “Superpave” selection and evaluation process. Adherence to the procedures will be required.

In general applications, or where a mix has not been specified, materials will comply with the following requirements developed by the Plantmix Asphalt Industry of Kentucky (PAIKY).

AGGREGATES

- A General:** Use materials and gradations that have performed satisfactorily in previous installations.
- B Coarse Aggregate:** Sound, angular crushed stone, or crushed gravel, complying with KTC Standard Specifications Section 805.
- C Fine Aggregate:** Natural sand or sand prepared from stone, gravel, properly cured blast-furnace slag, or combinations thereof complying with KTC Standard Specifications Section 804.
- D Recycled (Reclaimed) Asphalt Pavement (RAP):** milled or removed asphalt pavement may be utilized in accordance with KTC Standard Specifications Section 409.

ASPHALT MATERIALS.

- E Asphalt Binder:** AASHTO MP 1, Performance Graded Binder PG 64-22 for general applications.
- F Tack Coat:** Comply with provisions in KYTC Standard Specifications Section 406.

MIXES

- G Hot-Mix Asphalt:** Hot-laid, hot-mix asphalt plant mixes meeting the requirements of the Standard Specifications of the Kentucky Transportation Cabinet (KYTC) or Asphalt Institute (AI) MS-2 and complying with the following requirements:
 - 1 Base Course:** Produce KYTC mixture designation Class 2 Base or a Marshall mixture from AI MS-2. There shall be no restrictions on polish resistant aggregates (utilize KTC Type “D” aggregates). Recycled Asphalt Pavement (RAP) may be utilized in accordance with KYTC Standard Specifications Section 409.

- 2 **Surface Course:** KYTC mixture designation Class 2 Surface or a Marshall mixture from AI MS -2. The mixture gradation may pass through the restricted zone and there shall be no restriction on polish resistant aggregates (utilize KYTC Type “D” aggregates). Recycled Asphalt Pavement (RAP) may be utilized in accordance with KTC Standard Specifications Section 409.

H Hot-Mix Asphalt: Hot-laid, hot-mix asphalt plant mixes designed according to procedures established by the Kentucky Transportation Cabinet (KYTC) or Asphalt Institute (AI) MS-2 and complying with the following requirements.

- 1 **Provide mixes complying with composition, grading, and tolerance requirements in KYTC Standard Specifications or AI MS-2 for the following nominal, maximum aggregate sizes:**
 - a **Base Course:** Mixture with a nominal maximum aggregate size of 0.75 inch (19 mm) with a minimum Voids in the Mineral Aggregate (VMA) of 12 percent.
 - b **Surface Course:** Mixture with a nominal maximum aggregate size of 0.38 inch (9.5 mm) with a minimum VMA of 14 percent.

A Job Mix Formula previously approved by MSD will generally be accepted, but must still be submitted for each Project.

8.2.2. Bituminous Tack Coat. This material shall meet the requirements for SS-1h emulsified asphalt as set forth in Section **406** of the KYTC Standard Specifications (**latest edition**).

8.2.3. Portland Cement Concrete. This material shall meet the requirements for Class A concrete as set forth in Section 6 of these Specifications.

8.2.4. Aggregate Base. This material shall meet the requirements as set forth in Section 805 of the KYTC Standard Specifications (**latest edition**). If not from a previously approved source, prior to construction of the aggregate base, the Contractor shall submit a grain-size distribution for the aggregate base material. The grain-size distribution shall be developed in accordance with KM 64-620. The oven-dry bulk specific gravity, determined in accordance with KM 64-607, shall be submitted with the grain-size distribution. Testing of the aggregate base shall be performed by an Independent Testing Laboratory or by a Certified Aggregate Technician employed by the supplier.

8.2.5. Fill Materials. These materials shall be used in the construction of fill to the specified lines, grades, and cross-sections. The fill shall consist of selected excavated material meeting the requirements of Section 3.3.4.1. or borrow material meeting the requirements of Section 3.3.4.3. of the current MSD Standard Specifications.

8.3. EXECUTION OF WORK

8.3.1. Pavement Cut Back. Existing pavements shall be saw cut along straight lines running parallel to and on each side of the trench. They shall be cut such that the new pavement surface will be constructed in uniform widths at least 50 feet in length measured along the trench. Pavement material shall be removed and disposed of. An additional saw cut shall be made 12 inches back on each side of the trench, after trenching Work is complete, extending down to the base material or subgrade soil. The exposed base material, if present, or subgrade soil shall be refilled and compacted with manual tampers or rollers to a density equal to 95 percent of standard Proctor density, as determined by ASTM D 698.

For Portland cement concrete pavements, if saw cuts are within 4 feet of a formed joint in the existing pavement, then the existing slab shall be broken and removed to the joint.

8.3.2. Roadway Excavation Protective Covering (Steel Plates). The objective is to provide optimal drive ability on all streets throughout the year. Avoiding damage to snow removal equipment from objects in the street is a seasonal issue. While the City, County and MSD recognize and encourage placing plates over roadway excavation sites to enable traffic to pass over the site when work is not proceeding, the desire is also that the plates be minimally disruptive and meet all safety standards.

Requirements for Collector, Arterial Streets, and County through Roads:

November 1 to March 31: Recessed plates at all sites where Project lasts longer than two working days. No flat plates allowed.

April 1 to October 31: Recessed plates or beveled plates pinned to road surface.

Requirements for Residential Streets:

November 15 to March 31: Recessed or pinned beveled plates where Project lasts longer than two working days. No flat plates allowed.

April 1 to November 14: Recessed or beveled plates allowed where construction lasts five days or longer.

8.3.3. Manhole Adjustments. From November 1 to March 31 of the following year, manhole lids shall be adjusted in conjunction with placement of bituminous concrete pavement courses in order to avoid damage to snow removal equipment. Work related to maintaining manhole lids flush with the roadway surface shall be incidental to surfacing.

8.3.4. Pavement Milling. After milling and texturing, the finished surface shall provide a smooth riding surface free from gouges, ridges, oil film, and other imperfections of workmanship, having a uniform texture, and true to the required grade and cross section. The elevation of the longitudinal edges of adjacent cuts shall not differ more than 1/8-inch. When practicable, vertical longitudinal faces shall not be left during non-working hours to expose

public traffic. When it is necessary to expose public traffic to longitudinal faces, the faces shall be no more than 1-1/4 inches in height and shall be tapered in a manner approved by MSD, to avoid creating a hazard for traffic.

Where sound pavement has been gouged, torn, or otherwise damaged during the milling operations, or damage is done to any property of any kind including utility frames, grates, and covers, repairs shall be made by the Contractor at no cost to MSD.

Lateral limits extend from the inside edge of the integral curb and gutter section a distance of at least 6-feet 6-inches into the existing pavement area. Remove existing pavement material that extends into the gutter portion of the integral curb and gutter section.

8.3.5. Grading and Aggregate Base Construction

8.3.5.1. Clearing and Grubbing. This item of Work shall consist of clearing, grubbing, removing and disposing of all vegetation, structures and debris, which are located within the designated limits of the proposed pavement. All Work shall be performed in accordance with Section 2 of the MSD Standard Specifications.

8.3.5.2. Preparation for Placement of Fill. Prior to the placement of any fill material or the placement of any pavement materials, the surface of the cleared and grubbed area shall be thoroughly inspected by the MSD Inspector. The entire surface shall be "proof-rolled" using a loaded pan, a loaded tri-axle dump truck or a heavy flat-drum roller. The MSD Inspector shall observe the behavior of the surface for signs of pumping, rutting or excessive settlement.

Areas which pump, rut, settle, or exhibit other undesirable behavior shall be undercut to firm material and backfilled, stabilized in place using KTC No. 2 crushed aggregate (*as specified in Section 805 of the KTC Standard Specifications*), or aerated and compacted in-place.

8.3.5.3. Placement of Fill Material. This item of work shall include placing and compacting fill material to the specified lines, grades and cross-sections.

Only acceptable materials shall be used to construct the fill. Fill material shall not be placed on frozen areas, or areas containing snow or ice.

Where required on the Plans, benches with horizontal and vertical faces shall be excavated into the original ground.

The fill material shall be placed and compacted in uniform horizontal layers not exceeding twelve inches in thickness, loose measurement. Each layer shall be thoroughly compacted to a minimum of 95 percent of standard Proctor density at moisture content between plus two percent and minus four percent, as determined by ASTM D 698. Each layer shall be properly compacted before the next succeeding layer is placed.

8.3.5.4. Subgrade. Final grading shall be performed to construct the subgrade to the lines,

grades, and cross-sections indicated on the plans. The surface of the subgrade shall be compacted to a uniform slope at a uniform density throughout. High areas shall be removed by scarifying and low areas shall be filled by placing and compacting suitable material.

When a sheepsfoot roller is used, the compaction shall be finished with a steel-wheel roller, a multiple-wheel pneumatic-tire roller, or other suitable equipment having sufficient weight to smooth out and compact the indentations made by the sheepsfoot roller.

Once final grading is complete, the embankment shall be maintained at the specified line, grade, and cross-section and at the specified density and moisture content. If the material subsequently loses its density or moisture content, it shall be recompacted to the proper density at the required moisture content.

The subgrade shall show no deviation greater than one-half inch in 10 feet from the specified section and shall be constructed uniformly so that the base, binder, and surface courses can be constructed within their specified tolerances.

8.3.5.5. Aggregate Base. Materials shall conform to the requirements identified in the contract documents. In addition, initial layers of aggregate base shall be maintained to a uniform grade and cross-section during compaction. The final layer shall be shaped to the specified line, grade and cross-section. When the final layer is to be trimmed to the final grade by an automatic grading machine, the final layer shall be constructed approximately one-half to one inch above grade, so that the grading machine cuts constantly. After the final pass of the grading machine, the surface shall be wetted and rolled. The surface of the finished aggregate base shall be smooth and uniform and shall not deviate by more than one-half inch from the specified cross-section. The longitudinal grade shall not deviate more than three-eighths of an inch within ten feet in any direction.

Immediately prior to paving, the Contractor shall remove aggregate base material from trench areas. The thickness of the material to be removed shall equal the thickness of the bituminous concrete required in the trench area, as stated in the Special Provisions. Aggregate base remaining in the trench, but loosened by this operation, shall be wetted and recompacted, as directed by MSD.

Construction scheduling operations shall be coordinated so that the aggregate base is completely covered with the specified pavement courses before work is suspended for the winter months, or for any other long delays.

8.3.5.5.1. Dense Graded Aggregate Base Course. Where required in the Project Special Provisions or Plans, dense graded aggregate (DGA), having been thoroughly mixed with water in a twin shaft pugmill-type mixer shall be delivered to the site. The amount of water added shall be an amount which will provide the mixture with a satisfactory moisture content for compaction to the specified in-place density. The plant-mixed material shall be

transported in such manner as to deliver the mix to the Project without loss of moisture or segregation. Only the aggregate base material which can be properly placed and compacted shall be transported to the site. DGA should not be stored or stockpiled on the job site without written permission from MSD. During placement, the base material shall be wetted as directed to maintain the moisture content at the level necessary to ensure proper compaction. Unless otherwise permitted, the compacted depth of each layer shall be no less than 3 inches or more than 6 inches. The determination of target density and conformance testing with comply with section 302.03.04 of the KYTC Standard Specifications. Manually operated tampers or walk-behind rollers will be required in trenches and other restricted areas inaccessible to paving rollers.

DGA base material in trench areas will be placed as soon as practicable. Trench backfill which was flushed and jetted will have drained and completed its settlement before base material is placed. If paving operations are not to begin immediately, the aggregate base shall be placed even with the existing pavement surface, and the roadway shall be opened to traffic. Any damage which occurs to the exposed base, such as raveling or the formation of potholes, shall be repaired immediately by the Contractor. All edges of the repaired areas shall be sealed.

8.3.6. Asphalt Pavement

8.3.6.1. General. Asphalt paving shall conform with **Section 403** of the KTC Standard Specifications.

8.3.6.2. Cleaning Existing Pavements. The Contractor shall clean all pavement areas which are to receive tack coat and bituminous surface course. Cleaning shall be with water jets, mechanical sweepers, and hand brooms, as necessary to completely remove all foreign materials from surfaces which are to be paved.

8.3.6.3. Asphalt Tack Coat. Tack coat material shall be applied to the cleaned surface of the underlying asphalt course prior to the application of the surface course. The tack material shall be diluted with water at a ratio of 1:1, and applied at a rate of 0.10 gallons per square yard.

The tack coat shall be allowed to cure to a dark black color before the surface course is applied.

Upon approval of MSD, the application of the tack coat may be eliminated when the surface course is placed within 48 hours of the placement and compaction of underlying binder course, provided the binder is not disturbed during curing.

"Fresh Oil" signs shall be placed where they are clearly visible during the period that tack coat material has been applied to a roadway. The signs shall not be removed until the tack coat has been paved over with the bituminous surface.

8.3.6.4. Leveling and Wedging. Leveling and wedging of uneven, irregular areas, including

preexisting conditions and paved shoulders, shall be performed when necessary, to provide a smooth, uniform base upon which the asphalt surface will be placed. The asphalt mixture for leveling and wedging shall be placed with a paving machine. After satisfactory spreading of the mixture has been completed, the mixture shall be thoroughly compacted by a paving roller. Tack coat material shall be applied to areas which have received wedge or leveling course. Cost shall be incidental to surfacing. Areas that are heaved or otherwise deformed due to Contractor's operations, shall be removed and restored to original contours in accordance with section 8.3.6.3.

8.3.6.5. Edge Keys. Edge keys will be required at the paving limits where new bituminous pavements join existing pavements. An edge key shall consist of a cut in the existing pavement 2 feet wide by 1 inch deep, and shall extend across the complete width of the roadway. The Contractor shall use care when making edge key cuts, to ensure that the specified depth is not exceeded by using a milling machine.

Edge keys will not be required at driveways and entrances. The bituminous surface course shall be tapered to allow a smooth transition from the edge of the pavement into the existing driveway. Feathering of the edge will be acceptable. The edge of new paving at driveways and entrances shall be straight and parallel to the curb or centerline of the roadway.

8.3.6.6. Temperature and Weather Limitations. No paving shall take place between November 15 and April 1 without written permission from MSD. Asphalt paving shall not be placed on any wet surface or when the ambient air temperature is less than that specified in the following table.

TEMPERATURE LIMITATIONS

(Minimum ambient air temperature and minimum temperature of the existing surface for placing asphalt mixtures)

<u>Asphalt Mixtures</u>	<u>(Degrees Fahrenheit)</u>
Asphalt Surface, 1" thick or less	45
Asphalt Surface, thicker than 1"	40
Asphalt Binder	35
Leveling and Wedging	45

MIXING AND LAYING TEMPERATURES

(Degrees Fahrenheit)
(Using PG64-22)

Aggregates	Min 240 - Max 330
Asphalt Cement	Min 230 - Max 330
Mixture at Plant (measured in truck)	Min 250 - Max 330
Mixture When Placed (measured in truck when discharging)	Min 230 Max 330

8.3.7 Pavement Restoration For Utility Cuts - Milled Streets. The compacted asphalt binder

course shall be 4-inches for subdivision streets and 6-inches (2-3 inch thick layers) on County through roads for utility cuts, including cuts for property service connections.

8.3.8 Adjustment of Shoulders. When the placement of asphalt results in an abrupt vertical transition at the edge of pavement, the Contractor shall place and compact additional material within a 1 to 2-foot distance from the edge of the pavement. For purposes of these Specifications, “abrupt vertical transition” shall mean a 2½-inch vertical drop over a horizontal distance of less than 6 inches. The material placed shall be of the same character as the existing shoulder material. It shall be graded so as to provide a smooth transition from the pavement surface to the original shoulder.

8.3.9. Temporary Paving

8.3.9.1. Temporary Surface. Temporary pavements shall be constructed over trenches as shown on the Plans or Special Provisions in areas of heavy traffic or where safety is a concern as directed by MSD. Temporary paving shall consist of a 6-inch thick compacted aggregate base and a 2-inch compacted asphalt binder. The thicknesses specified are minimums and may be increased by the Contractor, if in his opinion, a thicker base or surface is warranted. The temporary paving shall be maintained by the Contractor and depressions and potholes which develop shall be promptly repaired. Prior to constructing the permanent paving, all temporary binder and base material shall be removed from the trenches and wasted away from the Project.

8.3.9.2. Temporary Roads. All temporary roads shall be constructed of the materials and to the dimensions shown in the Plans or Special Provisions.

8.3.9.3 Temporary Trench Surface. Upon completing backfill work in roadways the Contractor shall immediately place DGA over trench areas to provide a temporary travel surface, at no additional cost to MSD.

8.3.9.4 Construction Entrances. Construction entrances shall be constructed as shown in the Standard Drawings or Special Provisions.

8.3.10. Concrete Paving.

Concrete paving shall be performed in accordance with **Section 501** of the KTC Standard Specifications.

8.3.10.1. Concrete Base Associated with Trench Backfill. When required in the Special Provisions or shown on the plans, Class A concrete shall be used as base material in trench and cut back areas. The thickness of the concrete base shall be as identified. In situations where asphalt surface will be placed over the concrete base, the concrete shall be thoroughly cleaned, and shall be sprayed with tack coat material as specified in Subsection 8.3.6.3 of these Specifications.

8.3.11. DRIVEWAYS

8.3.11.1. Concrete Driveways. Driveways to be reconstructed shall be restored with 6 inches of Class "A" concrete, 4 inches DGA and formed and shaped as designated on the Plans. The concrete shall be reinforced with polypropylene fiber at 2 pounds per C.Y. as specified in Section

6.2.2.3. Contraction joints shall be constructed as required by MSD. Non-extruding, preformed expansion joint material, 1/2 inch thick, shall be used at back of curb and against any abutting concrete, unless otherwise directed by MSD.

8.3.11.2. Asphalt Driveways. Driveways to be reconstructed shall be restored with 4 inches of compacted DGA as a base and 2 inches asphalt surface, shaped as designated on the Plans.

8.3.11.3 Stone Driveways. Driveways to be constructed shall be restored with 4 inches of crushed stone to match existing stone driveway, shaped as designated on the Plans.

8.4. INSPECTION AND TESTING

8.4.1. General. The paving operations, including subgrade preparation, placement and compaction of the base material, and the placement and compaction of the pavement shall be performed in the presence of the MSD inspector. Field and laboratory testing shall be performed by an agency designated or approved by MSD to provide pavement inspection and materials testing.

8.4.2. Field Inspection. In addition to routine visual inspection, periodic field measurements of the thickness of the granular base shall be performed by the inspector. Areas lacking in thickness shall be noted and reported to the Contractor.

During placement of the bituminous concrete pavement, field measurements of the temperature of the mix in the truck bed shall be performed to ensure compliance with the Project specifications. Measurements of the course thickness shall be performed by the inspector during placement. Discrepancies shall be noted and reported to the Contractor.

8.4.3. Field Density Testing

8.4.3.1. Embankment. As a minimum, one field density test shall be performed on the compacted fill for each 500 cubic yards of material placed, with a minimum of one test performed each lift and one test performed each shift (day). Additional density tests shall be performed when directed by MSD, or when there is a suspicion of a change in material, moisture content, or degree of compaction control.

8.4.3.2. Granular Base. As a minimum, field density tests shall be performed on the granular base at the rate of one test per **10,000** square feet, with a minimum of one test per shift during which granular base is placed.

8.4.3.3. Asphalt Pavement. As a minimum, one field density test shall be performed on the asphalt pavement for every **1,000** linear feet of material placed, with a minimum of one test per shift during which asphalt pavement is placed.

8.4.4. Laboratory Testing

8.4.4.1. General. Laboratory tests shall be performed on the materials used for construction of the granular base and the bituminous concrete pavement. Testing shall be performed by an agency designated or approved by MSD to provide materials testing.

8.4.4.2. Granular Base. Sampling and laboratory testing of the granular base material shall be performed when difficulties are experienced by the Contractor, in obtaining the specified density, or when the inspector suspects that the material used for the granular base does not meet the Project specifications.

As a minimum laboratory testing shall consist of the performance of a moisture content test (ASTM D 2216), a specific gravity test (KM 64-607) and a wet sieve analysis (KM 64-620).

8.4.4.3. Asphalt Pavement. Sampling and laboratory testing of the asphalt pavement material shall be performed on a regular basis on MSD Projects. Samples of the asphalt materials shall be tested, both in the morning and in the afternoon on projects involving the full-time placement of pavement. On smaller Projects, a minimum of one sample shall be obtained per project.

When requested, the Contractor shall submit to MSD a sample of the asphalt cement being used in the batching of the asphalt paving mix. Samples shall be obtained, identified and delivered to the inspector in accordance with KM 64-404.

Laboratory testing shall consist of the performance of an extraction test (KM 64-405) and a sieve analysis (KM 64-407).

SECTION 9

MSD STANDARD SPECIFICATIONS

CHANNEL AND SLOPE STABILIZATION, SITE RESTORATION AND CLEAN UP

9.1. DESCRIPTION OF WORK

9.1.1. Channel and Slope Stabilization. This work consists of the stabilization of channels, waterways and ditches using grass linings, erosion control blankets, turf reinforcement mats and “hard” linings such as Class II and Class III channel lining, rip-rap, mattresses, gabions and concrete paved channels.

9.1.2. Site Restoration. This work shall consist of topsoil replacement, permanent soil stabilization, and sodding to restore or establish vegetative cover on the site.

9.1.3. Clean Up. This Work shall consist of daily and final clean-up of the project site.

9.2. MATERIALS

9.2.1. Agricultural Limestone. Agricultural limestone shall contain not less than 85 percent of calcium carbonate and magnesium carbonate combined and shall be crushed so that at least 85 percent will pass the No. 10 sieve and 100 percent will pass the 3/8 inch sieve.

9.2.2. Dolomitic Limestone. Natural dolomitic limestone containing not less than 85 percent of total carbonates with a minimum of 30 percent magnesium carbonates, ground so that not less than 90 percent passes a No. 10 sieve and not less than 50 percent passes a No. 100 sieve.

9.2.3. Fertilizer. Manufactured fertilizer shall be a standard commercial fertilizer, Grade 10-10-10, or 20-10-10 as specified herein, containing the specified percentages by weight of nitrogen (N), phosphate (P_2O_5) and potash (K_2O). A minimum of 50% of the nitrogen (N) shall be slow release nitrogen or the fertilizer shall be a complete formula. The fertilizer shall be furnished in standard containers with the name, weight, and guaranteed analysis clearly marked. The containers will ensure proper protection in handling and transporting the fertilizer. All commercial fertilizer shall comply with the Kentucky Fertilizer Law.

9.2.4. Permanent Seed. The seed shall meet the requirements set forth in **Section 827.04 of the KYTC Standard Specifications (latest edition)**. **Particular attention is directed to the manufacturer’s expiration date.** If requested, the Contractor shall furnish a certified laboratory report from an accredited commercial seed laboratory showing the analysis of the seed furnished and approving the seed purity and germination. The report shall be signed by a Senior Member of the Society of Commercial Seed Technologists. The seed mixture to be

used for permanent seeding shall be as follows and shall be the Turf Quality Tall Fescue mixture unless the Contract stipulates otherwise.

All seeding rates specified in these specifications and in the Contract shall be in terms of the rate of pure live seed to be seeded. The actual seeding rate shall be calculated using the following formula:

$$\text{ASR} = \frac{10,000 (\text{PLSR})}{(\% \text{GERM}) (\text{PURITY})}$$

where: ASR = Actual Seeding Rate (lbs/1000 sf)

PLSR = Pure Live Seed Seeding Rate (lbs/1000 sf)

% GERM = Percent Germination

PURITY = Pure Seed Content (Percent)

Permanent Seed Mixtures

- (A) Native Grasses and Forbs: For use in native woodlands, riparian buffers, and stream crossings through native areas and basins. Use mixture of grasses and forbs as specified in Section 12.

The following seed mixture shall be applied at the pure live seed rate of 0.23 lb/1000 sq. feet. (10 lb/acre).

- (B) Turf-Type Tall Fescue: Use blend of three or four of the top ten performing varieties listed in the most current edition of the Kentucky Turfgrass Research (published by the University of Kentucky College of Agriculture), mixed in equal proportions. Seed at a pure live seed rate of 8 lbs./1000 sq. feet.
- (C) Kentucky Bluegrass: Use mixture of 85 percent Bluegrass with 15 percent Perennial Ryegrass. The Bluegrass blend should consist of two or three of the top ten performing varieties listed in the most current edition of the Kentucky Turfgrass Research (published by the University of Kentucky College of Agriculture), mixed in equal proportions. Seed at a pure live seed rate of 2 lbs./1000 sq. feet.
- (D) Kentucky 31 Tall Fescue: Use mixture of 70 percent of Kentucky 31 Fescue, 15 percent Creeping Red Fescue, 10 percent Redtop, and 5 percent Dutch Clover. Seed at a pure live seed rate of 3 lbs./1000 sq. feet.

9.2.5. Straw Mulch. Straw for mulching shall be baled wheat, oat, barley or rye straw. It shall be reasonably free from weed seeds, foreign matter, or chaff and shall not contain any Johnson Grass, Canada Thistle, or Nodding Thistle. Straw for mulching shall be reasonably bright in color and shall not be musty, moldy, or otherwise of low quality, and shall not contain any chemicals toxic to plant growth.

9.2.6. Wood Cellulose Fiber Mulch. Wood cellulose fiber may be used in place of straw material or as a mulch anchor. Wood cellulose fiber mulch shall consist of specially prepared wood cellulose processed into a uniform fibrous physical state. Wood cellulose fiber mulch shall not contain any germination or growth inhibiting elements. Wood cellulose fiber mulch shall be dyed green or contain a green dye in the tackifier that will provide an appropriate color to facilitate visual inspection of the uniformly spread slurry. Wood cellulose fiber mulch shall conform to the following parameters: fiber length to approximately 10mm diameter approximately 1 mm., pH range 4.0 to 8.5, maximum ash content of 1.6% and minimum water holding capacity of 90%.

9.2.7. Mulch Anchoring

9.2.7.1. Jute Netting. Undyed jute yarn woven into a uniform, open, plain weave mesh with approximately one inch openings, weighing not less than 90 pounds per 100 square yards, or in rolls.

9.2.7.2. Photodegradable Plastic Netting. Photodegradable plastic netting for holding down mulch shall consist of extruded, oriented, photodegradable plastic net (colored green) having a minimum width of 45 inches, 5/8 inch to 3/4 inch mesh openings and weighing approximately 3 pounds per 1,000 square feet. Photodegradable plastic netting shall not be used in natural and/or riparian areas.

9.2.7.3. Staples. Staples shall be V-shaped and made from No. 11 gage steel wire, or another approved material, having an effective driving depth of at least 8 inches or a 1 or 2 inch crown. Means other than steel staples shall be used in residential areas.

9.2.7.4. Tackifier. Synthetic/chemical binders, emulsions and slurries used to and or mulch. These products shall be non-toxic and biodegradable. No asphalt emulsions shall be allowed.

9.2.8. Sod. Sod shall be well-rooted Turf Quality Tall Fescue or Kentucky Bluegrass as directed by MSD or as stipulated by the Contract. The sod shall be completely free from noxious weeds, and reasonably free from other objectionable grasses and weeds and stones or other foreign materials detrimental to the development and future maintenance of the sod. The source of sod shall be covered with grass having a height of no more than 3 inches and shall be available for inspection and approval prior to cutting.

9.2.9. Erosion Control Blankets. Erosion control blankets (straw, coconut fiber, wood fiber, etc.) shall meet the requirements set forth below, shall not be damaged or torn, and shall meet the manufacturer's specifications.

9.2.9.1. Wood (Excelsior) Blankets. Wood blankets shall consist of a machine produced mat of curled wood fibers, 80 percent of which shall be 6 inches or longer in length with consistent thickness and fibers evenly distributed over the entire area. Blankets designated on the Plans as "High Velocity" shall be covered on both sides with heavy duty plastic

netting having a mesh opening of approximately 3/4 inch by 3/4 inch. Other blankets shall be covered on one side with the plastic netting.

9.2.9.2. Straw Blankets. Straw blankets shall consist of a machine-produced mat of 100% agricultural straw evenly distributed over the entire area of the mat. The top side of the blankets designated for use on mild slopes (3:1 or flatter) and low-flow swales shall be covered with polypropylene netting having an approximate 1/2 inch x 1/2 inch mesh size. The blanket shall be sewn together with cotton thread. Other blankets shall be covered on both sides with the polypropylene netting. The blanket shall be sewn together with cotton thread. It shall be supplied in rolls weighing approximately 0.5 lbs/square yard. When required, accelerated photodegradable netting shall be provided to assure blanket deterioration in 30 to 45 days.

9.2.9.3. Straw/Coconut Fiber Blankets. The blanket shall consist of a machine produced mat of 70% agricultural straw and 30% coconut fiber evenly distributed over the entire area of the mat. The top side of the blanket shall be covered with UV stabilized polypropylene netting having an approximate 5/8 inch x 5/8 inch mesh, and the bottom side shall have a polypropylene netting with an approximate 1/2 inch x 1/2 inch mesh size. The blanket shall be sewn together with cotton thread. It shall be supplied in rolls weighing approximately 0.5 lbs/square yard.

9.2.9.4. Coconut Fiber Blankets. Coconut fiber channel lining shall consist of a machine-produced mat of 100% coconut fiber evenly distributed over the entire area of the mat. The blanket shall be covered on top and bottom with UV stabilized polypropylene netting having an approximate 5/8 inch x 5/8 inch mesh size. The blanket shall be sewn together with black polyester thread. It shall be supplied in rolls weighing approximately 0.5 lbs/square yard.

9.2.9.5. Recycled Nylon Fiber Blanket. The nylon fiber permanent channel liner shall consist of a machine-produced mat of 100% recycled nylon fiber evenly distributed over the entire area of the mat. The top side of the blanket shall be covered with UV stabilized polypropylene netting having an approximate 1/2 inch x 1/2 inch mesh size, and the bottom net shall be UV stabilized polypropylene with a 5/8 inch x 5/8 inch mesh size. The blanket shall be sewn together with black polyester thread. It shall be supplied in rolls weighing approximately 0.8 lbs/square yard.

9.2.9.6. Seed-Incorporated Blankets. The seed-incorporated blanket shall consist of 2-ply 100% recycled, unbleached, cellulose tissue. Unless specified otherwise in the Contract, a standard seed mix of 66% Ky 31 Tall Fescue and 33% Annual Ryegrass at a rate of .05 lbs/sq. yard shall be uniformly distributed upon the bottom ply of cellulose tissue and fully overlaid with a top cellulose ply to provide complete envelopment of the seed layer. The seed-filled cellulose medium shall be sewn to the bottom side of the specified erosion control fabric.

9.2.9.7. Biodegradable Blankets. Biodegradable erosion control blankets shall be composed

of straw, straw/coconut fiber, or coconut fiber mats meeting the specifications of those given in Subsections 9.2.9.2, 9.2.9.3, and 9.2.9.4 above. The blanket shall be covered on top and bottom with woven natural fiber netting having an approximate 1/2 inch x 1 inch mesh size. The blanket shall be sewn together with biodegradable thread. It shall be supplied in rolls weighing approximately 0.5 lbs/square yard.

9.2.10. Erosion Control Fabrics. Erosion fabrics (coir, jute, etc.) shall meet the requirements set forth below, shall not be damaged or torn, and shall meet the manufacturer's specifications.

9.2.10.1. Coir Fabrics. The coir erosion control fabric shall consist of 100% natural coir drawn from coconut husks. The yarn shall be wheel spun, well cleaned, evenly spun and uniformly twisted. The fabric shall have an open weave construction. The weight of the fabric, allowable water flow velocities, maximum shear stress and its durability shall equal or exceed the fabric(s) specified on the Plans or in the Contract.

9.2.10.2. Jute Fabrics. Jute erosion control fabrics shall be manufactured using woven jute that is undyed and unbleached. The fabric shall have an open weave construction. The weight of the fabric, allowable water flow velocity, maximum shear stress and its durability shall equal or exceed that of the jute fabric(s) specified on the Plans or in the Contract.

9.2.11. Turf Reinforcement Mats. Turf reinforcement mats shall be manufactured using synthetic materials, natural materials, or a combination of both. Turf reinforcement mats shall be those specified on the Plans or in the Contract. No substitutions are allowed unless directed by MSD and approved by MSD.

9.2.12. Anchors for Erosion Control Blankets, Erosion Control Fabrics, and Turf Reinforcement Mats

9.2.12.1 Staples. Staples for securing the erosion control blankets shall be U-shaped and made from No. 11 gage (minimum) steel wire or other approved material with an effective driving depth of at least 8 inches on disturbed soil and 6 inches on undisturbed soil. Staples shall have a 1-inch to 2-inch crown. Staples shall meet and be installed according to the blanket manufacturer's specifications. If any conflict exists between the manufacturer's and MSD's specifications, the more stringent requirements shall be met unless otherwise directed by MSD. The Contractor shall supply a set of specifications for MSD's use. Means other than steel staples or pins **may** be used to anchor blankets, fabrics and mats in residential areas.

9.2.12.2. Pins. Pins may be steel, plastic or wood. They must meet or exceed the requirements or recommendations of the blanket, fabric or mat manufacturer. Means other than steel staples or pins shall be used to anchor blankets, fabrics and mats in residential areas.

9.2.12.3. Dead Stout Stakes. Dead stout stakes shall be constructed using 2-inch x 4-inch

(nominal) hardwood lumber, 18 to 24 inches in length, cut diagonally across its length to form two stakes. The length of stakes shall be in accordance with the specifications of the manufacturer of the erosion control product.

9.2.12.4. Wood Stakes for Securing Sod. Wood stakes shall be 1-inch x 1-inch untreated pine with a minimum length of 6 inches.

9.2.13. Concrete. Concrete paved ditches and channels shall be constructed using Class A Concrete as defined in Section 6 of these Specifications.

9.2.14. Concrete Reinforcement. Deformed steel reinforcing bars, welded wire fabric, and polypropylene fibers shall be as defined in Section 6 of these Specifications.

9.2.15. Aggregate for Class II Channel Lining. Aggregate for Class II Channel Lining shall be limestone meeting the general requirements of KYTC **Standard** Specifications (**latest edition**). This material shall be produced by using a crusher, grizzly, or sieve with openings of 9 inches and by such additional processing as may be necessary so that no more than 20 percent of the finished product will pass through square openings 5 inches by 5 inches.

9.2.16. Aggregate for Class III Channel Lining and Rip-Rap. Material for Class III Channel Lining and Rip-Rap shall meet the general requirements of **the most current edition of the** KYTC **Standard** Specifications. No less than 80 percent, by volume, of individual stones shall range in size from 1/4 to 1-1/2 cubic feet. Stones of smaller sizes are permissible for use in filling voids in the upper surface and dressing to proper slope.

9.2.17. Aggregate for Mattresses. Aggregate for mattresses shall be hard, durable, clean limestone meeting the general requirements of **the most current edition of the** KYTC **Standard** Specifications. Stone size shall be from three (3) to six (6) inches for nine (9) inch deep units. For units of six (6) inch nominal depth, the stone size shall not exceed four (4) inches unless directed by MSD.

9.2.18. Aggregate Fill for Gabions. Aggregate fill for gabions shall meet the general requirements of **the most current edition of the** KYTC **Standard** Specifications except that stones used shall be from four (4) to eight (8) inches in size for units over 12 inches deep. In units 12 inches deep, stone size shall be from four (4) to six (6) inches, unless otherwise directed by MSD.

9.2.19. Mattress Units. Mattress units shall meet the requirements of **the most current edition of the** KTC **Standard** Specifications, unless otherwise stated in these Specifications. The nominal diameter, after zinc coating, of the mesh wire and lacing wire shall be 0.0866 inches (U.S. Gage No. 13); and of selvage wire shall be 0.1063 inches (U.S. Gage No. 11).

All wire gages are subject to tolerances in accordance with ASTM A 640-1982 Table 3.

An MSD inspector may sample each shipment of mattresses for testing of the wire size and

zinc coating. Any other tests deemed necessary by MSD shall be performed at the Contractor's expense. Other tests may include load test, elongation test, or test of tensile strength in accordance with the following standards:

- (A) TENSILE STRENGTH of all wire used for manufacturing the gabions and lacing wire shall be in accordance with ASTM A 641, measured before fabrication of netting.
- (B) LOAD TEST shall be conducted in accordance with Federal Specifications (QQ-W-461 H Class 3).
- (C) ELONGATION TEST shall be conducted in accordance with Federal Specifications (QQW-461 H Class 3).

Acceptance will be based on laboratory results or visual inspection.

9.2.20. Gabion Baskets. Gabion baskets shall meet the requirements of **the most current edition of the KYTC *Standard*** Specifications. In addition, gabions shall be manufactured in such a manner that their sides, ends, lid and diaphragm(s) can be assembled to form rectangular units of the specified dimensions. The front, base, back and lid shall be woven into a single unit, with ends and diaphragm(s) factory connected to the base. The nominal diameter, after zinc coating, of the mesh wire shall be 0.1180 inches (U.S. Gage No. 11); of selvage wire shall be 0.1535 inches (U.S. Gage No. 9); and of lacing and connecting wire shall be 0.0866 inches (U.S. Gage No. 13).

All wire gages are subject to tolerances in accordance with ASTM 641A-71A (1980) Table 3.

An MSD inspector may sample each shipment of gabion baskets for testing of the wire size and zinc coating. Any other tests deemed necessary by MSD shall be performed at the Contractor's expense. Other tests may include load test, elongation test, or test of tensile strength in accordance with the following standards:

- (A) TENSILE STRENGTH of all wire used for manufacturing the gabions and lacing wire shall be in accordance with ASTM A 641, measured before fabrication of netting.
- (B) LOAD TEST shall be conducted in accordance with Federal Specifications (QQ-W-461 H Class 3).
- (C) ELONGATION TEST shall be conducted in accordance with Federal Specifications (QQW-461 H Class 3).

Acceptance will be based on laboratory results or visual inspection.

9.2.21. Anchor Bars. Anchor bars for mattress units shall be Grade 40, or better, steel reinforcing bars of the dimensions shown on KTC Standard Drawing No.

RDD-030-07.

9.2.22. Geotextile Fabric. Geotextile fabric for use as a filter beneath aggregate channel linings shall be a woven or non-woven fabric consisting only of long chain polymeric filaments or yarns such as polypropylene, polyethylene, polyester, polyamide or polyvinylidene-chloride formed into a stable network such that the filaments or yarns retain their relative position to each other. The fabric shall be inert to commonly encountered chemicals, and free of defects or flaws which significantly affect its physical and/or filtering properties.

The fabric shall be formed in widths of at least 6 feet. Sheets of fabric may be sewn together to form fabric widths as required. The sheets of fabric shall be sewn together at the point of manufacture or other approved locations.

The geotextile manufacturer is responsible for establishing and maintaining a quality control program so as to assure compliance with the requirements of this Specification.

During all periods of shipment and storage, the fabric shall be wrapped in a heavy duty protective covering to protect the fabric from direct sunlight, ultraviolet rays, temperatures greater than 140°F, mud, dirt, dust, and debris.

The Contractor shall furnish, with each shipment of fabric, a Certificate of Compliance from the manufacturer of the fabric. The Certificate shall attest that the fabric meets the chemical, physical, and manufacturing requirements stated in this Specification. The Certificate also shall include actual test results for each physical requirement of this specification, as shown in the following table.

<u>Property</u>	<u>Minimum Value</u> ¹	<u>Test Method</u>
Grab Strength (lbs.)	200	ASTM D 4632
Elongation (%)	15	ASTM D 4632
Sewn Seam Strength ² (lbs.)	180	ASTM D 4632
Puncture Strength (lbs.)	80	ASTM D 3787
Burst Strength (psi)	320	ASTM D 3786
Trapezoid Tear (lbs.)	50	ASTM D 4533
Apparent Opening Size (U.S. Std. Sieve)	Hole Size Equal to or Smaller than a U.S. #40 Sieve (0.425 mm)	Corps of Engineers Standards CW-02215
Permeability (cm/sec)	0.010	AASHTO M 288

Ultraviolet Degradation
at 500 hours

70% Strength Retained for
all Classes

ASTM D 4355

Flow Rate (gal./min./ft²)

40

AASHTO M 288

¹ Minimum. Use value in weaker principal direction. All numerical values represent minimum average roll value (i.e., test results from any sampled roll in a lot shall meet or exceed the minimum values in the table). Stated values are for non-critical, non-severe applications.

² Values apply to both field and manufactured seams.

9.2.23. Fastener Pins. Fastener pins for use when fabric is installed in underdrain systems shall be formed of No. 9 or heavier steel wire and shall be at least 12 inches long with a 4 inch right angle bend on one end.

Fastener pins shall be installed according to manufacturer's specifications. The Contractor will supply a set of specifications for MSD's use.

9.3. EXECUTION OF WORK

9.3.1. Channel and Slope Stabilization

9.3.1.1. General

- (A) Site Preparation and Earthwork: Site preparation and earthwork shall be performed in accordance with Sections 2 and 3 of these Specifications. The area to receive channel lining, ditch lining or slope protection shall be graded and shaped to conform to the cross-sections indicated on the Plans, within a tolerance of plus or minus 0.2 foot from the slope lines and grades.
- (B) Geotextile Fabric: When shown on the Plans or in the Contract, geotextile fabric meeting the requirements of Section 9.2.22. shall be used as a filter between subgrade and aggregate channel lining, rip-rap slope protection mattresses and gabions. The fabric shall be placed in the manner and at the locations shown on the Plans. At the time of installation, fabric will be rejected if it has defects, rips, holes, flaws, deterioration, or damage incurred during manufacture, transportation or storage. The surface to receive the fabric shall be prepared to a relatively smooth condition free of obstructions, debris or sharp objects that may puncture the fabric. Construction equipment will not be permitted to operate directly on the fabric. The fabric shall be protected at all times during construction from contamination by surface runoff and any fabric so contaminated shall be removed and replaced with uncontaminated fabric. Fabric shall be covered within fourteen (14) calendar days after placement; fabric not covered within the time shall be removed and replaced at the Contractor's expense if damage or deterioration is evident, as determined by MSD. Fabric not covered within thirty (30) calendar days after placement shall be removed and replaced at no additional cost to MSD. Field splices at edges or ends of the fabric made by sewing shall be sewn

by use of a portable sewing machine which produces a lock stitch. The thread shall be of a material meeting the chemical requirements specified for the plastic yarn. The adjacent sheets of fabric shall be sewn the full length of the boundary between them. The strength across the seam shall be at least 90 percent of the fabric strength in that direction. Geotextile fabric shall be placed with the long dimension parallel to the channel or toe of slope and shall be laid smooth and free of tension, stress, folds, wrinkles, or creases. If more than one strip is necessary, the strips shall overlap a minimum of 18 inches. Transverse laps shall be placed so that the upstream strip laps over the downstream strip. Horizontal laps shall be placed so that the lower strip laps over the upper strip. Laps may be eliminated provided the joint is sewn as specified.

Fastener pins shall be installed through both strips of overlapped fabric at no less than 5 foot intervals along a line through the midpoint of the overlap, and at any other locations as necessary, to prevent any slippage of the fabric.

The fabric shall be protected from damage due to the placement of the slope protection or channel lining by limiting the height of drop of the material to no greater than 3 feet or by placing a cushioning layer of sand on top of the fabric before dumping the material, at the Contractor's option. The Contractor shall demonstrate that the placement technique will prevent damage to the fabric. Placement of material shall begin at the toe and proceed up the slope.

9.3.1.2. Grassed Channel Lining. Grassed channel lining shall be established in accordance with the seeding or sodding procedures outlined above. When shown on the Plans, erosion control blankets shall be utilized for protection in lieu of mulch and netting.

9.3.1.3. Erosion Control Blankets. Installation requirements shall be in accordance with manufacturer's instructions and the Contract Documents. If any conflict exists between these methods, the more stringent requirements shall be met unless otherwise directed by MSD. Contractor shall submit the manufacturers recommended installation method to MSD for approval. The area to be covered shall be properly prepared, fertilized and seeded in accordance with these Specifications before the blanket is placed. The blanket shall be unrolled in the direction of the water flow. When using two blankets side by side in the ditch, the seam shall not be in the center of the ditch, but offset by 6 to 12 inches. The blanket shall be butted snugly at their ends and sides and secured.

The blankets shall be secured using staples driven vertically in the ground. Four staples shall be used at the start of each roll. Staples shall be placed in rows on each side and in the middle at intervals of 2 feet. Two rows of staples shall be placed alternately between the side and middle row of staples at 2 foot intervals.

9.3.1.4. Turf Reinforcement Mats. Turf reinforcement mats shall be installed in strict accordance with the Contract Documents and the manufacturer's installation requirements. If any conflict exists between these methods, the more stringent requirements shall be met unless otherwise directed by MSD. The Contractor shall submit the manufacturers recommended installation method to MSD for approval. No substitution may be made for the

Turf Reinforcement Mat specified in the Contract unless it is directed by MSD.

9.3.1.5. Class II and III Channel Lining. Channel Lining Class II and III shall be constructed to the dimensions shown on the Plans or directed by MSD. The stone may be dumped in place, and the placing shall be conducted in a manner to produce a surface of approximate regularity, varying no more than 3 inches from a true plane. Hand placing will not be required except as necessary to correct any surface irregularities exceeding the specified tolerance.

9.3.1.6. Rip-Rap Slope Protection. Unless otherwise shown on the Plans or unless solid rock is encountered, rip-rap slope protection shall begin in a trench 2 feet below the natural ground. Where solid rock is encountered, the lower terminus of the slope protection shall be keyed into rock.

Rip-rap shall be constructed to a minimum thickness of 2 feet measured perpendicular to the slope unless otherwise specified in the Contract. The stone may be dumped in place and placing shall be conducted in a manner to produce a surface of approximate regularity not varying more than 6 inches from a true plane.

9.3.1.7. Mattresses. Construction requirements shall be in accordance with the manufacturer's instructions and with these Specifications. If any conflict exists between these methods, the more stringent requirements shall be met unless otherwise directed by MSD. The Contractor shall submit the manufacturer's recommended assembly method to MSD for approval.

In assembling the mattresses, a single mattress base shall first be removed from the bundle, unfolded flat on the ground, and flattened to remove any kinks and bends. The mattress shall then be assembled individually, by erecting the sides, ends and diaphragm(s), ensuring that all creases are in the correct position and the tops of all sides level. The four corners of the mattress shall be laced first, after overlapping the mesh, followed by lacing the edges of the internal diaphragm(s) to the sides. The recommended lacing procedures consist of cutting a length of lacing wire approximately 1 1/2 times the distance to be laced, not to exceed five (5) feet, securing the wire terminal at the corner by looping and twisting, then proceeding to lace with alternating single and double loops at approximately four (4) to five (5) inch intervals.

The assembled mattresses are carried to the job site and placed in their proper location. For structural integrity, all adjoining empty mattresses must be laced along the perimeter of their contact surfaces in order to obtain a monolithic structure.

Mattresses may be filled by almost any type of earth-handling equipment such as backhoe, gradall, crane, etc. Along all exposed mattress edges, the outer layer of stone shall be carefully placed and packed by hand in order to ensure proper alignment and a neat, compact, square appearance. The last layer of stone shall be level with or slightly higher than the top of the mattress to allow proper closing of the lid.

The lids shall be stretched tight over the fill, using crowbars or lid closing tools, until the lid meets the perimeter edges of the front and end panels. The lid shall then be tightly laced along the edges, ends and diaphragm(s) in the same manner as described for assembling mattresses per manufacturer's recommendation. Adjacent lids may be wired down simultaneously. All ends of wire shall be turned into mesh on completion of each mattress.

WELL-PACKED FILLING WITHOUT UNDUE BULGING AND WITH SECURE LACING IS ESSENTIAL IN ALL STRUCTURES.

If the mattress unit is placed on a grade, the placing of the stone shall begin at the bottom of the slope and progress up the grade.

When a complete mattress unit cannot be installed on the slope because of space limitations, the unit shall be cut to fit, in the manner indicated on the Plans.

When mattress units are placed on a 5% or greater grade, or when otherwise required, anchor bars shall be driven in place at the locations shown on the KTC Standard Drawing No. RDD030-07.

9.3.1.8. Gabions. Construction requirements shall be in accordance with the manufacturer's instructions and with these Specifications. If any conflict exists between these two methods, the more stringent requirements shall be met unless otherwise directed by MSD.

Individual gabion baskets shall be assembled by placing flat on the ground, flattening any kinks or bends, and then erecting the sides, ends and diaphragms. All creases shall be in the correct position and the tops of all sides level. The four corners of the gabions shall be laced together with alternating single and double loops at 5 inch intervals, with both sides of the lacing wire secured by looping and twisting. Internal diaphragms shall be installed, and laced in a similar way. Lacing wire should be cut to a length of approximately 1 1/2 times the distance to be laced-not to exceed five (5) feet. Individual assembled baskets shall be placed in their proper location and all adjoining gabions connected. This connection shall be accomplished using individual tie wires looped and twisted at approximately 3 inch intervals along the entire perimeter of the contact surfaces.

Gabions may be filled by almost any means of earth-handling equipment such as backhoe, gradall, crane, etc. Along all exposed gabion faces, the outer layer of stone shall be carefully placed and packed by hand in order to ensure proper alignment and a neat, compact, square appearance.

Each course of gabions shall be stretched to proper alignment by partially filling the first gabion in line for anchorage, and stretching the connected gabions, in increments not to exceed 100 linear feet, using a come-along or other means of at least one-ton capacity. Gabions shall be kept in tension while being filled. Gabion joints shall be controlled to avoid any unraveling. Gabions shall be carefully filled in one-foot layers, in a manner that will minimize voids. Two connecting wires shall be placed in each direction between each layer

in all cells by looping lacing wire around two mesh openings in the front and back face, and in the ends and diaphragms. The ends of the connecting wires shall be securely twisted to prevent their loosening under tension.

Cells in each course of gabions shall be filled in stages, i.e. at no time shall any cell be filled to a depth exceeding one foot more than the adjoining cell. The last layer of stone shall be leveled with the top of the gabion to allow proper closing of the lid and provide an even surface for the next course. Lids shall be stretched tight over the stone fill using crowbars or similar methods, until the lid meets the edges of the front and ends. The lid shall be tightly tied along all edges, ends, and diaphragms in the same manner as required for connecting adjoining gabions.

Succeeding courses of tiers shall be placed and connected as specified for the first course. Baskets for succeeding courses shall be placed so vertical joints are offset at least 18 inches from course to course, unless otherwise shown on the Plans or Standard Drawings. Gabions shall be placed as headers or stretchers in accordance with the Standard Drawings. Each course of gabions shall be tied to the lower course after stretching but before filling, by use of individual tie wires and diaphragms. Vertical edges at each end of the wall that are not connected to an adjoining gabion shall be reinforced by looping and twisting individual tie wires at approximately 3 inch spacing the full length of such edges.

Filter fabric should be used behind the baskets to keep the earthen backfill from washing through the voids.

Place backfill behind gabion walls simultaneously with the gabion construction operation in accordance with Section 3.3.5 of these Specifications.

Care shall be exercised during all gabion wall construction to ensure the stone fill is firmly in place, bulging or distortion of the filled baskets is minimal, and all lacing and tying is thoroughly wound, looped and twisted to preclude loosening in service.

9.3.1.9. Concrete Paved Channels and Ditches

- (A) Subgrade Preparation: Soft or yielding materials shall be removed, replaced with suitable earth materials, and compacted to provide a firm foundation. Material type and method of application shall be submitted by the Contractor and approved by MSD. The subgrade shall be moist when concrete is placed.
- (B) Concrete Work: The requirements for concrete formwork, reinforcement, placing concrete, removal of forms, removal of defective concrete, curing and finishing of concrete as defined in Section 6 of these Specifications shall apply to the construction of concrete channel and ditch lining.
- (C) Drainage: Weep holes, consisting of 4 inch pipe or formed to 4 inches in diameter, covered on the backside with geotextile fabric and stone, shall be placed at horizontal intervals not to exceed 20 feet in concrete paved ditch walls, unless shown otherwise on the Plans. The outlet invert elevations of weep holes in channel walls shall be

placed 4 inches above the water surface level of the channel. Adequate provisions shall be made for thorough drainage of backfill as specified ***KYTC Standard Specifications (latest edition)*** or as shown on the Plans.

- (D) **Joints**: Transverse expansion joints shall be provided as shown on the Plans or Standard Drawings in concrete channels and at all existing concrete structures and as instructed by MSD. Expansion joints shall be constructed at right angles to the centerline of the channel and throughout the channel bottom and sidewalls in conformance with the Plans. The thickness of the preformed expansion joint material shall be as directed by MSD and shall be to the full depths of the slab and walls. Formed or sawed transverse contraction joints (**1/2" to 1" deep**) will be required at 20 foot maximum intervals along concrete paved ditches. Contraction joints shall be placed or installed as soon as the concrete initial set will allow.
- (E) **Reinforcement**: Steel reinforcing bars shall be used as reinforcement in vertical sidewalls and slabs for concrete channel lining. Polypropylene fibers shall be used as reinforcement in concrete ditch or sloped channel wall lining unless shown otherwise on the plans.
- (F) **Finish**: Sidewalls for concrete paved channels shall be given an ordinary surface finish and the bottom slab shall be given a floated surface finish as defined in Section 6 of these Specifications. Concrete paved ditches shall be given a floated surface and broom finish. Concrete paved channels shall be tool edged when finishing.
- (G) **Concrete Storm Drains**: Existing and new storm drains intercepted by the channel shall be formed into sidewalls and cut off flush and smooth with the inside face of the wall so as to not leave obstructions along the wall. Channel sidewalls shall be poured monolithically around pipe sections. Intercepted drains shall be oriented at right angles to the wall or skewed in the direction of the channel flow. The steel reinforcement shall be placed around each pipe end as it intersects the channel wall in accordance with the Plans. Existing pipe intercepted by the channel shall be extended as required for proper connection and pipe extensions will be of the same material as the existing pipe.
- (H) **Backfilling**: Immediately after the concrete has set sufficiently and the forms have been removed, the spaces on each side of the ditch paving shall be filled with suitable earth material and thoroughly compacted. Full backfill behind vertical channel sidewalls shall not be placed until representative test samples of the concrete used in the channel lining attain a compressive strength of 3,500 pounds per square inch. In addition, the concrete shall have been placed a minimum of seven days. Backfill shall be brought up simultaneously behind the sidewalls to maintain uniform loading. Placement and compaction of the backfill shall be in accordance with Section 3 of these Specifications.

9.3.2. Site Restoration

9.3.2.1. General

- (A) Planning: The Contractor shall notify MSD at least 48 hours in advance of the time he intends to begin sowing seed or placing sod and shall not proceed with such Work until permission to do so has been granted by MSD. Before starting seeding or sodding operations on any area, final dressing and the preparation of the seed bed or sod bed shall have been completed in accordance with these Specifications. All seeding, sodding and related operations shall be continuous operations. The following schedule shall be followed for seeding or sodding operations, unless otherwise permitted or directed by MSD.

<u>Work Item</u>	<u>Accepted Work Interval</u>
Permanent Seeding	Feb. 15 to May 15 or August 15 to Nov. 1
Native Seeding See	12.3.6.2.
Sodding	See 9.3.2.4.

- (B) Scheduling: By August 1, the Contractor shall provide a plan to restore disturbed areas by October 31; such plan to be implemented upon approval by MSD.

Likewise, by February 1, a plan to restore disturbed areas by May 30 shall be submitted for implementation upon approval by MSD.

- (C) Replacement of Vegetation: As soon as backfill operations permit, the Contractor shall replace, to the original location or nearest suitable location, all ornamental or landscape plants designated to be replaced, which were removed during excavation for the sanitary or storm drainage facility. The Contractor shall properly water and maintain the transplanted vegetation immediately upon replanting and at suitable intervals thereafter. If shrubs, plants, or trees die after transplanting and before the expiration of the guarantee period, the Contractor shall, at his expense, replace same with equal shrubbery, plants or trees.

- (D) Replacement of Fences: Any fences disturbed within the right-of-way/easement limits shall be replaced to the satisfaction of MSD at no additional cost to MSD. Fences in such poor condition that they cannot be removed and replaced shall be replaced with fence material similar in original quality, size, and appearance to the removed fence, or a written release shall be obtained from the property owner and a copy provided to MSD.

- (E) Restoration of Turfed Areas: After final restoration of settled trench and/or graded surfaces, all areas within the right-of-way or easement limits which were established turfed areas prior to construction will be restored in accordance with these Specifications unless otherwise provided in the Contract. ***See Section 9.3.2.2 for information about topsoil placement.***

- (F) Restoration of Curb, Curb and Gutter, and Sidewalk: The Contractor shall replace, to the original location, all curb, curb and gutter, and sidewalk sections disturbed within the right-of-way/easement limits.

- G) Native Plant Restoration: Refer to Sections 12 and 13 of these specifications.

9.3.2.2. Topsoil Placement

- (A) Topsoil Replacement. Topsoil shall be replaced at no additional cost to MSD.
- (B) Site Preparation. Maintain grades on the areas to be topsoiled according to the Plans. Adjust grades and elevations for receipt of topsoil.
- (C) Subsoil Roughening. Immediately prior to spreading topsoil, loosen the subgrade by disking or scarifying to a depth of at least 4 inches to ensure bonding of the topsoil and subsoil. If no amendments have been incorporated, loosen the soil to a depth of at least 6 inches before spreading topsoil.
- (D) Spreading Topsoil. Uniformly distribute topsoil to a minimum compact depth of 2 inches on 3:1 slopes and 4 inches on flatter slopes. Do not spread topsoil while it is frozen or muddy or when the subgrade is wet or frozen.

Correct any irregularities in the surface that result from topsoiling or other operations to prevent the formation of depressions or water pockets.

Compact the topsoil enough to ensure good contact with the underlying soil, but avoid excessive compaction as it increases runoff and inhibits seed germination. Light packing with a roller is required where high-maintenance turf is to be established.

9.3.2.3. Permanent Seeding

- (A) Preparing the Seed Bed for Turf and Natural Areas: Each area to be seeded shall be scarified, disked, harrowed, raked, or otherwise worked until it has been loosened and pulverized to a depth of not less than three inches. Stones and other foreign materials shall be removed. This operation shall be performed only when the soil is in a tillable and workable condition. Grade 10-10-10 fertilizer, at the rate of not less than 25 pounds per 1,000 square feet, and agricultural limestone, at the rate of not less than 100 pounds per 1,000 square feet, shall be distributed evenly over the seed bed, unless other requirements are shown on the Plans or in the Contract. The limestone and fertilizer shall be lightly harrowed, raked, or otherwise incorporated into the soil for a depth of approximately one-half inch. Fertilizer need not be incorporated in the soil as specified above when mixed with seed in water and applied with hydraulic equipment. The Contractor shall apply the seed, fertilizer and mulch within 24 hours of preparing the seed bed. The lime/fertilizer rates shall not relieve the Contractor of his responsibility to provide the proper amounts of these materials. The Contractor is encouraged to have soil analyses performed (at the Contractor's expense) to establish proper lime/fertilizer rates so that satisfactory turf growth is promoted.
- (B) Seeding for Turf: Permanent seed shall be sown as soon as preparation of the seed bed has been completed and thoroughly watered after seeding. Care shall be

exercised not to wash seeding by overwatering. Seed shall be sown uniformly by means of a rotary seeder, wheelbarrow seeders, hydraulic equipment, or other satisfactory means, and unless otherwise shown on the Plans or in the Contract, at the rates indicated in Section 9.2.4. Permanent seeding shall be performed only when the soil is in a tillable and workable condition, and only during the acceptable work intervals given in Section 9.3.2.1 (A) of these specifications, unless otherwise permitted or directed by MSD.

- (C) Seeding for Natural Areas: Seeding shall be done, weather permitting, within seven days of all topsoiling. Do not seed if soil is excessively dry or is saturated. Seed during favorable weather conditions. Mix seed with two-thirds of a bushel of moist vermiculite or one-half rate of seed oats per acre prior to sowing. No covering of seed with soil is required. Seeding shall be performed by one of these methods:

Hand Broadcasting: Hand broadcast seed over open area by walking and sowing seed first in one direction, then walking perpendicular to the first direction while sowing the remaining seed for that area. Rake lightly or drag area to cover seed no deeper than ¼ inch. Roll seeded areas with a water filled roller upon completion of seeding.

Mechanical Power Drawn Seeder: Sowing shall be performed by a mix mechanical power drawn broadcast seeder capable of uniformly mixing and broadcasting all seed sizes listed in the seed mix. Seed to be planted not deeper than ¼ inch. Seeding operation shall be kept as close as possible to the contours and not up and down slopes. After seeding, cover seed using drag mat. Then compact with land roller, such as a cultipacker or equivalent. With proper equipment, drag matting and cultipacking in one operation is satisfactory.

- (D) Protection for Turf: Placing of materials for protection shall follow seeding as soon as possible, and no later than 48 hours after seeding. In no instance shall the mulch be placed on crusted seeded areas, and any eroded areas shall be repaired and reseeded before protection is applied. The materials shall be placed uniformly, all clumps loosened and scattered, and care shall be taken to avoid thicker applications than those specified.

After the seeding has been satisfactorily completed, the following methods of protection shall be used:

Straw Mulch Crimping: Straw mulch may be crimped or punched into the soil to a depth of 2 inches to 4 inches using a mulch anchoring tool or a dull, serrated farm disk that is set straight. Crimping shall not cut the mulch. This method shall be used in flat areas and on slopes no steeper than 3H:1V and only where equipment can be operated safely. Machinery shall be operated on the contour. Straw mulch material shall be applied at a rate of 90 lbs per 1,000 square feet.

Straw Mulch and Netting: This method shall be used on slopes 3H:1V or steeper.

Installation of the netting shall be in accordance with the KTC Standard Drawing No. RRE002-03. Straw mulch material used under netting shall be plain straw and shall be applied at the rate of 90 lbs per 1,000 square feet.

Tackifier: When approved by MSD, synthetic/chemical binders and tackifiers may be used in lieu of the above methods for protecting seeded areas. No asphalt emulsions shall be allowed.

Hydromulch: When approved by MSD, hydromulch may be used in lieu of the above methods for protecting seeded areas. Wood cellulose fiber mulch shall be applied at the rate of 40 pounds per 1,000 square feet. This method is not acceptable for native seeding.

Erosion Control Blankets: Manufactured erosion control blankets (straw, coconut fiber, wood fiber, etc.) shall be utilized when shown on the Plans, as directed by MSD, or at the Contractor's option in lieu of straw mulch or hydromulch. The areas to be covered shall be properly prepared, fertilized and seeded in accordance with these Specifications before the blanket is placed. The blankets shall be installed according to the manufacturer's specifications. In general, however, the blankets shall be unrolled in the direction of surface water flow. When using two blankets side by side in a ditch, the seam shall not be in the center of the ditch, but offset by 6 to 12 inches. Individual blanket rolls shall be butted snugly at their ends and sides, and properly secured. The blankets shall be secured using staples driven vertically in the ground. Staple patterns should be in accordance with the manufacturer's specifications. Loose blanket edges shall be stapled and buried in trenches according to the manufacturer's specifications.

Use only the specified erosion control blankets or blankets that meet or exceed their specifications when they are specified on the Plans or in the Contract. When the Contractor elects or is directed to use erosion control blankets to achieve improved protection over conventional mulching and netting or hydromulch, the following guidelines shall be used to select the appropriate blanket type:

<u>Blanket Type</u>	<u>Comments</u>
Straw/Netting Matrix	Generally provides effective protection for 2H:1V to 4H:1V slopes, or low flow swales. Usually degrades in 30 to 90 days, depending on product.
Straw/Coconut/Netting Matrix	Generally provides effective protection for 2H:1V to 1H:1V slopes of medium flow channels. Can provide protection for 6 months to more than one growing season, depending on the product.
Coconut/Netting Matrix	Generally provides long lasting protection (up to 2

years) for slopes of 1H:1V or steeper, or for high discharge channels, depending on the product.

Wood Fiber/Netting Matrix Light to heavy duty wood fiber blankets are available with short to long term protection capabilities, similar to coconut/straw blankets.

Seed-Incorporated Erosion Control Blankets: Seed-incorporated erosion control blankets (straw, coconut fiber, wood fiber, etc.) shall be utilized when shown on the Plans, as directed by MSD. The areas to be covered shall be properly prepared and fertilized in accordance with these Specifications before the blanket is placed. The blankets shall be installed according to the manufacturer's specifications and the requirements given under Item 9.3.2.3(D) of these specifications.

- (E) Stage II Topdressing: A second application of slow release fertilizer (Grade 20-10-10) shall be applied to seeded areas no sooner than 6 weeks after seeding, but not until a satisfactory stand of vegetation exists. For spring seedings, the fertilizer shall not be applied after May 1, and for fall seedings, the fertilizer shall not be applied after December 1. For spring seedings performed during the period of March 15 to May 15, the Stage II fertilizer shall not be applied until after September 1. The fertilizer shall be distributed evenly over the new grass area at a rate of 12 pounds per 1,000 square feet.
- (F) Maintenance and Repair: For turf areas, all seeded areas shall be cared for and maintained properly to MSD's satisfaction until final acceptance of the Work and for the duration of the guarantee period. Such care shall include, but not be limited to, watering as necessary, fertilizing, reseeding and repairing of mulch materials as required, and mowing the seeded areas when required by MSD. When mowing is required, mower blades shall be set at 3 inches for sufficient height to protect the vitality of the growth. Areas which have been previously seeded and mulched in accordance with this Section, but which have been eroded, damaged or failed to successfully establish a stand of grass, shall be repaired as directed by MSD. All material and labor required to maintain and repair seeded areas shall be furnished by the Contractor at no cost to MSD. If MSD directs the Contractor to place additional fertilizer on the area to be reseeded, an additional 4 pounds of agricultural limestone will be required for each additional pound of fertilizer. Natural (native grasses and forbs) areas shall not be mowed.

9.3.2.4. Sodding

- (A) Cutting Sod: Prior to cutting sod, the grass shall be mowed to a height of no more than 3 inches and the mowed area shall be raked to eliminate all clippings, cuts and trash. The sod shall be cut in rectangular sections as required. Sections may vary in length not exceeding 8 feet, but shall be of uniform width of 10 inches or more, and shall be cut to a depth of at least 1 inch and no more than 2 inches. The sod shall be cut to such thickness that practically all of the dense root system will be retained but exposed in the sod strip, and to such width and length so that it can be handled

without undue tearing and breaking. When cut in strips, the sod shall be rolled without damage with the grass folded inside.

The sod shall be cut by means of an approved mechanical sod cutter. During dry weather, the sod shall be watered before cutting to prevent loss of soil while handling. The sod shall not be cut when in a sufficiently wet condition which could interfere with proper handling. All sod must be delivered to the Project and placed within 18 hours after being cut.

- (B) Preparation of Sod Bed: The sod bed shall be loosened to a minimum depth of one inch and shaped to a smooth even surface and shall be graded to such elevation so the sod, when in place, shall be flush with any adjacent seeded or turfed area, pavement, curb, or other structures, except when otherwise directed.

Prior to placing the sod, the fertilizer (Grade 10-10-10) and limestone shall be applied uniformly at the rate specified in Subsection 9.3.2.3; and shall be harrowed, raked, or otherwise incorporated into the soil. The sod bed, when dry, shall be moistened to the loosened depth.

- (C) Placing Sod: Sod shall be placed within 18 hours of being cut and it shall not be placed when the atmospheric temperature is below 32°F, or when the sod or sod bed is frozen, or during other weather or soil conditions detrimental to the Work.

The sod shall be carefully placed by hand so that each section closely joins the adjacent section without overlapping. All open spaces or gaps shall be plugged with sod cut to the appropriate size and shape. When placed on slopes, the sod shall be laid with the long edges of the strips parallel to the contour starting at the bottom of the slope. Successive strips shall be neatly matched and all joints staggered or broken. The sodding shall be carried at least 18 inches beyond the top of the slope to prevent surface water from undermining the sod.

When placed on slopes 2H:1V or steeper and 6 feet or more in height, and in all sodded ditches, each strip or section of sod shall be staked securely with at least 2 wood stakes or wire staples no more than 2 feet apart and driven flush with the surface. Wire staples shall not be used in residential areas.

The sod, after it is placed, shall be wetted thoroughly and tamped or rolled sufficiently to incorporate the roots into the sod bed and to ensure tight joints between the sections or strips.

- (D) Maintenance and Repair: The sod shall be watered as frequently as necessary to maintain and assure it in a moist and living state. After a period of two weeks, or as otherwise directed by MSD, but not during June, July or August, 20-10-10 fertilizer shall be applied at the rate of 6.0 pounds per 1,000 square feet, and the sod given an additional watering to enhance growth. The Contractor shall not allow any

equipment or material to be placed on any sodded area and shall erect suitable barricades and guards to prevent his equipment, labor, or the public from traveling on or over any area planted with sod. Care shall include periodic watering, fertilizing and mowing as necessary to maintain the vitality and appearance of the sod. When mowing is required, mower blades shall be set at 3 inches for sufficient height to protect the vitality of the growth. Sodded areas that become eroded, damaged or failed to successfully establish a stand of grass, shall be repaired and/or replaced as directed by MSD. All material and labor required to maintain and repair sodded areas shall be furnished by the Contractor at no cost to MSD. Sod must be living at the time of final acceptance of the Project and through the duration of the warranty period.

9.3.3. Clean Up

9.3.3.1. Daily Clean Up. During the progress of the Work, the Contractor shall daily maintain all areas within the limits of his operations from accumulations of waste materials, rubbish and other debris resulting from the Work.

9.3.3.2. Final Clean Up. Before final acceptance of the Work, all rights-of-way, easements, and access roads used by the Contractor, all streams in and over which he has worked, and all ground occupied by the Contractor in connection with the Work shall be cleaned of all debris, construction plant, and materials. Right-of-way and easement areas not designated for alteration by the Contract shall be restored to their original condition in accordance with the Plans and Specifications. Areas which have been sodded or seeded and mulched in accordance with this Section, but which have been eroded, damaged or failed to successfully establish a stand of grass, shall be repaired as directed by MSD. Waste and debris shall be disposed of in areas approved by MSD and provided by the Contractor outside of the rights-of-way and easements.

SECTION 10

MSD STANDARD SPECIFICATIONS

DUPLEX SEWAGE PUMP STATION

10.1 GENERAL

10.1.1 Work Included

- A. These specifications cover the work necessary to furnish, install, and complete a duplex submersible non-clog or grinder pump station to MSD's Standards. These specifications are in addition to MSD's Standard Specifications which are referred to by section number throughout this specification.
- B. The Work to be accomplished under this Section of the Specifications consists of furnishing all labor, materials, equipment, and services necessary for the construction of a duplex pump station and valve vault as shown on the Contract Drawings. The facility components shall include, but not necessarily be limited to, two (2) submersible raw sewage pumps; pump discharge connections; guide rails; bottom, intermediate, and upper guide rail supports; lifting cables; discharge piping, valves, and supports; aluminum access hatches; vents; liquid level sensors; electrical controls; and any other items required to make the installation function per its design intent. All components shall be installed in, on, or near a precast concrete wet well basin and valve vault. The structures and dimensions shall be as shown on the Contract Drawings.
- C. The following major Work items are included in the Contract:
 - 1. Site work.
 - 2. Construction of new pump station, valve vault, and appurtenances.
 - 3. Installation of a new electrical service.
 - 4. Installation of a standby generator, if required.

10.1.2 Definition of Engineer

- A. For the purposes of reviewing submittals and interpreting MSD's standard drawings, specifications, policies, and procedures, the term "Engineer" shall mean the person holding the position of *Director of the Engineering Division* of MSD or any person whom MSD may designate to act in place of said *Director*.
- B. For matters concerning design, cost, and general professional judgment, the term "Engineer" or "Design Engineer" shall mean the Kentucky Registered Professional Engineer *hired by the developer or client to design and supervise the project*.

10.1.3 Contractor Requirements

- A. *The Contractor shall become familiar with all details of the Work, shall verify all dimensions in the field, and shall advise the Engineer of any discrepancies before initiating the Work.*
- B. *The Contractor shall use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the Work of this Section.*
- C. *The Contractor shall use equipment adequate in size, capacity, and numbers to accomplish the Work of this Section in a timely manner.*
- D. The Contractor shall comply with the permit and code provisions contained in these specifications.
- E. The Contractor shall submit certified shop and erection drawings and data regarding pump and motor characteristics and performance. The data shall include performance curves, based on actual shop tests of pumping units, which show that the units meet the specified requirements for head, capacity, efficiency, and horsepower for the various capacities specified. Except as hereinafter specified, certified tests of mechanically duplicate units will be acceptable. Curves shall be submitted on 8-1/2-inch by 11-inch sheets. For units of the same size and type, only curves for a single unit need **to** be provided.
- F. The Contractor shall submit complete shop drawing packages and operation and maintenance manuals in accordance with Section 1.07 of these specifications.

10.1.4 Permits and Approvals

- A. Obtain any permits and inspections related to or required by the Work in this Contract. *The Contractor is advised that Special Conditions as required by the U.S. Government are included in this Contract.*
- B. The Contractor shall furnish electrical inspection by an agency licensed or otherwise qualified to perform electrical inspections in the Commonwealth of Kentucky.
 - 1. All costs incidental to the electrical inspection shall be borne by the Contractor.
 - 2. The Contractor shall provide a Certificate of Compliance with NEC after final approval by the electrical inspector. Final acceptance will be withheld until he has presented the Engineer with the aforementioned Certificate of Compliance.

10.1.5 Codes and Standards

- A. Comply with applicable codes and regulations of authorities having jurisdiction. Submit copies of inspection reports, notices, citations, and similar communications to MSD.
- B. All electrical equipment and details of installations shall comply with the requirements of the latest editions of the National Electrical Code (NFPA-70), the National Electrical Safety Code (ANSI C2), OSHA, KYOSHA, and all applicable codes.
- C. **Pump stations must satisfy the regulations of agencies having jurisdiction. Pump stations, at a minimum, shall conform to this specification, MSD's Miscellaneous Electrical, Instrumentation & Control Design Standards, and to the Recommended Standards for Wastewater Facilities, 2004 Edition (Ten State Standards).**

10.1.6 System Characteristics

- A. Duplex Station.
- B. Non-clog or Grinder Pump.
- C. Pump Rating:
 - 1. _____ HP.
 - 2. _____ volts.
 - 3. _____ phase.
 - 4. _____ amps.
- D. Service Rating:
 - 1. _____ volts.
 - 2. _____ phase.
 - 3. _____ amp.
 - 4. _____ wire.
- E. Design Operating Point:
 - 1. _____ gpm.
 - 2. _____ TDH (feet).
 - 3. _____ % hydraulic efficiency.
- F. Shut-off head: _____ TDH.
- G. Third operating point: _____ gpm, _____ TDH.
- H. Discharge diameter: _____-inch.
- I. Solids passing size: _____-inch.

- J. Cycle time: _____ min.; Running time: _____ min./hour.
- K. Maximum operating speed: _____ RPM.
- L. Manufactured by: _____.
- M. Model _____, or approved equal.
- N. Force main pressure rating: _____ psi.

10.1.7 Submittals

A. Shop Drawing Submittals

1. Prior to submitting the manuals described below, the Contractor shall submit seven (7) complete sets of shop drawings to MSD for review and approval. The shop drawings shall be tailored to the specific project details and shall include, but not necessarily be limited to, the following information:
 - a. Pump manufacturer's literature indicating model, double guide rails, and hardware.
 - b. Electrical schematics; electrical components; cut sheets; feeder, branch, and control conductors; disconnect switches; fuses, circuit breakers, and overloads; raceways and fittings; enclosure component layout; and complete motor nameplate data.
 - c. **Generator and transfer switch.**
 - d. Wet well base, barrel, and top.
 - e. Vent piping.
 - f. Access hatches (wet well and valve vault).
 - g. Piping (force main and pump station), piping supports, watertight through-wall pipe connections, couplings, fittings, and scaled fabrication drawings.
 - h. Valve vault top, base, and barrel.
 - i. Swing check valves, gate valves, ball valve at gauge connection, PVC check valve on drain line between valve vault and wet well, and air release valve.
 - j. Pressure gauge.
 - k. Air release and cleanout vaults (top, bottom, base, frame, lid, and watertight through-wall pipe connections).
 - l. Concrete and grout mix designs and mix design support history.
2. Additional information may be requested by MSD at any time for clarification.

B. Operation and Maintenance Manual

1. The operation and maintenance manual (O&M Manual) shall be a thorough and useful reference source for training, educating, and assisting MSD personnel in the operation and maintenance of the pump station facility. The information

contained in the manual shall specifically address the equipment supplied and shall contain no superfluous material. Both the draft and final versions of the O&M Manual shall be bound in suitably labeled, hard cover, 3-ring binders furnished with indexes and tabbed dividers between subject matter.

2. Four (4) copies of the draft version of the O&M Manual shall be delivered to MSD for review and comments as soon as possible after approval of the shop drawings. The draft manual shall include, but not necessarily be limited to, the following information:
 - a. Complete operating instructions.
 - b. Complete parts list (including catalog numbers), parts catalogs, and assembly drawings.
 - c. Preventive maintenance schedules.
 - d. Maintenance and alignment instructions.
 - e. Troubleshooting guides.
 - f. A list of complete nameplate data for each piece of equipment supplied.
 - g. The necessary figures, tables, and wording to supplement the material listed above.
 - h. Complete listing of manufacturers' **and local suppliers'** names; addresses; telephone numbers; **fax numbers; and web site addresses for pumps, valves, alternating relays, motor starters, and where applicable, generator and transfer switch.**

Two (2) copies of the marked up draft O&M Manual will be returned to the Contractor so that any corrections, additions, or deletions can be incorporated into the final version.

3. **Seven (7)** copies of the final O&M Manual must be delivered to and approved by MSD prior to acceptance of the pump station. The final version of the document shall have been revised to satisfactorily address the draft review comments and to incorporate the final record drawings of the control panel, pump station, valve vault, and appurtenances.

10.1.8 Approval and Making of Equipment

Electrical devices and materials shall be listed and/or labeled by the Underwriters' Laboratories, Inc.

10.1.9 Protection of Electrical Equipment

Electrical equipment shall be protected from the weather, especially from water dripping or splashing upon it, at all times during shipment, storage, and construction. Equipment shall not be stored outdoors even if its enclosure is rated as weatherproof, watertight, etc. Where equipment is installed or stored in moist areas, such as unheated buildings, etc., it shall be provided with an acceptable means of preventing moisture damage such as a uniformly distributed source of heat to prevent condensation.

10.1.10 Defective or Damaged Equipment

- A. Should it be determined by the Contractor, MSD, or Engineer that any equipment or material has been subjected to possible damage by water, it shall be thoroughly dried and put through a dielectric test as directed by the manufacturer and at the expense of the Contractor, or it shall be replaced ***by the Contractor without change in contract price***. Any equipment found to be marginal or that fails to meet manufacturer's standards shall be replaced at no additional charge to MSD.
- B. Any equipment damaged during shipment, while stored, or during construction shall be replaced ***at the Contractor's expense***. Minor scratches on equipment cabinets, etc. may be repaired on site. Any current carrying parts, switch blades, operators, coils, contacts, etc., which are damaged, shall be replaced at no cost to MSD.

10.1.11 Electrical Service

- A. The Contractor shall obtain and install a complete electrical service with new service equipment. The new equipment connections and conduit shall be sized for the application, and the service shall meet the requirements of the National Electrical Code (NEC), latest edition, and Louisville Gas and Electric.
- B. The Contractor shall make all necessary arrangements for transfer of power by Louisville Gas and Electric.

10.2 PRODUCTS

10.2.1 General

- A. Since each pump station has its own set of characteristics based on the pump model selected in the design and since it is prohibitive to prepare design specifications and drawings for each pump model approved by MSD, these Specifications and Standard Drawings have been prepared based on the constraints given for a particular pump model. This is not intended to prevent **the** use of other pump models or equipment approved by MSD but is intended to establish the standard of quality and general configuration of the equipment desired.
- B. Should the Contractor propose to supply a different pump model or type of equipment which has previously been approved by MSD, the Contractor shall revise the pump station Drawing(s) and Specification(s) by red lining the revisions to detail them to meet the characteristics of the proposed pump system for MSD's review and approval. Any changes shall first be approved by the Engineer prior to submittal to MSD for review.
- C. If approved by MSD, all revisions shall be shown on the final record drawings and be included in the O&M Manual, which must be furnished prior to final acceptance of the pump station.

- D. Pump models and equipment not previously approved by MSD must be reviewed by MSD's "New Products Review Committee" and must have received final approval by MSD *prior to bid* in order to be considered for approval. The proposed product(s) for review shall be subject to conditions set forth by the committee. *Requests for time extensions due to MSD's "New Products Review Committee" review process will not be considered.* As a condition of final approval, manufacturer must provide maintenance training and literature sufficient for manufacturer certification of MSD maintenance personnel as qualified technicians for repair of manufacturer's Class I, Division 1 or 2, pumps. Unless notified otherwise in writing by MSD, training must take place within 6 months of initial approval, else initial approval is void.

10.2.2 Standard Products

Material and equipment shall be new, shall be the standard products of a manufacturer regularly engaged in the manufacture of the products, and shall essentially duplicate items that have been in satisfactory use at least two (2) years *prior to the bid opening*.

10.2.3 Nameplates

Two nameplates shall be supplied for all pumps and motors. These nameplates shall have the manufacturer's name, address, type or style, model or serial number, catalog number, design flow in gpm, total dynamic head in feet, power in horsepower, voltage, phase, rotational speed in rpm, full load current in amperes, and safety factor stamped on them. One nameplate shall be secured to the item of equipment, and the other shall be given to the Engineer.

10.2.4 Equipment Guards

Belts, pulleys, chains, gears, projecting set screws, keys, and other rotating parts, so located that any person may come in close proximity thereto, shall be enclosed or guarded per OSHA standards.

10.2.5 Padlocks

Upon acceptance of the pump station by MSD, MSD will provide and install padlocks to secure the facility.

10.2.6 Piping

- A. The pipe inside the pump station wet well and valve vault shall be either stainless steel or ductile iron as indicated on the Contract Drawings.

1. Stainless steel pipe and fittings shall conform to ASTM A167, Type 304.

- a. Pipe shall be Schedule 40, and fittings shall be Schedule 80.
- b. Joints shall be threaded or flanged.

2. **Ductile iron pipe and fittings shall be Class 53 conforming to Section 4.2.2.2. of the MSD Standard Specifications.**

- a. **Joints shall be flanged.**
- b. **Pipe and fittings shall be cement lined.**

3. **Flanges shall be Class 125; flange bolts shall be stainless steel ASTM A193, Grade B-8, Type 304; and flange gaskets shall be 1/8-inch ring gaskets.**

- B. A detailed and scaled shop drawing of the piping, fittings, valves, etc. shall be submitted for approval when necessary for clarity.
- C. The installed discharge piping, valve system, and force main shall meet the testing requirements described in MSD's Standard Specification Section 4.3.5.4. Hydrostatic Tests for Force Mains. The Contractor will be required to perform both pressure and leakage tests to ensure conformance to the testing requirements of the preceding paragraph if the pressure test fails.

10.2.7 Vent Pipe

- A. The vent pipe shall be Schedule 40 steel pipe, ASTM A53, with butt weld, standard weight Grade B fittings, ASTM A234. A stainless steel insect/bird screen shall be provided on the vent. The vent pipe shall be painted with one (1) coat **of** Pittsburgh Paint red inhibitive primer UC 30003 and two (2) coats of **black** Pittsburgh Paint 97-600 series fast dry enamel or approved equal.
- B. A prefabricated vent such as The Green Vent (4-inch pipe diameter) is also acceptable.

10.2.8 Sewage Pump General Design

- A. Non-clog pumps shall be submersible, centrifugal type designed to pump raw, unscreened sewage containing solids and stringy materials.
- B. Grinder pumps shall be submersible, centrifugal type designed to macerate and pump raw, unscreened sewage containing solids and stringy materials.
 - 1. The grinder assembly shall consist of a grinder impeller and a shredding ring and shall be mounted directly below the volute passage. The grinder impeller shall be threaded onto the stainless steel shaft and shall be locked with a screw and washer. The shredding ring shall be pressed onto an iron holding flange for easy removal. The flange shall be provided with tapped backoff holes so that screws can be used to push the shredding ring from the housing. All grinding of solids shall be from the action of the impeller against the shredding ring.
 - 2. Both the grinder impeller and the shredding ring shall be of #440 stainless steel hardened to 58-60 Rockwell C.
 - 3. The grinder unit shall be capable of macerating all materials found in normal domestic and commercial sewage, including reasonable amounts of foreign

objects such as wood, plastic, glass, rubber, sanitary napkins, disposable diapers, panty hose, and the like, to a fine slurry that will pass freely through the pump and the discharge piping.

- C. The raw sewage pumps shall be capable of continuous operation under submerged or dry motor conditions without adverse effects due to heat generation. In addition, the pumps shall be capable of adequate cooling when they are left running with the liquid level lowered to the pump suction inlet to help clean the wet well. Pumping units which require a connection to an external cooling water source to dissipate the heat generated under the conditions specified above will not be acceptable.
- D. Each pump shall be supplied with a mating discharge stand which shall be permanently installed in the wet well along with the discharge piping. There shall be no need for personnel to enter the wet well. The pumps shall be automatically connected to their discharge stands when lowered into place and shall be easily removed for inspection and service. No portion of the pump shall bear directly on the floor of the wet well.
- E. Connection of the pump to its discharge stand shall be accomplished by a simple linear downward motion of the pump along a rail mounted installation system as specified under Section 2.17 herein. For non-clog applications, the rail system shall be comparable to the **Pumpex** design and shall be compatible for reuse with the pumping units of other manufacturers.
- F. The pumps shall be certified explosion proof for installation in Class 1, Division 1, Group D environments by Factory **Mutual, UL, CSA, or other appropriate governing authorities having jurisdiction.**

10.2.9 Pump Casing

- A. Pump casing shall be constructed of cast iron, ASTM A48, Class 30. The casing shall be of uniform quality and free from blow holes, porosity, hard spots, shrinkage cracks, and other injurious defects. The casing shall be capable of withstanding an operating pressure 50 percent greater than the maximum calculated operating pressure. The volute shall have smooth passages which provide unobstructed flow through the pump.
- B. Watertight mating surfaces shall be machined and fitted with nitrile rubber O-rings such that sealing is accomplished by metal-to-metal contact between the mating surfaces, resulting in proper compression of the O-rings without the requirement of specific torque limits.
- C. Exterior surfaces of the casing in contact with sewage shall be protected by a sewage resistant coating. All exposed nuts and bolts shall be AISI stainless steel, **Type 304.**

10.2.10 Impeller

- A. The pump impellers shall be dynamically balanced.
- B. Grinder pumps shall have recessed impellers designed to handle ground slurry without clogging or binding.
 - 1. Impellers shall be of 85-5-5-5 bronze.
 - 2. Impellers shall be threaded onto the pump shafts.
- C. Non-clog pumps shall have channel type impellers designed to handle solids, fibrous materials, sludge, and other items normally found in raw wastewater. Recessed vortex type impellers may be acceptable when specific circumstances warrant; however, their use in typical installations should be avoided due to the reduced hydraulic efficiency of the equipment.
 - 1. Impellers shall be of Grade 60-45-15 ductile iron, ASTM A395.
 - 2. Impellers shall be slip fit and keyed to the pump shafts whereby they cannot be loosened by torque from either the forward or reverse direction.
 - 3. The pumps shall be capable of passing a minimum 3-inch diameter solid sphere.

10.2.11 Pump Shaft

The pump shafts shall be stainless steel of the AISI type recommended by the pump manufacturer. The shafts shall be of adequate size and strength to transmit the full driver horsepower.

10.2.12 Seals

A tandem mechanical shaft seal system running in an oil bath shall be provided. Upper seals shall be carbon/ceramic with the lower seals being tungsten carbide/tungsten carbide. Each seal interface shall be held in contact by its own spring system. Conventional mechanical seals which require a constant pressure differential to effect sealing will not be allowed.

A sensor shall be mounted in the lower end of the seal chamber to detect any water leakage into the seal chamber. The sensor shall provide a discrete signal for shutting off the pump. Sensors that detect water leakage into the motor housing in lieu of the seal cavity are not acceptable.

10.2.13 Bearings

Pump bearings shall be ball or roller type designed to handle all thrust loads in either direction. Pumps depending only on hydraulic balance end thrust will not be acceptable. Bearings shall have a minimum B-10 life of 50,000 hours.

10.2.14 Motor

- A. The watertight pump motors shall be designed for continuous duty, shall be capable of sustaining a minimum of ten (10) starts per hour, and shall be rated for Class 1, Division 1, Group D service.
- B. The motors may be either air filled or oil filled and shall be NEMA B design in accordance with NEMA MG-1. **Temperature sensors shall be embedded in the windings to provide a discrete signal for shutting off the pump when the winding temperature exceeds the threshold established by the motor manufacturer.**
 - 1. Air filled motors shall have Class F insulation.
 - 2. Oil filled motors shall have Class B insulation.
- C. Based on the pump manufacturer's standard design, especially for pump models with larger horsepower drives, water or oil jackets encircling the stator housings may be utilized for motor cooling purposes, provided connections to external coolant sources are not required.
- D. Motor ratings shall be as shown in Section 1.06 "System Characteristics" of these specifications.
- E. The Contractor shall verify that the existing electrical service is compatible with the specified equipment before ordering the equipment.

10.2.15 Spare Parts (grinder pump only)

The Contractor shall provide one (1) set of spare parts for each grinder pump furnished. The set of spare parts shall include a grinder assembly (grinder impeller and shredding ring), impeller, upper and lower seals, and any gaskets, pins, nuts, washers, etc. needed to install the above listed parts. **Spare parts shall be submitted to the MSD Project Inspector prior to pump station acceptance.**

10.2.16 Power Cable and Cable Entry

- A. The pump power cable shall comply with NFPA No. 70, Type SO, and shall be of standard construction for submersible pump applications. The cable length shall be such that no splices will be required between the pump and the control panel while providing a two (2) foot vertical sag in the cable between the control panel and cable holder.
- B. The cable entry water seal design shall insure a watertight and submersible seal.

10.2.17 Installation System

- A. The pumps shall be easily lowered into place and removed for inspection and service without the need for personnel to enter the wet well. Connection of the pump to its

discharge stand shall be accomplished by a simple linear downward motion of the pump along a rail mounted installation system.

1. For grinder applications, the pump/check valve assembly shall be hydraulically sealed to its discharge case with dual O-rings. A brace, easily removable from the top of the wet well, shall be provided to lock the parts together and to prevent line surges from breaking the seal and allowing leakage.
 2. For non-clog applications, sealing shall be accomplished by the weight of the pump pressing tightly against its discharge connection elbow with a machined metal-to-metal watertight contact. Sealing of the discharge interface by means of a diaphragm, O-ring, or other devices will not be acceptable.
- B. A rail mounted installation system incorporating two (2) guide rails; bottom, intermediate, and upper guide rail supports; sliding pump bracket; and lifting cable shall be furnished for each pump.
1. The guide rails shall be non-sparking and of the size standard with the pump manufacturer.
 2. The guide rails shall be Schedule 40, Type 304 stainless steel pipe, ASTM A167.
 3. All supports and fasteners shall be stainless steel and of a design standard with the pump manufacturer.
 4. Intermediate guide rail supports, if required, shall be spaced evenly between the discharge stand and upper guide rail support in order to minimize deflection of the rails.
 5. The guide rails shall not support any portion of the weight of the pump.
 6. The sliding pump bracket, designed to be non-binding and to ride on the guide rails, shall be an integral part of the pumping unit.
- C. A lifting cable shall be provided to raise and lower the pump through the limits indicated on the Contract Drawings. The cable and all associated hardware shall be stainless steel and shall be capable of supporting the pump with a Safety Factor of two (2).
- D. The Contractor is to demonstrate, in the presence of MSD's inspector prior to or during the start-up procedure, that pumps have proper hatch clearance, guide rail positioning, and seating. The pumps are to be raised and lowered twice to ensure proper operation. Any necessary alterations or adjustments are to be made by the Contractor, to MSD's satisfaction, at no additional cost to MSD.

10.2.18 Wet Well

- A. The wet well shall be constructed of precast reinforced concrete as specified hereinafter and shall be sized as indicated on the Contract Drawings.
- B. Precast Reinforced Concrete

The precast reinforced concrete wet well and top slab shall conform to "Specifications for Reinforced Concrete Manhole Sections," ASTM C478, latest

revision. The wet well sections shall contain one or two lines of circular steel reinforcement as required by the ASTM standards. All sewer pipe connections to the precast **wet well** shall be made with a positive seal gasketing system conforming to ASTM C923 and MSD's Standard Drawing No. GM-01-01. All wet well joints shall be watertight as described in MSD's Standard Specification Section 5.2.7., Joint Sealants. Preference shall be given to the use of rubber O-ring joints whenever possible. To facilitate maintenance, the wet well shall have no more than one through-wall connection for influent sewage. All sewers draining to the wet well shall converge in a single manhole adjacent to the wet well. A single pipe shall connect this manhole and the wet well. The invert of the influent line shall enter the wet well at a higher elevation than the high wet well alarm level.

C. Access Door

1. The access door(s) to the wet well shall be 1/4-inch (minimum thickness) aluminum (6061-T6 Alloy, ASTM B-221) diamond pattern plate, designed to withstand a live load of 300 pounds per square foot. The frame shall be constructed of 1/4-inch thick, one piece extruded aluminum with a continuous 1-inch (minimum) anchor flange around the perimeter. The access door(s) shall be adequately sized to allow removal of the pump(s). The actual clear opening of the frame shall allow a minimum of 3-1/2 inches clearance between the pump(s) casing(s) opposite the discharge side of the pump(s) and the inside of the frame, and a minimum of 2-1/2 inches clearance between the sides of the pump(s) casing(s) and the inside of the frame. Factory finish shall be mill finish aluminum. Installation shall be performed in accordance with the manufacturer's instructions.
2. The manufacturer shall mark each door leaf, in two locations with a steel stamp using 3/8-inch lettering, with the words "Property of Louisville MSD." When the door(s) are in the open position, one mark shall be located approximately 3 to 4 inches from the edge on the top right corner of the underside of the door(s). The second mark shall be located approximately 3 to 4 inches from the side and above the hinge on the bottom left corner of the underside of the door(s).
3. The door(s) shall be equipped with stainless steel hinges, stainless steel pins, and recessed lift handle flush mounted and not protruding above the cover. Each door leaf, with a maximum of 15 lbs. of manual assistance, shall open to 90 degrees and automatically lock in that position with a stainless steel hold-open arm. The arm shall have a conveniently positioned release handle with a vinyl grip for easy and controlled closing. Door(s) shall be equipped with stainless steel spring operators designed to provide easy operation in opening and to act as a check in retarding downward motion of the door during closing. For safety purposes, should the locking mechanism fail or unauthorized entry occur, the spring operator shall be designed such that the door(s) shall remain in a fully closed position by its own weight. No item may protrude above the access cover except the heads of the carriage bolts and padlock assembly cover.
4. To minimize tampering and improve security, the hinges shall be bolted to the door(s) with stainless steel carriage bolts and nuts. The nuts shall be welded to the bolts on both the door(s) and frame. Door(s) shall be equipped with a recessed padlock and staple assembly which shall conceal an American #570

padlock and be designed to restrict bolt cutters from severing the padlock. MSD will provide and install the padlock upon completion of the project. All stainless steel hardware shall be type 304 (minimum) stainless steel. The manufacturer shall guarantee all components of the access doors against defects in material and workmanship for a period of five years.

5. When installing wet wells six feet in diameter and larger, a double leaf access door hatch shall be installed and sized to meet the ultimate pump size access demand and actual clearance as specified between the pump(s) casing(s) and inside of the frame. A large single door shall not be acceptable. The minimum leaf size shall be 30 inches by 30 inches. The maximum leaf size shall be such that the sum of the length and width of the leaf is less than or equal to 84 inches.

D. Level Instrument Stilling Well

To prevent damage to the submersible level instrument, a 4" schedule 40 perforated stilling well shall be installed. The stilling well shall be securely supported utilizing stainless steel support hardware. The bottom of the stilling well shall end approximately 6" from the bottom of the wet well. The top of the stilling well shall end approximately 12" below the wet well top deck. The centerline of the stilling well shall be aligned with the centerline of the core-drilled hole in the top deck used for float switch cords and the level instrument cable.

10.2.19 Valve Vault

- A. The valve vault shall be constructed of precast or cast-in-place reinforced concrete as specified hereinafter and shall be sized as indicated on the Contract Drawings.

B. Cast-in-Place Concrete

All cast-in-place concrete work shall conform to MSD's Standard Specification Section 5, Structures. Class AA concrete shall be used throughout the structure. All pipe connections to the vault shall be made with a positive seal gasketing system conforming to ASTM C923 and MSD's Standard Drawing No. GM-01-01.

C. Precast Reinforced Concrete

A precast reinforced concrete valve vault and top slab shall conform to "Precast Concrete Water and Wastewater Structures," ASTM C913, latest revision. All pipe connections to the precast valve vault shall be made with a positive seal gasketing system conforming to ASTM C923 and MSD's Standard Drawing No. GM-01-01.

D. Confined Space Equipment

The valve vault shall be equipped with an aluminum ladder as shown on the Contract Drawings. The ladder shall comply with OSHA requirements. A minimum clear space of 30 inches by 30 inches shall be provided as a landing area at the bottom of the ladder. The ladder shall have **retractable side rails or a retractable extension, such as a Bilco Ladder-Up or equal, to facilitate ingress and egress.**

E. Access Door

1. The access door(s) to the valve vault shall be 1/4-inch (minimum thickness) aluminum (6061-T6 Alloy, ASTM B-221) diamond pattern plate, designed to withstand a live load of 300 pounds per square foot. The frame shall be constructed of 1/4-inch thick, one piece extruded aluminum with a continuous 1-inch (minimum) anchor flange around the perimeter. The access door(s) shall be adequately sized to allow removal of the valves and fittings. Factory finish shall be mill finish aluminum. Installation shall be performed in accordance with the manufacturer's instructions.
2. The manufacturer shall mark each door leaf, in two locations with a steel stamp using 3/8-inch lettering, with the words "Property of Louisville MSD." When the door(s) are in the open position, one mark shall be located approximately 3 to 4 inches from the edge on the top right corner of the underside of the door(s). The second mark shall be located approximately 3 to 4 inches from the side and above the hinge on the bottom left corner of the underside of the door(s).
3. The door(s) shall be equipped with stainless steel hinges, stainless steel pins, and recessed lift handle flush mounted and not protruding above the cover. Each door leaf, with a maximum of 15 lbs. of manual assistance, shall open to 90 degrees and automatically lock in that position with a stainless steel hold-open arm. The arm shall have a conveniently positioned release handle with a vinyl grip for easy and controlled closing. Door(s) shall be equipped with stainless steel spring operators designed to provide easy operation in opening and to act as a check in retarding downward motion of the door during closing. For safety purposes, should the locking mechanism fail or unauthorized entry occur, the spring operator shall be designed such that the door(s) shall remain in a fully closed position by its own weight. No item may protrude above the access cover except the heads of the carriage bolts and padlock assembly cover.
4. To minimize tampering and improve security, the hinges shall be bolted to the door(s) with stainless steel carriage bolts and nuts. The nuts shall be welded to the bolts on both the door(s) and frame. Door(s) shall be equipped with a recessed padlock and staple assembly which shall conceal an American #570 padlock and be designed to restrict bolt cutters from severing the padlock. MSD will provide and install the padlock upon completion of the project. All stainless steel hardware shall be type 304 (minimum) stainless steel. The manufacturer shall guarantee all components of the access doors against defects in material and workmanship for a period of five years.
5. When installing valve vaults six feet in diameter and larger, a double leaf access door hatch shall be installed and sized to facilitate access to valves and fittings. A large single door shall not be acceptable. The minimum leaf size shall be 30 inches by 30 inches. The maximum leaf size shall be such that the sum of the length and width of the leaf is less than or equal to 84 inches.

10.2.20 Check Valve

Check valves shall be **lever and weight** swing type **with** bronze-to-bronze seating and shall be manufactured by Kennedy Valve or approved equal. The valve design shall allow for operation when negative heads are encountered. The valve shall be designed to operate at all pressures in the sewer system. The check valve shall be installed on the discharge line as shown on the Contract Drawings. Check valves shall be installed such that the lever arm may be totally disassembled, including the removal of hinge pins, without removing the valve from the line. **A limit switch with SPDT contacts rated for 120VAC, mounted on either the valve or on an aluminum floor stand, shall be provided and adjusted so that motion of the check valve lever arm is detected.**

10.2.21 Gate Valve

The gate valve shall be AWWA C509, resilient wedge, rising stem suitable for use in sewage applications. Each valve shall be provided with a handwheel opening **counterclockwise**. The valve shall have flanged ends with 125 lb. drilling. The valve shall be furnished and installed in the discharge pipe as shown on the plans. The valve shall be a Ken-Seal gate valve manufactured by Kennedy Valve or approved equal.

10.2.22 Emergency Pump Connection

As shown on the Contract Drawings, a 4-inch line shall be installed in the valve vault to enable a portable pump to be connected to the force main. The end of the pipe shall protrude through the top slab of the valve vault and shall be equipped with a 4-inch stainless steel male adapter designed to accommodate a positive cam-locking female coupler for quick, secure connection of the portable pump discharge hose. The adapter shall be threaded onto the pipe and shall be protected with a stainless steel locking dust cap. MSD will provide the required padlock.

10.2.23 Ball Valve/Gauge Tap

The ball valve shall be threaded and have a stainless steel body, stainless steel ball and stem, teflon seats and seals, and a regular port. The ball valve shall be manufactured by Crane Capri, Number 9302-S, or approved equal. The gauge tap assemblies shall be stainless steel and installed as shown on the Contract Drawings.

10.2.24 Pressure Gauge and Diaphragm Seal

- A. The pressure gauge shall be glycerine filled with a minimum dial size of 3-1/2 inches. The gauge shall be enclosed in a stainless steel case and shall have an operating range based on the actual system heads expected for the specific project. The operating range of the gauge shall be one of the manufacturer's standard designs and shall be labeled on the dial face in both pounds per square inch (psi) and feet of water. The

gauge shall have a polycarbonate window for shatter resistance. The lower stem shall have a 1/4-inch connection. The bourdon tube shall be AISI 316 stainless steel.

- B. The diaphragm seal shall have a 1/2-inch process and 1/4-inch gauge connection. The diaphragm seal and bottom housing shall be AISI 316 stainless steel. The diaphragm fluid shall be glycerine.
- C. The gauge shall be a 3-1/2-inch Ashcroft 35-1009 SWL -02L with an Ashcroft 50-310SSL-02T-CG diaphragm seal or approved equal.

10.2.25 Air Release Valve

The air release valve, when required, shall be specially designed for use in sewage applications. Specific size requirements shall be determined by the Engineer. The valve shall be furnished with backflush accessories such as inlet and outlet blowoff valves, quick disconnect couplings, and a minimum of 5 feet of hose. The valve shall be an APCO Model 400 or approved equal.

10.2.26 Mechanical Coupling

Mechanical couplings shall be installed as shown on the Contract Drawings. Mechanical couplings shall be epoxy coated ductile iron with stainless steel nuts and bolts. Couplings shall be **Dresser Style 38 or 138, Ford Style FC1 or FC2**, or approved equal.

10.2.27 Electrical

A. General

1. All materials and equipment installed shall be new and unused and shall be of the latest design of manufacturers regularly engaged in the manufacture of such products that conform with the requirements of the Contract Drawings and Specifications.
2. These Specifications, the associated Drawings, and other Contract Documents have been prepared with the intention of their yielding, through construction, electrical installations that are fully operable, safe, complete, and in full compliance with the latest editions of the National Electrical Code, local codes and ordinances, and any other authority having jurisdiction over the Work. The omission of miscellaneous electrical items or accessories not specifically called for in these Contract Documents which would detract from this intention shall not relieve the Contractor of the responsibility of furnishing and installing these items and accessories.

B. Conduit

1. All exposed conduit shall be rigid aluminum. All couplings, bushings, and connectors shall be of the same materials and intended for use in a rigid

aluminum conduit system. Threads, whether manufactured or made on the job site, shall meet the provisions of the NEC.

2. Below-grade plastic conduit shall be Schedule 40 PVC or Schedule 80 PVC, rated for use with 90-degree celsius conductors and for use in direct sunlight, with chemical weld joints. This Contractor shall provide all fittings, adapters, etc. required for a complete installation as required by the Drawings.

C. Wire and Cable

1. All conductors shall be of stranded softdrawn copper construction with thermoplastic type THHN/THWN 600 V insulation. Conductors shall be sized as shown on the Drawings. Power and lighting conductor sizes smaller than No. 12 AWG shall not be permitted.
2. Control Conductors: Conductors utilized within enclosures utilized for motor control, alarm, and discrete I/O signaling circuitry shall be type MTW, size #14 AWG stranded copper. Control conductors external to enclosures (not including pump, level transmitter, and float cables) shall be type THHN/THWN, size #14 AWG stranded copper. Conductors powered by a source in another enclosure shall be yellow. Analog signals shall utilize #18 AWG twisted, shielded pair cable with 300V insulation. Conductors within enclosures shall be neatly routed utilizing plastic Panduit-type wireway. Intrinsically-safe conductors shall maintain separation from all other conductors. Field wiring and internal control panel conductors shall be identified at each termination with black lettering on white background tags in a clear slide-on plastic sleeve as manufactured by Brady or equal. Conductor identification numbers shall indicate the terminal number on which the conductor shall terminate.

D. Control Panel Enclosures

1. Main Control Panel

- a. The control system, as listed, shall be housed in a single stainless steel, NEMA 3R enclosure suitable for outdoor installations with a stainless steel, three-point vault door closing handle and drip shield. It shall be manufactured from 14 gauge, Type 304 stainless steel. All hardware, including the hinges, latches, and provisions for a 5/8-inch diameter hasp opening for a padlock, shall be stainless steel. MSD will provide the padlock upon completion of the project.
- b. The enclosure shall have a 12 gauge steel, formed, removable subpanel. The panel shall be degreased, cleaned, and treated with a phosphatizing process, then primed and painted with white industrial-grade baking enamel. Space per the drawings shall be saved on the subpanel for mounting of a communication modem. Modem shall be provided and mounted by MSD. Access to this space shall not be blocked by the mounting of other internal panel components.

- c. The enclosure shall have a hinged inner door (dead front). The inner door shall be hinged on one side and held closed by two (2) hand operated, 1/4-turn fasteners or thumb screw fasteners on the other side. Operator devices are to be mounted on the inner door. The hinge and inner door assembly shall be of sufficient strength to prevent sagging, buckling or warping of the inner door after inner door devices are installed.

2. Other Enclosures and Boxes

Other enclosures shall be stainless steel, NEMA 4X with hinged door and provisions for pad locking.

E. Control Panel Components

1. Phase Monitor

- a. Loss of voltage on any phase, undervoltage, and loss of rotational sequence shall be detected by a phase monitor suitable for the electrical service provided. The monitor shall reset automatically when measured parameters return to the normal range of operation. The phase monitor shall include a means for adjusting drop out voltage, an LED indicating normal conditions, and shall plug into a DIN rail-mounted base.
- b. The phase monitor shall be Diversified Electronic Type UOA or SLA or equal.

2. Full-Voltage, Non-Reversing (FVNR) Combination Motor Starter (***Engineer to choose this specification or the soft starter below.***)

- a. Motor starters shall be NEMA-rated combination full-voltage, non-reversing, horsepower-rated starters with motor circuit protectors and solid state overload relays mounted in individual NEMA 4X stainless steel enclosures.
- b. Contactor shall meet the following requirements:
 - 1) Easily replaceable power contacts.
 - 2) No disconnection of wiring for contact inspection.
 - 3) Easily replaceable coil.
 - 4) Provide Square D Class 8536 or equal.
- c. Overload relay shall meet the following requirements:
 - 1) Phase loss and unbalance protection
 - 2) Selectable class 10, 20, 30 time current trip characteristics.
 - 3) Directly mountable on contactor.
 - 4) 120VAC remote reset solenoid.
 - 5) Isolated auxiliary contacts.

- 6) Provide Square D Class 9065 Motor Logic solid-state overload relay or equal.
- d. Short circuit protection shall be a molded case motor circuit protector meeting the following requirements:
- 1) Fixed continuous current rating.
 - 2) Adjustable magnetic trip settings
 - 3) 250VAC, 10 amp normally-closed alarm contact to indicate breaker trip.
 - 4) **External operating handle lockable in the open or closed position.**
 - 5) AIC rating of 25,000A minimum @ 480VAC.
 - 6) Provide Square D Mag-Gard motor circuit protector with alarm contact kit or equal.
2. Reduced-Voltage, Solid-State (RVSS) Combination “Soft” Starter (*Engineer to choose this specification or FVNR starter above*)
- a. Motor starters shall be an RVSS combination, horsepower-rated starters with motor circuit protectors with microprocessor-based reduced voltage starting and stopping.
- b. Reduced-voltage, solid-state combination “soft starters” shall have the following features:
- 1) 480VAC input/output voltage.
 - 2) Motor short circuit protection with external operator handle lockable in the open or closed position and rated for the fault current available at the starter.
 - 3) Integral “up-to-speed” bypass contactor.
 - 4) Current monitoring and motor protective features active in start up and bypass mode.
 - 5) Pump control option with acceleration and deceleration ramp algorithms especially designed to reduce water hammer in pumping systems.
 - 6) A starter-mounted operator interface module for programming parameters and displaying alarms, faults, fault logs, and metering data.
 - 7) NEMA 4X stainless steel padlockable enclosure.
 - 8) Line-side protective module for protection against transients.
 - 9) RVSS starter shall be Allen-Bradley SMC Flex Smart Motor Controller.
- c. Short circuit protection shall be a circuit breaker as recommended by the RVSS manufacturer. Accessories for the circuit breaker shall include a normally-closed 120VAC-rated alarm contact to indicate breaker “tripped”.

3. Human-Machine Interface (HMI)

- a. Provide a touch screen color HMI with the following features:
- b. Color 8.3" x 6.2" display area with 640 x 480 resolution.
- c. Field replaceable backlight
- d. Battery-backed real-time clock.
- e. 384 touch cells rated for 1,000,000 operations.
- f. One RS-232 DF1 communication port and one RS-232 download/printer port. Note that no intermediate protocol conversion device to convert a non-DF1 protocol will be accepted.
- g. Connect communication cable to the mini-din port of the PLC specified below.
- h. 120VAC supply voltage.
- i. The HMI shall be an Allen-Bradley PanelView 1000.
- j. HMI program development shall be provided by Owner.**

4. Pushbuttons and Selector Switches

- a. Push buttons shall be watertight/oil-tight NEMA 4/13, black, flush-mounted, full voltage with legend plate as indicated on the drawings.
- b. Selector Switches shall be watertight/oil tight NEMA 4/13, maintained, with black standard operator, number of positions and contact blocks as indicated on the drawings.
- c. The push buttons and selector switches shall be Square D Class 9001 Type K or equal.

5. Programmable Logic Controller

- a. General:
 - 1) Function: Used for process monitoring and control by emulating functions of conventional panel mounted equipment such as relays, timers, counters, PID controllers, calculations.
 - 2) Type: Microprocessor based , programmed using ladder logic.
 - 3) Parts: central processing unit (CPU), power supply, input/output modules, and cables.
 - 4) Provide components required to make a complete and totally operational system.
- b. Environmental:
 - 1) Temperature Range: Operating: 32 to 131 degrees F, minimum. Storage: -40 to +185 degrees F, minimum.
 - 2) Humidity: Operating range 5 to 95 percent noncondensing.
 - 3) Vibration Operating: 0.015 inches peak-to-peak displacement 10-57 Hz, 5g 57
- c. Central Processing Unit (CPU):

- 1) Type: Microprocessor, 16-bit minimum, firmware version 7.0 or later.
- 2) Memory Size: 14K minimum, user configurable memory for program and data.
- 3) Scan Time: Minimum of 1.0 ms per 1K words of relay ladder logic.
- 4) Instruction Set:
 - a) Timers and Counters: Minimum timer resolution 0.1 seconds; minimum counter count range 0 to 32,000.
 - b) Math: Signed integer and floating-point math including add, subtract, multiply, divide, square root, and compare.
 - c) Register Operations: Shift registers, bit shift, bit set, bit clear, data move and data format conversion.
 - d) Process Loop Control: User configurable direct or reverse acting PID loop control computation with the capability of both AUTO and MANUAL modes of operation.
 - e) Real Time Clock: Date and time set and compare.
 - f) Miscellaneous: Jump or skip to a label, one shots, sequencing drums, subroutines.
- 5) Diagnostics:
 - a) Indicators: Low battery fault, PLC fault, Power On, Communications Active, PLC in Run Mode.
 - b) Error Codes: Failure codes for communications, scan, configuration, communications, I/O, special functions.
 - c) Power Up: PLC checks status of PROMs upon powerup; runs self-diagnostics on power-up; periodically runs self-diagnostics while in RUN mode, halts logic processor and sets outputs to configured state if fatal error is detected.
- 6) Agency Approvals and Standards:
 - a) UL listed.
 - b) CSA certified.
- 7) CPU shall be Allen-Bradley **MicroLogix** Model 1764-LRP.
 - a. Power Supply Voltage: 120VAC
 - b. Chassis: DIN-rail mounted.
 - c. Discrete Inputs:
 - 1) Voltage: 120VAC.
 - 2) Number of Points: As shown on drawings..
 - 3) LED status indicator for each point.

- 4) Base Unit shall be Allen-Bradley Model No. 1764-24AWA or equal. Expansion input card shall be Allen-Bradley Model No. 1769-IA16.
- g. Discrete Outputs:
- 1) Type: Isolated Form C relay.
 - 2) Voltage: 120 volts, 60-Hz.
 - 3) Number of Points: As shown on drawings.
 - 4) Load Rating: 15 amps make, 1.5 amps break, 2.5 amps continuous.
 - 5) Type: Relay Contact Outputs.
 - 6) LED status indicator and fuse for each point.
 - 7) Base Unit shall be Allen-Bradley Model No. 1764-24AWA.
- h. Analog Inputs:
- 1) Type: Current, 4 to 20 mA dc, differential.
 - 2) Number of Points: As shown on drawings.
 - 3) Accuracy: ± 0.35 percent of full scale.
 - 4) Analog Input Resolution: 14 bits, minimum, plus sign.
 - 5) Normal Mode Rejection Ratio: Current -15dB at 50Hz, -18dB at 60Hz.
 - 6) Analog Input Modules shall be Allen-Bradley Model No. 1769-IF4.
- k. Communication Ports: Two RS-232 for ports configurable for DF1 half or full duplex communication. One for communication with modem, the mini-din port shall be used for communication with a panel-mounted HMI. Note that no intermediate protocol conversion device to covert a non-DF1 protocol will be accepted.
- j. Programming: Programming of PLC shall be provided by Owner. Pump start and stop levels, and level transmitter calibrated span, shall be provided to Owner by Engineer.
6. Heaters
- a. The control panel and starter enclosures shall have silicone rubber insulated space heaters with integral thermostats and wattage as indicated on the drawings.
 - b. The heaters shall be Chromalox Type SL-B or equal.
7. Legend Plates
- a. All equipment, disconnect switches, circuit breakers, motor starters, pushbutton stations, relays, and similar devices shall be clearly labeled or function otherwise identified. Identification labels shall be engraved lamacoid plates having black background with white letters. Attach each plate with aluminum or stainless steel screws.

8. Packaged Power Source (*Delete this section if single phase 120VAC power is available from the utility for the proposed pump station.*)

- a. A 120V power source for miscellaneous loads shall be provided and shall meet the following requirements:
- b. Transformer, primary circuit breaker, and secondary circuit breakers combined in a painted, stainless steel, NEMA 3R enclosure.
- c. 240/120V transformer secondary voltage, primary voltage and KVA rating as indicated on the drawings.
- d. Number of secondary breakers as indicated on the drawings including spares.
- e. The packaged power source shall be Square D Class 7400 Mini Power-Zone or equal.

9. Circuit Breakers

- a. Circuit breakers for supplying ancillary systems shall be operable from front of the control panel inner door. The breakers shall be rated for the fault current available and shall have the number of poles as indicated on the drawings.
- b. Circuit breakers shall be Square D Type QO molded case circuit breakers or equal.

13. DC Power Supply

- a. The DC power supply shall have the following features
 - 1) 120VAC input.
 - 2) 24VDC +/- 1%, 10 amps output.
 - 3) Internal input fusing and transient surge protection.
 - 4) Operating temperature of -25 to 60 degree C.
 - 5) Operating humidity of 0-95% non-condensing.
 - 6) Casing capable of horizontal DIN rail mounting.
 - 7) Isolated power supply failure contact
- b. Power supply shall be Phoenix Contact Quint Power Supply or equal.

14. Uninterruptible Power Supply (UPS)

- a. The UPS shall have the following features:
 - 1) 120VAC input, 120VAC output.
 - 2) 500VA/300W output capacity.
 - 3) Line interactive technology.
 - 4) Stepped sine wave output in battery mode.
 - 5) Automatic bi-weekly battery testing.
 - 6) User replaceable "hot swappable" batteries.

- 7) Four 15A battery back up + surge protection receptacles, 2 surge protection only receptacles.
 - 8) Protection against frequency variations, spikes, blackouts, surges, sags, over and under voltages.
 - 9) Battery run times: 8 minutes @ 100% load, 24 minutes @ 50% load.
 - b. The UPS manufacturer shall be Sola Hevi-Duty Type S2K.
14. Control Relays
- a. Control relays shall be general purpose, plug-in type, with spade terminals, DIN rail sockets, a temperature operating range of -40 degrees C to +45 degrees C, on/off indicator, manual operator, 10A contacts and coil voltage as required by the drawings.
 - b. Control relays shall be Square D Class 8501 Type K or equal.
15. Timing Relays
- a. **On-delay** timing relays shall be single range, plug-in type, with DIN rail blade-type sockets, adjustable from 0.3 to 30 seconds, 120VAC coil, and 10A contacts.
 - b. **On-delay** timing relays shall be Square D Class 9050, Type JCK or equal.
 - c. **On-delay/off-delay timing relays shall be plug-in type, with blade-type sockets, provide individual adjustments for each timing function (on or off delay) adjustable from 0.3 to 30 seconds, 120VAC coil, and 10A contacts.**
 - d. **On-delay/off-delay timing relays shall be Diversified Electronics TDJ series or equal.**
16. Duplex Receptacle
- a. The receptacle shall be 120 volt, 20 amp NEMA 5-20R GFI receptacle with "Test" and "Reset" buttons, DIN rail-mounted device box, and external wiring terminals.
 - b. The receptacle shall be Phoenix Contact EM-DUO-120/20/GFI or equal.
17. Control Wiring Terminal Blocks
- a. Terminal blocks for control wiring shall meet the following requirements:
 - 1) Voltage rating of 300V.
 - 2) Current rating of 20A.
 - 3) Screw-type terminals made of corrosion-resistant alloys.
 - 4) DIN rail mounted.

- b. Terminal blocks shall be Phoenix Contact Type UK2,5N or equal. Provide end terminals as required. Analog terminals shall be segregated from discrete terminals.

18. Power Distribution Blocks

- a. Power distribution blocks shall be aluminum, tin plated and must be compatible with copper conductors. Each block shall be sized appropriately for the size and number of wires being terminated and shall be based on NEC ampacity tables using 75⁰ Celsius wire.
- b. Power distribution blocks shall be Square D Class 9080, Type LB or equal.

19. Fuse Holders and Fuses

- a. Fuse holders shall be 600V, 30 amp high impact thermoplastic with copper alloy, tin plated clips.
- b. Fuses shall be 600V, 200,000AIC Class CC fuses.
- c. Holders to be as manufactured by Square D Class 9080, Type FB or equal.

F. Grounding

- 1. The resistance value of the main grounding conductor measured between the main disconnect and a good earth ground shall not exceed five (5) ohms.
- 2. Ground Rods: Ground Rods shall be the copper clad steel type and shall be a minimum of 10 feet in length, 3/4-inch in diameter. Ground rods shall be equal to those as manufactured by Copperweld Steel Company.
- 3. Grounding electrode conductors shall be bare copper. Equipment grounding conductor shall be copper, THHN/THWN insulated, green (or green with yellow tracer) in color, and rated at 600 volts.

G. Float Switches

- 1. Liquid level detention shall be by sealed, single pole, float switches encased in a **plastic** case. **The switch shall utilize a steel ball in a tube to provide electrical switching. No mercury-type switches are acceptable.** The float switches shall be weighted, suspended by cables which shall contain the wiring for the switches. All materials shall be highly resistant to sewage and associated atmospheres. Floats requiring fasteners to maintain their depth in the wet well are unacceptable. The tilt bulb hanger bracket and hardware shall be stainless steel (ASTM A167, Type 304).
- 2. The float cables shall be supplied of sufficient length to be installed without splicing.
- 3. Floats to be Anchor Scientific Eco-Float or equal.
- 4. Mounting bracket to be Ohio Electric Control Model 100-6 or equal.

H. Level Transmitter

A submersible level transmitter shall be provided for analog level measurement. The transmitter shall have the following features.

1. Sensor and transmitter electronics housed in the submersible casing. No above-grade electronics required for conversion of sensor signal to analog output signal.
2. 4-20mA two-wire loop powered transmitter.
3. Polypropylene casing
4. Intrinsically safe design.
5. 316 Stainless steel diaphragm for waste water applications.
6. Accuracy: +/- 0.5% full scale
7. Steel re-inforced shielded, oil-resistant PVC electrical cable.
8. The level transmitter shall be MJK model 7060 or equal, range as required by Engineer. Level transmitter shall hang within a stilling well installed within the wet well. The bottom of level transmitter shall be approximately 12" above the floor of the wet well.

I. Main Circuit Breaker

1. The main circuit breaker shall be a molded case, thermal-magnetic circuit breaker in a NEMA 4X, stainless steel enclosure, front operated, with provisions for padlocking in open or closed position; voltage; ampere rating and number of poles as noted on the drawings, and rated for use as service entrance equipment. The breaker shall include an isolated alarm contact to indicate a breaker "tripped" status, and a neutral and/or grounding kits where required.
2. The circuit breaker shall be Square D Class 610 or equal.

J. Service Pole

1. For overhead service, the Contractor shall provide a 25-foot long, Class 4, wood pole for up to 200 amp service or as required by LG&E. For services over 200 amp, Contractor shall contact LG&E at 627-3265 for pole classification and requirements.

K. Cord Grips

1. Provide standard duty, single eye, single weave, stainless steel support grips of sufficient strength for pump power and control cords, and float switch cords.
2. Provide Class I, Division 2 aluminum cord seals for sealing cord entry into enclosures.
3. Cord grips shall be Kellems Grips as manufactured by Hubbell or equal. Cord seals shall be Appleton type CG aluminum or equal.

L. Alarm Horn

1. The alarm horn shall be 120VAC, NEMA 4X, 103dB @ 10 feet with housing for outdoor mounting. Power consumption shall be 15.6VA or less.
2. The horn shall be mounted near the top of the service pole or a treated wood pole approximately 10 ft. above grade.

3. The alarm horn shall be Edwards Signaling and Security Systems Model 870P series or equal.

M. Alarm Light

1. The alarm light shall be 120VAC, NEMA 4X, 15W flashing incandescent light for outdoor industrial applications. Power consumption shall be 18VA or less.
2. The light shall include a red lens and polycarbonate, impact resistant base.
3. The light shall be mounted near the top of the service pole or a treated wood pole approximately 10 ft. above grade and near the alarm horn.
4. The alarm light shall be Edwards Signaling and Security Systems Model 114 FIN Series or equal.

N. Silence Pushbutton

1. The silence pushbutton shall be mounted in a NEMA 4X stainless steel pushbutton enclosure approximately 5 feet above finished grade and accessible to the public.
2. The pushbutton shall be as specified above under "Pushbuttons and Selector Switches".
3. The enclosure shall be as specified above under "Other Enclosures".

10.2.28 Emergency Generator

A. General

1. The engine, generator, and all major items of auxiliary equipment shall be manufactured by manufacturers currently engaged in the production of such equipment. The unit shall be factory assembled, tested by the engine manufacturer, and shipped to the job site by an authorized dealer having a parts and service facility in Jefferson County, Kentucky. The generator/engine shall be sized such that sequential starting of the pumps shall not produce a voltage drop greater than 20% for any step.
2. Equipment furnished under this Section shall be guaranteed against defective parts or workmanship for a period of two years after acceptance of the facility by MSD. The warranty shall cover 100% of all parts and labor.
3. On completion of the installation, start-up and testing shall be performed by a factory-trained representative.
4. Supplier shall have been regularly engaged in sales and service of engine-generator units for at least five years, have a complete service and parts facility within 100 miles, provide 24 hour service and be open for inspection.

B. Acceptable Manufacturers

1. Engine/Generator: Kohler, Caterpillar or equal.
2. Transfer Switch: Russelectric RMTD or equal.

C. Engine

1. Engine shall be diesel **or natural gas** fueled, 4 cycle, 1800 rpm, liquid cooled type with engine mounted radiator. Engine shall operate smoothly at all loads and shall be capable of acceleration to rated speed and accept full load within 10 seconds from a cold start.
2. The engine shall operate on No. 2 diesel fuel and shall have an electric starting system.
3. Prior to tests for final acceptance, the cooling system shall be filled with 50 percent ethylene glycol solution and water with rust inhibitor.
4. The engine shall be equipped with sensors and devices to interface with control panel for the following functions.
 - a. Low oil pressure shutdown
 - b. High water temperature shutdown
 - c. Over Speed shutdown
 - d. Over Crank shutdown
 - e. Low oil pressure pre-alarm
 - f. High water temperature pre-alarm
 - g. Low water temperature alarm
5. Accessories Mounted on Engine:
 - a. Thermostatically controlled block heaters. Heater input voltage shall be 208V or 240V single-phase, wattage as required by the generator manufacturer.
 - b. Dry type engine air cleaner.
 - c. Governor to maintain frequency regulation, no load to full load, at 60 Hz with steady state regulation plus/minus 3 %.

D. Generator

1. Generator shall be permanent magnet generator (PMG) type, 12 lead reconnectable and shall be capable of sustaining a 300% short circuit for 10 seconds. Current boost systems are not acceptable. Generator shall be drip-proof and ventilated by internal blower mounted on rotor shaft. Provide a main circuit breaker mounted on the generator set. Include an auxiliary normally-open contact on the breaker to indicate "tripped". This auxiliary contact shall be wired in parallel with the common fault contact described below.
2. Generator shall have Class "H" or better insulation and have a continuous standby rating of ____KW (____KVA at ____P.F.) for ____volts, ____-phase, 60 Hz using the fuel stated above.

E. Voltage Regulator

1. Voltage regulator shall be completely solid state type. Regulation shall be within 2 percent from no load to full load with 10 percent adjustment range.

F. Generator Control Console

1. Unit mounted controller shall be capable of facing right, left or rear and shall be mounted on vibration isolators. The DC circuit shall be fused and be capable of automatic remote start from a remote start signal. Speed sensing and a second independent starter motor disengagement systems shall protect against starter engagement with a moving flywheel. Battery charging alternator voltage will not be acceptable for this purpose. The controller shall have the following functions, indicator lights and accessories:

- a. Cranking cycle with 15 second on and off cranking periods
- b. Over crank protection
- c. Engine cool down timer, factory set at 5 minutes
- d. Overvoltage protection to shut down the unit.
- e. 3-position (Automatic-Off-Test) selector switch
- f. Indicator lights to signal:
 - 1) Not-in Auto (Flashing Red)
 - 2) Over crank (Red)
 - 3) Emergency Stop (Red)
 - 4) High Engine Temperature Shutdown (Red)
 - 5) Over speed Shutdown (Red)
 - 6) Low Oil Pressure Shutdown (Red)
 - 7) Battery Charger Malfunction (Red)
 - 8) Low Battery Voltage (Red)
 - 9) Low Fuel Level (Red) **for diesel-fueled generators.**
 - 10) **Low Fuel Inlet Pressure (Red) for natural gas-fuel generators.**
 - 11) Pre-Alarm High Engine Temperature (Yellow)
 - 12) Pre-Alarm Low Oil Pressure (Yellow)
 - 13) Low Coolant Temperature (Red)
 - 14) Auxiliary Pre-Alarm (Yellow)
 - 15) Fuel Leak (Red)
 - 16) System Ready (Green)
- g. Instrument Panel to include:
 - 1) Voltmeter
 - 2) Ammeter
 - 3) Voltmeter-ammeter phase selection
 - 4) Lights to indicate high or low meter scale
 - 5) Frequency meter
 - 6) Panel-illuminating lights
 - 7) Battery charging voltmeter
 - 8) Coolant temperature gauge
 - 9) Oil pressure gauge
 - 10) Running-time meter

- 11) Voltage-adjust rheostat
- 12) Test button for indicating lights
- 13) Alarm horn with silencer switch

- h. Isolated generator “running” contact.
- i. **Isolated generator “In Auto” contact.**
- j. Common alarm contact for signals indicated in Item f above.

G. Batteries and Charger

- 1. Batteries shall be lead acid mounted on a fully accessible rack.
- 2. Provide an automatic float and equalize battery charger with plus/minus 1% constant voltage regulation from no load to full load and plus/minus 10% AC input line variation, current limited during engine cranking and short circuit conditions, temperature compensated, voltmeter and ammeter, AC input and DC output fuses, and have reverse polarity protection circuitry.
- 3. Engine shall have a dedicated battery, and battery charger. Battery shall be located adjacent to engine. Cables from battery to starter shall be sized in accordance with manufacturer’s recommendation.

H. Engine Exhaust System

- 1. Muffler shall be of the critical rated silencer type.2. Silencer is to be mounted on top of weather housing with manufacturer’s standard mounting brackets.

I. Weather Housing

Provide a weather protective enclosure for outdoor service, sheet metal construction with hinged or removable panel access doors for service and maintenance. Unit arranged for full load service totally enclosed. Enclosure is to be mounted directly to channel base and shipped completely assembled. Exhaust muffler mounted on enclosure. Water jacket heater and battery charger installed within the enclosure.

J. Automatic Transfer Switch

- 1. An automatic transfer switch shall be furnished, as shown on Drawings. The switch shall be capable of switching all classes of loads and shall be rated for continuous duty, when installed in a non-ventilated enclosure. A NEMA 4X enclosure shall be provided and must conform to UL 50 standards.
- 2. Construction and Performance: The transfer switch shall be double throw, actuated by two electrical operators, momentarily energized and connected to the transfer mechanism by a simple over center type linkage. The time delay between the opening of the closed contacts and the closing of the open contacts shall also allow for voltage decay before transfer. Single operator switches programmed to stop in a neutral position are not acceptable. In-phase monitor will not be acceptable in lieu of two electrical operators.

3. Switching mechanism shall provide "quick-make", "quick-break" operation of contacts.
4. The normal and emergency contacts shall be positively interlocked mechanically and electrically to prevent simultaneous closing. Mechanical interlock must be separate from operating mechanism so as to provide positive interlock in the event of operator failure.
5. Operating mechanism must be metal. Plastic or phenolic type components, subject to breakage, will not be acceptable.
6. Main contacts shall be mechanically held in both positions without the use of hooks, latches, magnets or springs, and shall be silver alloy protected by arcing contacts, with deion grids and arc barriers on each pole.
7. The transfer switch shall be equipped with a manual operator that is designed to prevent injury to the operating personnel if the electrical operator should suddenly become energized during manual transfer. The manual operator shall provide the same contact to contact transfer speed as the electrical operator, to prevent a flash over from switching the main contacts slowly. Manual operation shall be safe and not require any prior disconnection of the automatic operators control wiring. Safe manual transfer shall be possible under all load conditions, energized or non-energized.
8. All operator interface devices and accessories shall be front mounted on an inner door behind a padlockable deadfront outer door.
9. Control wiring shall be flame retarding 600 volt, Type SIS throughout with numbered sleeve type identification on each end.
10. Sequence of Operation: If any phase of the normal source drops below 80% of rated line voltage, an engine start contact shall close, to start the generating plant after a time delay ignoring momentary dips. The transfer switch shall transfer to the emergency source after the voltage and frequency have reached 90% of rated. After restoration of normal power on the normal source, the load will be transferred back with a programmable delay.
11. Switch shall include provision to instantaneously return to normal source (if available) regardless of exerciser signals, time delays, etc. in the event of emergency source failure.
12. After the switch has retransferred to normal, the engine generator shall be unloaded and be readied for a subsequent operation.
13. Approval: As a precondition for approval, all switches, complete with timers, relays and accessories shall be listed by UL in their Electrical Construction Manuals Catalog, under Standard UL 1008 Automatic Transfer Switches and approved for use on emergency system.
14. When conducting temperature rise tests to Paragraph 22 of UL 1008, the manufacturer shall include post endurance temperature rise tests to verify the ability of the switch to carry full rated current after completing the overload and endurance tests.
15. In addition to the above, the transfer switch must have a stand alone short circuit withstand capability greater than the available system fault current at the point of connection to the transfer switch.

16. Transfer switch shall include a microprocessor-based controller to allow operator configuration of various threshold values, time delays, and to display metering and status data.
17. Ratings:
 - a. _____amps
 - b. _____volts
 - b. 3 phase
 - c. 60 Hz
 - d. _____poles
18. Accessories:
 - a. Time delay to override momentary outages and delay engine start.
 - b. Time delay relays to control contact transition time on transfer to either source
 - c. Adjustable time delay on retransfer to normal
 - d. Test switch to be mounted on the cabinet with automatic bypass to normal should the emergency source fail - provides for test operation of emergency generator and transfer switch
 - e. Auxiliary contact to close when normal fails (pilot contact to initiate starting controls on engine)
 - f. Mounted pilot light for indicating switch in normal position.
 - g. Mounted pilot light for indicating switch in emergency position
 - h. Auxiliary contact on main shaft, rated 25 amps, 120 VAC, (closed on normal)
 - i. Auxiliary contact on main shaft, rated 25 amps, 120 VAC, (closed on emergency)
 - j. Enclosure NEMA 4X
 - k. Frequency relay - prevents transfer to emergency until voltage and frequency of generating plant have reached 90% of rated voltage
 - l. Normal Source Available to indicate availability of normal power source regardless of transfer switch position.
 - m. Emergency Source Available to indicate availability of emergency power source regardless of transfer switch position.

K. Fuel System

For diesel powered generators, provide a sub-base fuel tank to the following specifications. Fuel tank shall be mounted under generator set, capacity for 100% load operation for 24 hours, UL-142 Secondary Containment listed, and provided with a mechanical fuel gauge, low fuel level float and alarm, leak detection float, normal vent with mushroom cap and emergency vent. Steel braided flexible fuel lines with protective covers shall be installed and plumbed between the engine and tank for supply and return. There shall be a baffle between the supply and return ports inside of the tank. Tank shall provide a conduit stub up area with a removable end plate for access.

L. Installation

1. The engine/generator sets shall be delivered on a structural steel base or skid and shall be installed complete where shown on the Drawings. Vibration isolators shall be installed between the unit base and the concrete mounting surface. The isolators shall be designed and manufactured for the weight, shock, and vibration produced according to the unit manufacturer's information on the particular unit being installed.
2. The generator neutral connection shall be solidly grounded to the electrical system ground via an equipment grounding conductor. The unit frame shall be grounded connected to the system ground.
3. All wiring between remote components shall be in conduit. All wiring between components mounted on the unit base shall be completely factory wired.
4. An aluminum platform shall be constructed to allow for operator access to the generator control panel for larger generators with excessively high control panels. The Owner shall review each installation on a case by case basis and render a decision on the need for an elevated platform.

M. Manufacturer's Representative

1. The installation of the engine/generator set, shall be made using complete factory written or drawn instructions. When the installation is complete, the Contractor shall notify the supplier and a field representative shall travel to the site to inspect the installation, direct the start-up procedures and perform any necessary adjustments and the field testing. The Engineer shall be notified at least one week in advance of the start-up and testing so that he may have the opportunity of witnessing these procedures.
2. Load bank testing for 2 hours (minimum) at full load shall be performed by the generator supplier. Record engine and generator performance data. If deemed so by the manufacturer's representative, certify the unit ready for operation upon test completion.

N. Fuel

For diesel-fueled generators, fuel shall be provided by the Contractor during all phases of testing and startup.

10.3 EXECUTION

10.3.1 General

The Contractor shall furnish and install as detailed, at the elevations given and where shown on the Drawings, complete duplex, pump stations capable of handling raw, unscreened domestic sewage. The stations shall include submersible grinder or non-clog sewage pumps, liquid level sensors, discharge piping, valves, electrical controls and alarm system, and a precast concrete wet well and valve pit.

10.3.2 Backfill and Finish Grading

- A. Class I (No. 9 crushed stone aggregate) backfill material shall be placed around the pump station to within 18 inches of the surface of the surrounding ground, with sufficient allowance for settlement. The remaining fill shall be earth material free of rocks in the areas of piping and excavated material in all other areas. Rock and/or shale excavation may be placed in the top 18 inches of fill, but shall not be above piping or any closer than 12 inches from finished grade.
- B. All fill shall be placed so as to load structures symmetrically, Rough grading shall be held below finish grade and then topsoil which has been stockpiled shall be evenly spread over the surface.
- C. Grading shall be brought to the levels shown on the Drawings or to elevations established by the Engineer. Final dressing shall be accomplished by hand work or machine work, or a combination of these methods as may be necessary to produce a uniform and smooth finish to all parts of the regrade.

10.3.3 Pump Tests

Pump tests shall be conducted on each pump. During each test, the pump shall be run at each head condition for a sufficient time to permit accurate determination of discharge, head, and power input. Certified copies of the test data shall be furnished to the Engineer for review. All tests shall be run in accordance with the Standards of the Hydraulic Institute.

10.3.4 Acceptance Tests

- A. After installation of the pumping equipment, and after inspection, operation, testing, and adjustment have been completed by the manufacturer's representative, each pump shall be given a running test in the presence of the Engineer during which it shall determine its ability to operate without vibration or overheating, and to deliver its rated capacity under the specified conditions. During the tests, observations shall be made of head, capacity, and motor input. All defects or defective equipment revealed by or noted during the tests shall be corrected or replaced promptly at the expense of the Contractor, and if necessary, the tests shall be repeated until results acceptable to the Engineer are obtained. The Contractor shall furnish all labor, piping, equipment, and materials necessary for conducting the tests.
- B. All adjustments necessary to place the equipment in satisfactory working order shall be made at the time of the above tests.
- C. The Contractor shall provide water for testing.
- D. In the event that the Contractor is unable to demonstrate to the satisfaction of the Engineer that the units will satisfactorily perform the service required and that they will operate free from vibration and heating, the pumping units may be rejected. The

Contractor shall then remove and replace the equipment at his own expense. The limits of vibrations as set forth in the 13th Edition of the Standards of the Hydraulic Institute shall govern. Field service report shall include all vibration readings made.

10.3.5 Pump Warranty

- A. The pump manufacturer shall warrant the units being supplied to the owner against defects in workmanship and material for a period of five (5) years from the date of installation. The pump manufacturer shall repair or replace defective equipment, parts, or components within seven (7) days of receipt of defective items shipped prepaid by MSD to the manufacturer's authorized repair facility.
- B. Warranties and guarantees by the suppliers of various components in lieu of a single source responsibility by the manufacturer will not be accepted. The manufacturer shall assume prime responsibility for the guarantee of the station and all components.
- C. The replacement or repair (including cost of parts and labor) of those items normally consumed in service, such as pump seals, oil, grease, etc., shall be considered as part of routine maintenance and station upkeep.

10.3.6 Electricial Installation

- A. Excavation, Backfilling and Grading:
 - 1. The Contractor shall perform all earth and rock excavation, backfilling and grading required for this part of the work. Rock excavation shall be made to a depth of 4 inches below pipe and filled to subgrade with dense graded aggregate limestone. After the Bid is submitted there will be no additional funds forthcoming for excavation work on this project. All excavation shall be Bid as unclassified.
 - 2. Trenches shall be maintained free of water until backfilling is completed.
 - 3. Backfilling material in earth excavation shall be clean earth to a line at least 12 inches above the top of the conduit. From this line upward, rock not more than 6 inches in diameter may be used provided it is spaced at least 12 inches apart. Filling between rock shall be of clean earth, thoroughly tamped in 6-inch layers to the finished grade. All surplus rock and earth shall be removed from the site as directed by the Engineer.
 - 4. Depth of bury for all conduit shall be a minimum of 24 inches below finished grade.
- B. Conduit:
 - 1. PVC shall be concrete encased where it passes under roadways. PVC shall not be used where exposed on the exterior nor where exposed to direct sunlight. This Contractor shall plan his work so that runs of conduit miss equipment by other trades. Conduit bushing shall have insulating material which has been permanently fastened to the fittings. Bushings for conduit 1-1/2 inches trade size and larger shall be complete with grounding lug and shall be bonded to the

box by means of bare copper wire. All field bends shall be made with standard tools and bending equipment manufactured especially for this purpose. Bends in metallic conduit shall be made while cold and in no case shall the conduits be heated. Conduits shall not be bent through more than 90 degrees. Size of conduits shall not be less than that required by the National Electrical Code.

2. All conduit installed on concrete surfaces shall be anchored with spacer type conduit clamps preventing contact between the conduit and the concrete surface. Conduits penetrating walls shall be grouted in place to form a seal. Conduits penetrating floors shall be sleeved.
3. All conduit shall be run continuous between devices with a minimum number of bends. Back-to-back 90 degree bends (180 degree change of direction) will not be acceptable. During construction, all new conduits shall be kept dry and free of moisture and debris.
4. No conduit smaller than 3/4-inch trade size shall be used.
5. Conduit Schedule:

Location	Schedule 40 PVC	Schedule 80 PVC	Aluminum
Underground/Encased	X		
Direct Buried		X	
Exposed			X
Emergence from UG			X

C. Wire and Cable:

1. Direct Burial Cable: No cable buried directly in the earth, not in raceway will be allowed on this project.
2. Wire shall not be installed until all work of any nature that may cause injury to the wire is completed. Mechanical means shall not be used in pulling in wires No. 8 or smaller. Approved wire pulling lubricant shall be used as required to prevent insulation damage and overstressing of the wire while pulling through conduit. In no case shall conductors be greased or coated with any substance injurious to the conductor insulation or sheath.
3. All wires connected to terminal boards, terminal blocks, or to other similar terminals shall terminate by means of pressure terminals. Where terminal boards, terminal blocks, etc. are designed and manufactured to accept bare wire and have a pressure plate on each side of the wire, no pressure terminals on the wire will be required. Where the wire would have to encircle the holding screw to make a proper connection, the wire terminals are required.
4. Where the wire is shown larger than that required for the load, it is done so for voltage drop or other purposes and must be installed as shown. Where the wire is stranded, the removal of strands in order to install the wire into a lug provided on any equipment will not be permitted. A larger lug shall be installed which will accept the wire size indicated.

D. Grounding:

1. Ground rods shall be driven vertically into the earth to at least 1 foot below finished grade. Where rock is encountered at a depth of less than 4 feet, rods shall be buried in a trench at not less than 2 feet below finished grade.
2. Connections to ground rods and all other ground connections below grade shall have a minimum mechanical contact surface area between the conductor and the ground rod of not less than three square inches. All connections made below finished grade shall be exothermic. Installation of grounding conductors shall be such that they are not exposed to physical damage. All connections shall be firm and tight.
3. All metal electrical equipment cabinets shall be securely bonded to a grounding conductor running through any conduit terminating at the cabinet or enclosure by use of a grounding lug bushing and jumper wire to the enclosure wall. Control cabinets shall be provided with an equipment ground bus (including lugs or screw terminals) securely bonded to the enclosure. Junction boxes and other enclosures shall utilize an equipment ground bus or lug as required to securely bond the equipment grounding conductor to the enclosure. The grounding conductor shall be connected with pressure connectors at the main disconnect to the main grounding system. Where screw terminals or set screw lugs are used, sufficient lugs shall be provided such that not more than one conductor is installed into each lug or terminal.
4. No flexible conduit shall serve as a grounding conductor.
5. Where lightning arresters are furnished and installed either separately or with equipment and the grounding connections are not inherently provided, a suitable, separate, grounding conductor shall connect the lightning arrester with a separate ground rod. This rod shall be bonded with any adjacent grounding system.

10.3.7 Utilities

A. Electricity

The Contractor shall coordinate the installation of a complete electrical service with Louisville Gas & Electric Company (LG&E). When applying for service, the Contractor shall inform LG&E that the service is for an MSD wastewater pumping facility. Developer's ENGINEER shall furnish all electrical data requested by LG&E. Raceway, conductors, and other installation shall be in accordance with the requirements of LG&E. The Contractor shall be responsible for securing all permits, inspections, and approvals necessary for the transfer of a functional electrical service and the associated LG&E account to MSD upon acceptance of the facility.

B. Natural Gas

For those facilities utilizing standby generators fueled with natural gas, the Contractor shall coordinate the installation of a complete natural gas service with Louisville Gas & Electric Company (LG&E). When applying for service, the Contractor shall inform LG&E that the service is for an MSD wastewater

pumping facility. Developer's ENGINEER shall furnish all natural gas usage data requested by LG&E. Piping, meter, and other installation shall be in accordance with the requirements of LG&E. The Contractor shall be responsible for securing all permits, inspections, and approvals necessary for the transfer of the natural gas service and the associated LG&E account to MSD upon acceptance of the facility.

SECTION 11

MSD STANDARD SPECIFICATIONS

NATIVE SEEDING

11.1. DESCRIPTION OF WORK

This work shall consist of revegetation in the form of native seeding. It shall include seed bed and soil preparation, and furnishing and installing seed, fertilizer, topsoil, mulch and mulch anchoring, and erosion control materials, maintenance, and warranty. All disturbed areas or other areas identified on the plans as Natural Areas for native seeding shall be revegetated in accordance with the schedule and provisions in these specifications. Those areas to be planted with live native plants are subject to the specifications provided in Section 13 Native Tree, Shrub and Herbaceous Planting. In areas where seeding and live plants are used, provisions of both sections shall apply.

11.2. MATERIALS

11.2.1. Seed

11.2.1.1. Native Seed. Native Seed includes warm season grasses, cool season grasses, and forbs/wildflowers for use in Natural Areas (those identified of the planting plan in the Plant Tables and Composition Tables). Seed supplied by the Contractor shall be clean and fresh and delivered to the site in the original, unopened containers showing net weight, composition of mix, and supplier's name and guarantee of analysis. The acceptable minimum seed viability standard shall be determined according to Pure Live Seeding (PLS) rate as per Section 11.2.1.3 of these specifications. Seed supplied by the Contractor shall also conform to applicable state and federal regulations and to test provisions of the Association of Official Seed Analysts.

11.2.1.2. Temporary Seed. **Annual Rye or Winter Wheat** shall be used as temporary seed for Natural Areas with their use to be in conformance with the acceptable time of year schedule as per Section 11.3.1.

11.2.1.3. Pure Live Seeding Rate. All seeding rates specified shall meet a minimum of 75% pure live seed (PLS) rate for native grass and forb/wild flower seed, and 90% for temporary seed, as determined by the percent germination multiplied by the percent seed purity. If the PLS is less than specified, the Contractor shall increase the seeding rate to compensate for the PLS difference at their own expense.

11.2.2. Topsoil. Topsoil shall consist of the upper portion of the soil profile and shall be loose, friable soil that is free from stones larger than one inch (1"), sub-soil, refuse and other debris including stumps, roots, brush, weeds, and non-organic materials. The acceptable soil

texture classification for topsoil, in accordance with the U.S. Department of Agriculture system is: clay (40% maximum), silt (70% maximum) and sand (60% maximum). Topsoil (both salvaged and furnished) shall meet the following minimum standards through analytical testing, unless otherwise directed by MSD:

Organic Matter	> 2%
PH (range)	5.8 – 7.0
Phosphorus	> 40 lbs / acre
Magnesium	> 35 lbs / acre
Potassium	> 85 lbs / acre
Soluble salts	< 500 parts per million

11.2.2.1. Salvaged Topsoil. Shall refer to topsoil from the site that is excavated, stockpiled and replaced on the project site. Excavated subsoil shall not be mixed with salvaged topsoil, and shall be stockpiled in a separate location.

11.2.2.2. Furnished Topsoil. Shall refer to topsoil obtained from an off-site location, the source of which shall be provided to MSD for approval.

11.2.2.3. Sub-topsoil. Shall refer to the soil layer immediately below the **topsoil**, and is variable in depth (see 11.3.4 for the minimum depth of sub-topsoil excavation).

11.2.3. Organic Fertilizers. Shall refer to commercially available products and shall include materials marketed as “organic” or natural fertilizers. Organic materials may include sea grasses/kelp, rock powder, bone meal, whey, bean meal, composted manure, and blood meal, etc. These are substances derived from plant, animal, or mineral matter not undergoing a synthetic process; typically encompassing the remains, residues, or waste products of living organisms. Organic fertilizers include a single or blended substance of the above materials, to supply any of the three primary plant nutrients, Nitrogen (N), Phosphorus (P), and Potassium (K). Product nutrient content shall be identified in the standard form of Nitrogen (N), Phosphorous (P), and Potassium (K) ratios.

11.2.3.1. Initial Fertilizer. Shall refer to a low-nitrogen organic fertilizer with a nutrient content of 1-1-1, 1-2-1, or an MSD-approved substitute.

11.2.3.2. Maintenance Fertilizer. Shall refer to organic fertilizer with a minimum nutrient content of 6-2-4, or an MSD-approved substitute.

11.2.4. Mulch

11.2.4.1. Straw Mulch. Straw for mulching shall be baled wheat, oat, barley, or rye straw. It shall be free from weed seeds, foreign matter, or chaff and shall not contain any Johnson grass, Canada thistle, or nodding thistle. Straw for mulching shall be reasonably bright in color and shall not be musty, moldy, or otherwise of low quality, and shall not contain any

chemicals toxic to plant growth.

11.2.4.2. Wood Cellulose Fiber Mulch. Wood cellulose fiber mulch shall consist of specially prepared wood cellulose processed into a uniform fibrous physical state. It shall not contain any germination or growth inhibiting elements. It shall be dyed green or contain a green dye in the tackifier that will provide an appropriate color to facilitate visual inspection of the uniformly spread slurry. Wood cellulose fiber mulch shall conform to the following parameters:

- fiber length to approximately 10 mm
- diameter approximately 1mm
- pH range 4.0 to 8.5
- maximum ash content of 1.6%
- minimum water holding capacity of 90%

11.2.4.3. Hydromulch. Shall refer to a mixture of wood cellulose fiber and water for hydraulic application. Wood cellulose fiber mulch shall be mixed with water at a ratio of 50 pounds of wood cellulose fiber per 100 gallons of water. The material shall be manufactured and processed in such a manner that it will remain in uniform suspension in water under agitation and will blend with seed, fertilizer and other additives to form a homogeneous slurry. The mulch material shall form a blotter-like ground cover.

11.2.5. Tackifier. Shall refer to synthetic/chemical binders and emulsions to anchor mulch. The tackifier shall contain a green dye that will provide an appropriate color to facilitate visual inspection of a uniformly spread slurry. Petroleum-based tackifiers shall not be used for Native Seeding operations.

11.2.6. Anchors for Erosion Control Blankets/Fabrics. Anchors shall meet the requirements set forth in Section 9.2.12.

11.2.7. Erosion Control Blankets/Seed Incorporated Erosion Control Blankets. These shall meet the requirements set forth in Section 9.2.9. Erosion control blankets with poly-filament netting shall not be used in riparian areas (e.g., within 100 feet of a stream).

11.2.8. Water. Shall refer to water used in the establishment and care of plants shall be free from toxicants and all other substances injurious to plant life.

11.3. EXECUTION OF WORK

11.3.1. Schedule. The Contractor shall notify the MSD at least 48 hours in advance of the time they intend to begin seeding and shall not proceed with such work until permission to do so has been granted by the MSD. Before starting seeding operations on any area, final dressing and the preparation of the seed bed shall have been completed in accordance with these Specifications. All seeding and related activities shall be continuous operations. The following schedule shall be followed for seeding operations unless otherwise permitted or

directed by the MSD:

<u>Work Item</u>	<u>Work Schedule</u>
Permanent Seeding (Cool Season grasses)	Feb. 15 to May 15 or Aug. 15 to Nov. 1
Permanent Seeding (Warm Season grasses, forbs)	April 15 to August 1
Temporary Seeding with Annual Rye	March 1 to November 1
Temporary Seeding with Winter Wheat	Sept. 1 to November 1

11.3.2. Transporting Material. During hauling operations (for all seeding materials), pavement surfaces shall be kept clean and clear. Any dropped material shall be immediately removed from the roadway surface.

11.3.3. Clearing and Grubbing. Clearing and grading shall be performed within the limits of disturbance as indicated on the Design Plans and shall be in accordance with Section 2.3.1.8 of MSD Standard Specifications. The Contractor shall grub and remove tree stumps and downed trees as specified on the Design Plans and in the Contract Documents.

11.3.4. Topsoil Salvaging, Storing, and Placement

11.3.4.1. Topsoil Salvaging and Storing. MSD shall inspect areas identified for topsoil salvaging prior to beginning salvaging operations. The depth of topsoil to be salvaged shall be in accordance with the Design Plans. The Contractor shall avoid removal of subsoil or other unsuitable material with the topsoil. Do not use topsoil infested with any parts (seed, rhizomes, roots, etc.) of Johnson Grass, Canada Thistle, Quack Grass, Nodding Thistle, other noxious weeds, or exotic invasive plants. Topsoil shall be stockpiled in marked stockpile areas, on well-drained land, away from water bodies and with appropriate Erosion Prevention and Sediment Control measures in accordance with Section 2. Topsoil shall be immediately and completely covered with straw mulch a minimum one-half inch (2") thick and anchored with a tackifier. Stockpiles shall not exceed four feet (4.0') in height. The Contractor shall maintain a complete cover of straw mulch and binder over the entire stockpile area throughout the construction process.

11.3.4.2. Subsoil Roughening. Immediately prior to spreading topsoil, loosen the subgrade by ripping or tilling to a depth of at least four inches (4") to ensure adequate aeration of the subsoil. The subsoil shall be free of loose stones or other foreign material three (3") inches or greater in size.

11.3.4.3. Topsoil Placement. Prior to placing topsoil, MSD shall inspect salvaged or

furnished topsoil to ensure that the topsoil is not infested with any parts (seed, rhizomes, roots, etc.) of Johnson Grass, Canada Thistle, Quack Grass, Nodding Thistle, or other noxious weeds or exotic invasive plants. Infested furnished topsoil shall be replaced with acceptable topsoil at the contractor's expense.

- (A) Topsoil Depth: Salvaged or furnished topsoil shall be placed at the depth in accordance with the Design Plans and the Contract Documents.
- (B) Spreading Topsoil: Uniformly spread topsoil within the project limits as indicated on the Design Plans or as directed by the MSD. Do not spread topsoil that is frozen, saturated or when the subsoil is wet or frozen. Incorporate the topsoil into the underlying subsoil a minimum of three inches (3") by means of light disking. When topsoil is to be placed on slopes 3:1 or greater, the Contractor shall work the topsoil into the subsoil in accordance with the design plans. The Contractor shall minimize compaction of the topsoil from construction equipment. The final grade of the topsoil shall be in accordance with the Design Plans.

The completed work shall be in conformance with the thickness, lines, grades and elevations as specified on the plans. Excess topsoil shall become the responsibility of the Contractor and shall be completely removed from the project site to an area with an approved erosion prevention and sediment control plan.

11.3.5. Seeding

11.3.5.1. Preparing Seed Bed for Native Seed and Temporary Seeding. Each area to be seeded shall be scarified, disked, harrowed, raked, or otherwise worked until it has been loosened and pulverized to a depth of not less than three inches (3"). Stones and other foreign materials shall be removed. This operation shall be performed only when the soil is in a tillable and workable condition; i.e., not frozen, snow covered, or saturated (ball formed of topsoil releases water when squeezed).

11.3.5.2. Native Seeding. Seeding shall be performed within seven (7) days of completion of all topsoil placement and final grade establishment. Areas to be seeded shall be reviewed by MSD or the Engineer prior to seeding. Seeding shall not occur during heavy rain (greater than one inch (1") in 24 hours), snow (any ground coverage), drought (less than one inch (1") rainfall in a month), or in windy conditions (>10 miles per hour, sustained).

11.3.5.3. Temporary Seeding. Temporary seeding shall be performed promptly at the locations and times directed by MSD, or in the Contract Documents, and in accordance with the schedule and corresponding seed in Section 11.3.1 of these specifications. Temporary seeding, ***such as Annual Rye or Winter Wheat***, shall be sown at the approximate rate of three pounds (3 lbs) per 1,000 square feet. Areas disturbed for greater than seven (7) days shall be stabilized with a tackifier only. If the Natural Area is to remain open for more than 30 days, it shall be temporarily seeded in accordance with these specifications.

11.3.5.4. Seeding Techniques. Seeding shall be performed by one of the methods identified below. Warm season grass seeding or warm season grass mixtures with forb/wild flower seed (identified on Design Plans) shall be performed only by drill seeding techniques, unless otherwise approved by MSD:

(A) Hand Broadcasting: Seeding shall be performed by applying a uniform cover of seed over each area by walking and sowing seed first in one direction, then walking perpendicular to the first direction while sowing the remaining seed for that area. Rake lightly or use a drag mat to cover seed no deeper than one-quarter inch (1/4"). Roll seeded areas with a water-filled land roller immediately after covering.

(B) Mechanical Power Drawn Seed: Seeding shall be performed by a mechanical power drawn broadcast seeder capable of uniformly mixing and broadcasting all seed sizes listed in the seed mix and approved by the MSD. Application shall follow the topographic contours. Rake lightly or use a drag mat to cover seed no deeper than one-quarter inch (1/4"). Roll seeded areas with a water-filled land roller immediately after covering.

(C) Hydroseeding: Seeding shall consist of the use of mechanized equipment designed to spread seed hydraulically via a slurry, typically in solution with water. Hydroseeding may also include emulsions of tackifier and wood cellulose fiber in suspension with the seed and water. Hydroseeding is to be utilized only when specified by the Design Plans and the Contract Documents. Hydroseeding shall not be used **for native seeding** where high pressure application may damage native seeds.

(D) Drill Seeding: Drill seeding shall be used to seed warm season grasses and mixes containing warm season grasses with forb/wild flower seed, as identified on the Design Plans and in the Contract Documents. This shall be accomplished by the use of a mechanical seed drill to ensure proper seed contact with the soil. To avoid uneven rates of seed flow in a standard gravity fed seed drill, and undesirable misses within the seed row, an inert carrier shall be used. This is necessary where light chaffty, awned or pointed seeds can influence seed spread. The inert carrier shall be cracked wheat, cracked corn, oat groats, or vermiculite. The inert carrier shall be mixed with the grass seed at half the bulk seed rate to improve seed flow.

In certain situations other seeding methods for warm season grass establishment may be acceptable with prior approval of MSD. This may include modified hand broadcasting, mechanical seeding, or hydroseeding techniques appropriately altered to provide required seed to soil contact.

11.3.6. Fertilization. Native seed shall not be fertilized at the time of seed application. Native seed shall only be fertilized after seed germination, or as directed by MSD. If specified on the Design Plans, an organic "initial fertilizer" shall be applied after germination, but not until midsummer or later. Fertilizer for herbaceous areas after germination shall be referred to as the "initial fertilizer". Fertilizer for the second growing season shall occur with the use of a "maintenance fertilizer". Fertilization rates (initial fertilizer and maintenance fertilizer) shall be 25 pounds per 1,000 square feet, or as otherwise specified in Design Plans and Contract Documents, or as approved by MSD.

11.3.7. Mulch Stabilization. Placing of mulch for protection shall follow seeding as soon as possible, and no later than 48 hours after seeding. In no instance shall the mulch be placed on crusted seeded areas, and any eroded areas shall be repaired and reseeded before mulch is applied. The materials shall be placed uniformly, all clumps loosened and scattered, and care shall be taken to avoid thicker applications than those specified. Re-treat at the originally specified rates any mulched areas damaged by rain before materials have dried. Re-treat at the same rate any mulched area damaged before acceptance, at the Contractor's expense. If the seed bed is destroyed, re-seed at originally specified rates.

11.3.7.1. Straw Mulch Crimping. Straw mulch shall be crimped or punched into the soil to a depth of two (2) to four (4) inches using a mulch anchoring tool or a dull, serrated farm disc that is set straight. Crimping shall not cut or chop the mulch. This method may be used in flatter areas and on slopes no steeper than 3H:1V and only where equipment can be operated safely. Machinery shall be operated on the contour. Use crimping only when it is specified on the Erosion Prevention and Sediment Control Plan.

11.3.7.2. Straw Mulch Tackifiers. Straw mulch tackifier shall be used only when specified on the Erosion Prevention and Sediment Control Plan. Tackifiers and associated emulsions must be used as recommended by the manufacturer to anchor mulch. No asphalt or petroleum-based tackifier shall be used in Natural Areas.

11.3.7.3. Hydromulch. As directed by MSD, hydromulch may be used with hydraulic seeding in lieu of the above methods for protected seeded areas. Wood cellulose fiber mulch shall be applied at the rate of 40 pounds per 1,000 square feet. Wood cellulose fiber used in anchoring straw mulch shall be applied at a net dry weight of 750 pounds per acre.

11.3.7.4. Erosion Control Blankets. Manufactured erosion control blankets (straw, coconut fiber, wood fiber, etc.) shall be used when shown on the Plans, as directed by MSD, or at the Contractor's option in lieu of straw mulch or hydromulch. The areas to be covered shall be properly prepared, fertilized and seeded in accordance with these Specifications before the blanket is placed. The blankets shall be installed according to the manufacturer's specifications. Individual blankets shall be secured using staples driven vertically in the ground. Staple patterns should be in accordance with the manufacturer's specifications. Loose blanket edges shall be stapled and buried in trenches according to the manufacturer's specifications. Only blankets without mono- or poly-filaments may be used in riparian areas (e.g., within 100 feet of a stream).

11.3.7.5. Seed-Incorporated Erosion Control Blankets. Seed-incorporated erosion control blankets (straw, coconut fiber, wood fiber, etc.) shall be used when shown on the Plans. The areas to be covered shall be properly prepared in accordance with these Specifications before the blanket is placed. The blankets shall be installed according to the manufacturer's specifications and the requirements shown in Section 11.3.7.4 above.

11.3.8. Watering. It shall be the Contractor's responsibility to supply water even if there is none available on the site. Any costs associated with supplying water shall be the

responsibility of the Contractor and shall be incidental to the items specified under these revegetation specifications.

11.3.8.1. Native Seed. Unless otherwise directed by the Engineer, the seed bed shall be watered immediately at a rate of 120 gallons per 1000 square feet, following covering of the seed bed with mulch. The water shall be applied by means of a hydro-seeder or a water tank under pressure with a nozzle that will produce a spray that will not dislodge the mulch. A second watering shall be made no sooner than seven (7) days and no later than ten (10) days after the initial application, provided that no significant rainfall has occurred. Should a significant rainfall (>one inch (1") in 24 hours) occur within seven (7) days of the initial watering, MSD may elect to delay or omit the second watering. The rate of water application during the second watering shall be 120 gallons per 1000 square feet.

11.3.9. Clean-Up. Until the Contractor receives final approval from the MSD, the Contractor shall, on a daily basis, maintain all areas within the limits of his/her operations and prevent the accumulation of waste material, rubbish or other debris. Before final acceptance of the work, all rights-of-way, easements and access roads used by the Contractor, all streams in and over which he/she has worked, and all ground occupied by the Contractor in connection with the work shall be cleared of all debris and construction materials. Right-of-way and easement areas not designated for alteration by the Contract Documents shall be, at a minimum, restored to their original condition. Waste material shall be disposed off-site at an area approved by the MSD and provided by the Contractor. During construction and watering, all areas which have been seeded and mulched, but which have been eroded, damaged, or have failed to successfully become established, shall be repaired as directed by the MSD.

11.3.10. Maintenance. The Contractor shall be responsible for all maintenance activities as specified below and in accordance with the Maintenance Schedule approved for this Contract. Any changes to the Maintenance Schedule must be approved by MSD. All plant material, seeding shall be maintained for throughout the duration of the warranty period after final inspection, and approval.

11.3.10.1. Permanent Seed Areas. Maintenance shall include, but not limited to, watering as necessary, fertilizing, and mowing , and/or burning (where applicable) the seeded areas as required by the Maintenance Schedule. All native and seeded areas shall be cared for and maintained properly to MSD's satisfaction until final acceptance of the work and for the duration of the warranty period.

- (A) Watering: Watering of the Permanent Seed Areas shall be as indicated in Section 11.3.8.1, or as directed by MSD.
- (B) Fertilization: Fertilizer applications are usually not required for native seed in the establishment year. An application of **slow-release** "maintenance fertilizer" **may** occur during the second growing season. The application rate shall be 25 pounds per 1,000 square feet, unless otherwise specified in the Maintenance Schedule.

- (C) Mowing: When mowing is required, mower blades shall be set at 6-12 inches for sufficient height to protect the vitality of the growth of native warm season grasses and forbs/wildflowers. Mowing shall occur only between March 1 to May 1 and October 1 to December 1 to protect ground nesting birds, to allow for seed set, and to provide winter cover.
- (D) Protection: Areas which have been eroded, damaged or failed to successfully establish a stand of grass, shall be repaired as directed by MSD. Should MSD determine that damage or erosion of these areas has occurred as a result of the fault or negligence of the Contractor, all material and labor required to repair the seeded areas shall be furnished by the Contractor at no cost to MSD. Should damage or erosion occur to seeded and mulched areas that had previously been acceptably completed, and this damage was due to no fault or negligence of the Contractor, the repair seeding and mulch shall be paid for by MSD as an extra work item.

11.3.11. Warranty. The Contractor shall maintain a one (1) year, 85% care and replacement warranty for all seeding, as determined by percent aerial coverage of living plants. The period of care and replacement shall begin after inspection and approval of the initial installation of all plants, **and** seeding and continue for one year, with one potential plant replacement period. Native seeding amendment shall be performed in accordance with native seed establishment measures in these specifications. The Contractor shall not be responsible for damage or plant mortality due to vandalism, wildlife predation, or Acts of God beyond the Contractor's control and responsibility.

SECTION 12

MSD STANDARD SPECIFICATIONS

NATIVE TREE, SHRUB AND HERBACEOUS PLANTING

12.1. DESCRIPTION OF WORK

This work shall consist of revegetation in the form of planting natives trees, shrubs, and herbaceous plants (including forbs and grasses). It shall include planting area preparation, furnishing and installing plants, soil amendments, mulch, and plant protection (including stakes and wires, and tree shelters, etc.), maintenance and warranty. This section shall apply to areas identified in the Contract Documents and on the Design Plans as Natural Areas for native tree, shrub, and/or herbaceous planting.

12.2. MATERIALS

12.2.1. Native Plant Material. Prior to the start of work on this item, the Contractor shall submit a proposed planting schedule, including source of plant material, to MSD for review. No work shall be performed until this schedule is approved by MSD.

12.2.1.1. Native Plant Material – General

- (A) Conformity: All plant material shall conform to the current issue of the American Standard for Nursery Stock (ANSI Z60.1) published by the American Association of Nurserymen.
- (B) Inspection: Plant material must be selected from certified nurseries that have been inspected by State and or Federal agencies. Nursery inspection certificates shall be furnished to MSD upon request.
- (C) Supply Source: The nursery supply source shall certify that the origin of the seeds from which the trees and shrubs were produced is from Hardiness Zone 6, East of the Mississippi River.
- (D) Collection: Plant material collected from the “wild” is prohibited.

12.2.1.2. Plant Stock Form. The acceptable forms of plant material shall include container-grown, balled and burlapped, bare root, plugs/peat pots, and tubelings as indicated in the composition and planting tables on the Design Plans.

- (A) Container-Grown Plants: Herbaceous plants, shrubs, and trees grown in a container long enough for the root system to have developed sufficiently to hold its soil. Roots shall visibly extend to the inside face of the growing container.

- (B) Balled and Burlapped Plants: Shall mean trees and shrubs that are field grown and are dug with a ball of soil around its roots which is then wrapped in burlap.
- (C) Bare Root Plants: Predominantly deciduous trees that are dug and handled and transported with very little or no soil on their roots.
- (D) Plug, Peat Pot, and Tubeling Plants: Herbaceous plants segmented by a “plug” of soil containing the root mass of the plant and living above-ground stems and leaves; peat pots are plants germinated in peat moss or similar medium and are small containerized units; and tubelings are well-rooted tree seedlings (with long taproots) grown in tube-like containers containing a soil mix.
- (E) Bulbs, Tubers, and Rhizomes: These are viable below-ground plant parts such as bulbs, roots, rhizomes, and stolons that are available for planting in the dormant state.

12.2.2. Shredded Hardwood Mulch. Mulch shall consist of aged, shredded hardwood. Mulch shall be free of weed seeds and non-organic debris and trash. The material size and individual shreds shall not exceed four inches on the longest axis.

12.2.3. Stakes and Wire. Shall consist of two-inch by two-inch by eight-foot long hardwood stakes. Wire shall be guy wire (consisting of two strands of twisted galvanized wire) with turnbuckles and rubber hose protective sleeve, or PVC chain links may be substituted.

12.2.4. Tree Shelters. Shall consist of tree tubes in the two foot (2') to five foot (5') size range (consistent with the relative height of the plants), and shall include wooden two-inch by two-inch stakes (of a length 18 inches longer than tree shelter height).

12.2.5. Waterfowl Exclusion Fencing. The standard materials shall include two-inch by two-inch woods stakes and heavy cotton twine. Other material may be substituted for waterfowl exclusion, with the approval of MSD.

12.2.6. Soil Amendments

12.2.6.1. Mycorrhizal Fungi. Mycorrhizal fungi shall consist of live spores of both endomycorrhizal and ecto-mycorrhizal fungi.

12.2.6.2. Organic Fertilizer. Shall refer to commercially available products and shall include materials marketed as ‘organic’ or natural fertilizers. Organic materials may include such items as sea grasses/kelp, rock powder, bone meal, whey, bean meal, composted manure, and blood meal, etc. These are substances derived from plant, animal or, mineral matter not undergoing a synthetic process; typically encompassing the remains, residues, or waste products of living organisms. Organic fertilizers include a single or blended substance of the above materials to supply any of the three primary nutrients, Nitrogen (N), Phosphorus (P), or Potassium (K). Product nutrient content shall be identified in the standard form of Nitrogen

(N), Phosphorus (P), and Potassium (K) ratios. The minimum nutrient content of organic fertilizers for the planting of trees, shrubs, and herbaceous plants shall be 6-2-4, or an MSD approved substitute.

12.2.7. Root gel. Shall consist of topically-applied hydrating root gel.

12.2.8. Water. Shall consist of clean water free from toxicants and other substances injurious to plant life.

12.3. EXECUTION OF WORK

12.3.1. General. All areas disturbed by construction identified for Native Area revegetation shall be planted in accordance with composition and planting tables for each designated planting zone on the Design Plans.

- (A) The Contractor shall refer to the Plant Table and Composition Table on the Design Plans for specific plant sizes and spacing requirements.
- (B) Clearing and grubbing shall occur in accordance with the Design Plans and Section 2.3.1.8 of MSD Standard Specifications, unless otherwise modified in the Special Provisions.
- (C) Site preparation shall consist of establishing finished grade as indicated on site plans, prior to planting. Site preparation for planting areas identified for planting native trees, shrubs, and herbaceous plants shall include the placement of a minimum of three inches (3") of topsoil (salvaged or furnished). This shall be accomplished in accordance with the Materials (Section 2.2.1 Topsoil) and Execution (Section 9.3.2.2 Topsoiling) specifications provided.
- (D) Immediately after site preparation and approval, trees, shrubs and herbaceous plants shall be planted unless otherwise specified on the Design Plans or in special provisions. Planting shall be conducted between March 15 to June 15 and September 15 to November 15, or as directed by MSD.
- (E) Sweating of Bare Root Plants is a technique that shall be used for bare root trees to be planted in the Spring. It consists of keeping both the top and roots covered with moist towels, sphagnum moss, straw, or shredded newspaper in a cool (not frozen) storage area. Once the buds begin to swell, the plants are releasing rooting hormones and shall be planted. Bare root tree species that require sweating include river birch (*Betula nigra*), oaks (*Quercus* spp.), linden (*Tilia* spp.), dogwoods (*Cornus* spp.), ashes (*Fraxinus* spp.), hackberries (*Celtis* spp.), locusts (*Robinia* sp. or *Gleditsia* sp.), hawthorns (*Crataegus* spp.), and red maple (*Acer rubrum*).
- (F) Root stock of the plants shall be kept moist during transport from the source to the project area and until planted.

- (G) Plants damaged in transportation or handling may be rejected by MSD.
- (H) All plants shall be stored in a staging area and watered daily until they are planted.

12.3.2. Planting. The Contractor is not required to stake out each individual planting pit, unless specifically directed to do so by MSD. However, upon planting a typical 100 foot by 100 foot section within each planting zone, the Contractor shall have MSD inspect and approve plant spacing and planting techniques prior to proceeding.

- (A) All planting pits shall be dug by hand, or by augering, unless otherwise specified on the Design Plans or in the Special Provisions. Large trees over four-inch (4") caliper shall be planted by the use of a tree spade. Walls of the planting pits shall be dug so that they are vertical or sloping outward in heavy soils. Scarify the walls of the pit after digging.
- (B) The planting pit shall be excavated to one and a half times the width of the root mass of the plant to be installed.
- (C) Remove all non-organic debris from the pit and tamp loose soil in the bottom of the pit by hand.
- (D) Plants shall be removed from their containers as follows:
 - Container Grown Plants - Remove the plant either by cutting or inverting the container.
 - Balled and Burlapped Plants – Remove top of burlap when the plant is in the planting hole and also remove all string, and wire/collars etc. before covering with soil.
 - Peat Pot, Plug or Tubeling Plants - Remove the entire unit from flat, tray, or container, but do not remove the peat pot or cut the root mass of herbaceous plugs or tubelings.
 - Bare Root Plants – Carefully separated individual plants and their root systems from one another when removing from packaging.
- (E) Do not handle plants by the branches, leaves or stem.
- (F) Place the plant straight in the center of the planting pit, always handling the plant by the root mass.
- (G) The Contractor may use a mechanical tree planting device for planting bare root or tubeling trees, with the approval of MSD.
- (H) For container grown, balled and burlapped, bare root trees and shrubs (more than 1 ½ foot tall), and peat pot and plug plants, place the fertilizer in the planting pit completely surrounding the root mass, within the upper one-third of the planting pit during backfilling. Place fertilizer at the time of planting according to the following rates unless otherwise specified on the Design Plans and in the Contract Documents, or as

directed by MSD:

- Container Grown Plants - Place one-half ounce (1/2 oz.) of organic fertilizer per each quart of container size for herbaceous plants. For trees and shrubs, place four ounces (4 oz.) of organic fertilizer in each planting pit for up to one gallon size containers, six ounces for up to three gallon container size, and place eight ounces for up five gallon container size.
 - Balled and Burlapped Plants – Place eight ounces of organic fertilizer for every 1inch caliper of plant stem.
 - Peat Pot, Plug or Tubeling Plants – Place one-quarter ounce (1/4 oz.) of **slow-release** organic fertilizer per each peat pot or plug plant. Organic fertilizer tablets with comparable composition are acceptable, if approved in advance by MSD.
 - Bare Root Plants (Seedlings/saplings greater than 18 " tall) – Place one ounce (1 oz.) of organic fertilizer per each one foot (1') of plant height.
 - Bare Root Plants (Herbaceous and woody seedlings less than 18" tall) – Spread (by mechanical spreader) organic fertilizer at rate of 10 pounds per 1,000 square feet of areas within the planting zone in lieu of fertilizing each individual plant.
- (I) In accordance with the Design Plans and the Contract Documents, mix a minimum of 500 spores of endomycorrhizal fungi and 30 million spores of ectomycorrhizal fungi to each cubic foot of backfill for tree and shrub planting. Mycorrhizal fungi tablets or packets may also be used if they provide comparable ratios of spores, and if approved by MSD prior to application.
- (J) Backfill the planting pit with existing soil and tamp firmly to fill all voids and air pockets. Do not over compact soil. Make sure plant remains straight during backfilling/tamping procedure.
- (K) The top of the root mass of container-grown or balled and burlapped plants should be flush with, or slightly elevated, (no more than 1/4 its height) from the final grade. Do not cover above the top of the root mass with soil (i.e., do not cover stem with soil).
- (L) For peat pot, plug and tubeling plants, make sure a thin layer of soil or mulch covers the root or peat ball to avoid moisture wicking out. Do not allow the edges of the root plugs or pot to stick up above the soil or mulch.
- (M) As specified on Design Plans and in Contract Documents, plant protection shall be installed as indicated below and in accordance with MSD planting details.

Tree stakes and wires shall be installed with all stakes straight and driven into the ground until stable. The two stakes on an individual plant shall be driven to an even depth relative to one another. The wiring and rubber hose shall be secured fastened and installed as not to girdle the tree or interfere with the growth pattern.

When specified, tree shelters ("tree tubes") shall be installed immediately after planting. The tree tubes shall be installed in accordance with the manufacturer's instructions.

Waterfowl Exclusion Fencing shall be installed as follows: The location of stakes must meet the site configuration, but shall be a maximum of 10 feet apart. The wooden stakes are driven into the ground a minimum of one foot (1') to be secure. The twine is then strung between stakes, wrapped and tied with secure knots. The distance between strands of twine shall be no more than seven inches (7") apart horizontally. The top twine shall be no lower than three feet (3') above the ground surface.

- (N) When planting bare root trees, identify the root crown to provide an indicator of where backfilled soil is to stop. This is identified visually by looking at the roots and stem. Find where the darker green color ends on the stem above the roots. Below this is the crown that is lighter in color. On seed-grown trees the crown is below the soil line and should be planted as such.
- (O) Mulch plants in accordance with the Design Plans the Contract Documents. For woody plants (trees and shrubs), create a mulch ring a maximum of three inches (3") thick. On slopes, a mulch berm shall be created on the down-slope side of the plants to slow water run-off, or a depression shall be created with a raised mulch rim. Do not place mulch around the stem of the plant.
- (P) During planting, all areas shall be kept neat, clean and free of all trash and debris, and all reasonable precautions shall be taken to avoid damage to adjacent existing plants.
- (Q) Water the plant thoroughly immediately after planting (to saturate the backfill), unless otherwise directed by MSD. After planting and initial watering, the application of water shall correspond to applying water monthly during June, July, August, and September throughout the life of the warranty. The need for additional watering, or determination of when watering is not necessary, shall be at the discretion of MSD. Watering shall occur of a sufficient quantity to saturate the backfill, and shall be applied slowly enough to sink into the soil avoiding runoff.
- (R) The Contractor shall leave no open planting pits at the end of each day.
- (S) Remove all tags, labels, strings and wire from the plants, unless otherwise directed by MSD.
- (T) Pruning of trees and shrubs shall be restricted to corrective pruning to enhance growth and vigor only. This includes removal of dead, damaged, diseased and/or conflicting branching. Do not cut the main leader of the tree or shrub. Pruning shall only be performed after the trees and shrubs are planted.

12.3.3. Maintenance. The Contractor shall be responsible for all maintenance activities as specified in the Maintenance Schedule. Any changes to the Maintenance Schedule must be approved by MSD. All plant material including trees, shrubs, and herbaceous plants shall be inspected and maintained for the duration of the warranty period, after final inspection and approval.

- (A) Final clean-up shall be the responsibility of the Contractor and consists of removing all trash, debris and other materials incidental to the project, and disposing of them off-site.
- (B) The plant material must be inspected and maintained (including replacement of plant material) for the warranty period indicated in Section 12.3.4, or as established in Special Provisions and Contract Documents.
- (C) The contractor shall provide maintenance water at required intervals, also as established in the Maintenance Schedule, with any deviations to be approved in advance by MSD.
- (D) It will be the Contractor's responsibility to supply water if there is none available on the project site. Any costs associated with supplying water shall be the responsibility of the Contractor.

12.3.4. Warranty. The Contractor shall maintain a one-year, **100%** care and replacement warranty for all trees, shrubs, and herbaceous plants, as determined by percent survival of original quantities planted. The care and replacement period shall begin after inspection and approval of the initial installation of all plants and shall continue for one year, with one potential replacement period. Replacement of trees, shrubs, and herbaceous plants shall be conducted in accordance with the material, execution (including schedule), and maintenance measures in these specifications. The Contractor shall not be responsible for damage or plant mortality due to vandalism, wildlife predation, or Acts of God beyond the Contractor's control and responsibility.

SECTION 13

MSD STANDARD SPECIFICATIONS

SOIL BIOENGINEERING

13.1 DESCRIPTION OF WORK

This work shall consist of harvesting (or purchasing), transporting, installing, and maintaining required materials for the installation of Live Stakes, Live Fascine, Branch Packing, Brush Mattress, Live Cribwall, Joint Planting, Coir Fiber Roll, Root Wads, Boulder Bank, and Rock Toe as specified on the plans and special provisions, or as directed by MSD.

13.2 MATERIALS

13.2.1 Live Stakes

(a.) Live cuttings for live stakes shall be one-half to one and a half inches (0.5"-1.5") in diameter and one and one-half to three feet (1.5'-3.0') in length. Side branches shall be removed and bark left intact prior to installation. Buds on the stakes shall be oriented in an upward position. The basal ends shall be tapered to a point for easy insertion into the soil. The top shall be cut smooth and square.

Live cuttings shall consist of a mix of three or more of the following species, with each species comprising no more than 50% and no less than 20% of the mix.

<i>Cornus amomum</i>	Silky dogwood
<i>Salix exigua</i>	Sandbar willow
<i>Salix humilis</i>	Prarie willow
<i>Salix interior</i>	Sandbar willow
<i>Salix nigra</i>	Black willow
<i>Salix rigida</i>	Heart-leaf willow
<i>Salix sericea</i>	Silky willow
<i>Salix purpurea</i>	Streamco willow
<i>Sambucus canadensis</i>	American elderberry
<i>Viburnum dentatum</i>	Southern arrowwood

13.2.2 Live Branch Layering

a. Live Branch Cuttings. Live branch cuttings shall be approximately one half inch (0.5") in diameter. Cuttings shall be long enough to reach the bank of the bench and extend a minimum of one foot (1') from the slope face. Side branches and bark shall remain intact prior to installation. Species selection shall be from the same list and composition requirements as for Live Stakes in Section 13.2.1 Material for Live Stake Installation (a)

b. Backfill. Backfill for the benches shall consist of existing soils excavated during bench construction.

13.2.3 Live Fascine

- a. Live Fascine Cuttings. Live fascine cuttings shall be approximately one half inch (0.5”) in diameter. Cuttings shall be three feet to eight feet (3’-8’) in length. Species selection shall be from the same list and composition requirements as for Live Stakes in Section 13.2.1 Material for Live Stake Installation (a).
- b. Live Pegs. Live cuttings for live pegs shall be one-half to one and a half inches (0.5’-1.5”) in diameter and between two and four feet (2’-4’) long. Side branches shall be removed and the bark left intact prior to installation. Buds on the pegs shall be oriented in an upward position. The basal ends shall be tapered to a point for easy insertion into the soil. The top shall be cut smooth and square. Live pegs shall consist of the same species identified for live branch cuttings.
- c. Dead Stake. Dead stakes shall be untreated 2” x 2” x 2.5’ hardwood lumber. Any stakes that split or shatter during **installation** shall be replaced.
- d. Twine. Twine used for tying live branch cuttings in place shall be natural jute twine or an approved equal.
- e. Footer Rock. Footer rock shall consist of native brownstone rock or rock located on site. Concrete will not be considered as an alternative to bank or footer rocks. Refer to the plans for specific sizes of boulder rocks for rock bank stabilization. Footer rocks shall come from the limits of disturbance of this contract. If sufficient material meeting the above requirements is not available from this Contract, the Contractor shall obtain material meeting specified requirements at no additional cost to MSD.
- f. Backfill. Backfill for the live fascines shall consist of on-site topsoil.

13.2.4 Branchpacking

- a. Live Branch Cuttings.
 1. Live branch cuttings shall be approximately one quarter inch to one inch (0.25”-1.0”) in diameter and long enough to reach the back of the **slope**, gully, or rill and extend a minimum of one foot (1’) from the rebuilt slope face. Side branches and bark shall remain intact prior to installation.
 2. Species selection shall be from the same list and composition requirements as for Live Stakes in Section 13.2.1 Material for Live Stake Installation (a).
 3. When trees are grouped together, at a very close interval, locate the approximate center of the grouping and list the most dominant species of the group.
- b. Backfill. Backfill for the **slope**, gully, or rill shall consist of existing soils excavated during construction.

13.2.5 Brush Mattress

a. Live Branch Cuttings.

1. Live branch cuttings shall be approximately one quarter inch (0.25") to inch (1.0") in diameter and long enough to cover the entire, or majority of, the area along the streambank or slope being repaired. Side branches and bark shall remain intact prior to installation.
2. Species selection shall be from the same list and composition requirements as for Live Stakes in Section 13.2.1 Material for Live Stake Installation (a).

b. Biodegradeable Rope. **Rope used for tying the branch cuttings together shall be made of natural abaca or an approved equal.** Rope shall be five-sixteenth inch (5/16") or three-eighths inch (3/8") diameter rope with standard tensile strength of at least 1,000 lbs., minimum tensile strength of at least 900 lbs. and approximate density of 2.6 lbs. per hundred feet.

c. Live Stakes. Species selection shall be from the same list and **composition** requirements as for Live Stakes in Section 13.2.1.

d. Backfill. Backfill for the area shall consist of existing soils excavated during construction.

13.2.6 Joint Planting

Live Cuttings. Live cuttings for joint plantings shall be one-half to one and a half inches (0.5"-1.5") in diameter and one and one-half to three feet in length. Side branches shall be removed and the bark left intact prior to installation. Buds on the cuttings shall be oriented in an upward position. The basal ends shall be tapered to a point for easy insertion into the soil. The top shall be cut smooth and square.

Species selection shall be from the same list and composition requirements as for Live Stakes in Section 13.2.1 Material for Live Stakes Installation (a).

13.2.7 Coir Fiber Roll

a. Coir Fiber Roll. Cylindrical rolls shall consist of 100% coir fiber with a density greater than or equal to nine pounds per cubic foot (9 lbs./cf), encased in coir fiber net of two inch (2") squares. Roll diameter shall be twelve inches (12") and length shall be twenty feet (20').

b. Large Wood Stake. Oak or Southern Yellow Pine stakes shall be untreated 2" X 2" X 4' stakes, free from knots or other defects that can cause splitting. A three inch (3") galvanized nail with a head shall be located two inches (2") from the top of the stake. Any stakes that split or shatter during construction shall be replaced.

c. Backfill. Backfill for the coir fiber rolls shall consist of on-site topsoil.

13.2.8 Root Wads

- a. Root Wads. Root wads shall consist of the root fan and trunk of a hardwood tree with a trunk diameter at breast height (DBH) of eighteen to thirty (18"-30") inches. Root fans shall be oblong to circular in shape and have a minimum spread of four feet (4') as measured at its narrowest axis and covering an area a minimum of 16 square feet. The **associated** trunk and root fan shall be ten to twelve (10'-12') feet in length.
- b. Footer Logs. Footer logs shall consist of straight hardwood logs with a diameter of twenty-four to thirty-six inches (24" to 36") and a length of ten to twelve feet (10'-12').
- c. Cutoff Logs. Cutoff logs shall consist of straight hardwood logs with a diameter of twelve to twenty-four **inches** (12"-24") and a length of fourteen to twenty feet (14'-20').
- d. Anchor Rocks. Rocks for securing footer and cutoff logs shall consist of native brownstone rock and have a minimum of twenty **inches** (20") with a density of 130 lbs./cu.ft.
- e. Equipment. The use of a backhoe with a "live" hydraulic thumb opposing the bucket is recommended for correct and efficient placement of all logs and boulders.

13.2.9 Boulder Bank

Boulder Banks and Footer Rocks. Preferred boulder bank and footer rocks shall consist of rock brown in color (brownstone). Concrete will not be considered as an alternative to boulder bank and footer rocks. Boulder bank and footer rocks shall be angular and have a median diameter not less than twenty-four inches (**24"**). **Samples** should be **approved by MSD prior to installation**.

13.2.10 Rock Toe

Footer and Boulder Toe Rocks. Footer rocks consist of rocks placed below the invert of the proposed channel to provide support for the boulder toe rocks and prevent scour at the toe of the bank. The boulder toe rocks shall be stacked on top of the footer rocks as shown on the Design Drawings.

The dimensions of the rock will be a minimum of 3 feet (3') and maximum of 5 feet (5') along the long (a) axis, a minimum of 2 feet (2') and maximum of 4 feet (4') along the median (b) axis, a minimum of 1 foot (1') and a maximum of 2 feet (2') along the short (c) axis. Samples shall be **approved by MSD prior to installation**.

13.3 EXECUTION OF WORK

13.3.1 General

These general provisions apply to soil bioengineering techniques requiring live cuttings including Live Stakes, Live Branch Layering, Live Fascine, Branch Packing, Brush Mattress, Live Cribwall and Joint Planting.

- a. Inspection. All materials and construction techniques shall be inspected and approved by MSD prior to installation.
- b. Harvesting. The source of all live cuttings shall be from purchased stock or located on-site or within twenty five (25) miles of the project site. The Contractor shall locate, flag, and code the live cutting sites. The Contractor shall notify MSD seventy-two (72) hours prior to harvesting to review and approve all harvesting sites. Upon approval by MSD, the Contractor shall be responsible for harvesting and transporting the cuttings to the job site.
- c. Schedule. Prior to the start of work on this item, the Contractor shall submit a proposed harvesting and construction schedule, including source of supply of live cuttings, to MSD for review and approval. No work shall be performed until this schedule is approved by MSD. Harvesting, transporting, and installation shall take place when plants are dormant (December 1 through April 1).
- d. Purchasing. If the Contractor is unable to located sufficient harvesting sites for the live stakes, upon approval from the MSD the Contractor may purchase live branch material. The material shall meet all of the specifications found in this section.
- e. Live Material Preparation.
1. Shrubs and young trees used in preparation of live stakes shall be cut directly above the ground. All cuts shall be smooth and the cut surface kept small. The use of large pruning shears or power saws may be required. Trees that are more than three inches (3") in diameter shall be topped.
 2. The live materials shall be transported to the construction site within eight (8) hours of harvesting and then cut to size, as specified above and on the details. Live materials must be protected against drying out and overheating before/during transport (e.g., they shall be covered, transported in unheated vehicles, moistened, kept in soak pits) and on-site prior to installation (e.g., by storing in controlled conditions, storing in shade, covering with evergreen branches or plastic, placing in moist soil, or spraying with anti-transpirant chemicals). Live materials shall receive continuous shade, shall be sheltered from the wind, and shall be continuously protected from drying by being heeled into moist soils.
 3. Where water is available, live branch cuttings shall be sprayed or immersed. Warm water (over 59° F) stimulates growth and should be used only upon the approval of MSD. **The Contractor shall be responsible for any costs associated with such.**
 4. Live materials **should** be installed the same day that the cuttings area harvested. If installation of live materials cannot be **accomplished** on the same day and storage is required, live materials shall be stored for a period no longer than two (2) days. Any storage of live materials must be approved by MSD prior to storing.

13.3.2 Installation Techniques

13.3.2.1 Live Stakes

- a. Drive live stakes into the ground so that sixty percent (60%) of the stake is below the ground surface. The contractor shall use a dead-**blow** hammer for driving the stake directly into the ground or drive a pilot hole, smaller in diameter than the live stake, and then driving the live stake into the pilot hole. Stagger the live stakes one foot (1') on center throughout the specified planting area.
- b. Placement of the live stakes shall be as indicated on the Contract Drawings and details. Live stake **shall be installed with** buds facing upward.
- c. All live stakes split during installation may be left in place but must be supplemented with a new live stake that remains un-split after installation.
- d. Live branches shall be bundled together in lengths varying from six to twenty feet (6'-20') depending on site conditions and limitations in handling. All growing tips shall be oriented in the same direction. Stagger the cuttings in the bundles so that tops are evenly distributed throughout the length of the live fascine.

13.3.2.2 Live Branch Layering

- a. Benches for installation of live branch layering shall be constructed two to three **feet** (2'-3') deep.
- b. If used in conjunction with rootwads or rock toe protection, the branch rows shall begin eighteen inches (18") above the rootwad fan or rock protection.
- c. Benches shall be excavated horizontally, on the contour. The surface of the bench shall be sloped so that the outside edge is higher than the back edge.
- d. Place a three inch (3") layer, a minimum of sixteen (16) branches per linear foot, of live branch cuttings on the bench, horizontal to the slope face. Place the branches in a crisscross configuration with the growing tips of the live material oriented toward the outside of the bench.
- e. Live branch cutting tips shall extend a minimum of one foot (1') beyond the edge of the bench.
- f. Backfill shall be placed on top of the branches and compacted to hold the live branch cuttings in place.

13.3.2.3 Live Fascine

- a. Live Fascine Toe Protection shall be installed according to the Sequence of Construction, the plans and details, and the following specifications.

- b. The Live Fascine shall be constructed so that approximately one quarter to one-third ($1/4$ - $1/3$) of the face of the live fascine roll is exposed beyond the proposed grade.
- c. The top of the footer rock shall be placed flush with the proposed stream invert.
- d. Excavate a one foot (1') wide and six to eight inch (6"-8") deep trench directly above and slightly recessed behind the footer rock along the sloped contour.
- f. Place the live fascine in the trench, resting on the live pegs. Overlap live fascine bundles a minimum foot (1').
- f. Drive the dead pegs directly into and through the live fascine as indicated on the plans. Extras stakes shall be used at the ends of each live fascine.
- g. Drive live pegs in between the footer rock and live fascine bundle. Stagger the live pegs between the dead pegs. The live pegs shall protrude two to three inches (2"-3") above the live fascine.
- h. Backfill soil in trench and on top of the live fascine. Gently tamp and water backfill to ensure that all voids are filled with soil. The top of the live fascine (approximately $1/4$ to $1/3$ of the bundle) shall be visible when installation is completed.

13.3.2.4 Branchpacking

- a. Live cuttings shall be cut to a length matching the depth of the slump, gully, rill, etc. being repaired with approximately one foot (1') of the cutting protruding from the slope.
- b. Place approximately one foot (1') of fill in the bottom of the slump, gully, or rill.
- c. The cuttings shall be placed three to eight inches (3"-8") thick and arranged in a criss-cross pattern. The basal end shall be installed into the slope so that the basal end is at an elevation lower than the protruding tip. When repairing a gully or rill, in plan view, the branches shall be installed in a convex pattern to direct runoff away from the center.
- d. Backfill shall be placed on top of branches and compacted such that soil **reaches** between all the branches. If necessary the backfill should be saturated with water to ensure maximum soil to branch contact.
- e. Continue this construction process until the entire slump, gully, or rill area has been repaired.

13.3.2.5 Brush Mattress

- a. Prepare the streambank or slope by clearing away all debris and grading the area so that the branches will lay flat on the streambank or slope. Excavate a horizontal trench eight to twelve inches (8"-12") along the toe of the streambank or at the base of the slope area being repaired.

- b. Place the branches flat across the graded area in a criss-cross pattern with the basal ends placed as deeply in the trench as possible. If the vertical length of the area being covered is longer than the cuttings, overlap the cuttings so the entire area is covered.
- c. Lay the cuttings along the streambank or slope until approximately 80% ground cover is accomplished and the mattress is six to twelve inches (6"-12") thick.
- d. With a dead-blow mallet, pound two to three foot (2'-3') long live stakes partially into the mattress in a grid formation with the stakes three to four feet (3'-4') on center. Secure the brush mattress by tying the biodegradeable rope in a diamond pattern in such a way that the holding capabilities of the remaining rope will not be sacrificed if an area should break.
- g. After securing the mattress with the biodegradeable rope, pound the live stakes farther into the ground to tightly compress the mattress against the streambank or slope. When constructing a brush mattress on a streambank, remove all loose overhanging branches that may catch on material floating down the stream that could rim the mattress from the streambank.
- f. Secure the toe of the mattress by placing large, locally collected rocks around and on top of the basal ends. Other acceptable techniques for securing the toe of the mattress include live fascines and coir fiber rolls.
- g. Backfill around and in between the branches with the material excavated from the trench. Pouring or spraying water over the mattress will help work the soil into the mattress. A minimum of one quarter (1/4) of the depth of the mattress should be covered with soil. If installing a mattress to existing vegetation for more security if possible.

13.3.2.6 Live Crib Wall

- a. At the base of the streambank to be protected excavate an area two to three feet (2'-3') below the existing grade of the streambed the length of the streambank to be protected and five to six feet (5'-6') back into the streambank.
- b. The crib wall foundation shall be excavated at a decline into the streambank at a slope ranging from 10H:1V to 6H:1V to increase the structure's stability.
- c. Place the first course of logs or timbers at the front and back of the foundation (approximately 5'-6' apart) and parallel to the slope contour.
- d. Place the next course of logs or timbers directly on top of the ends of the first course of logs or timbers perpendicular to the slope so that the ends overhang the front and back logs or timbers by three to six inches (3"-6"). Secure the two courses together with reinforcement bars.
- h. Repeat Steps 3 and 4 until the structure reaches the elevation equivalent to the biological benchmark (elevation in the stream cross section where woody plants persist) as specified on the Contract Drawings or as directed by MSD. Place rock fill into the crib wall structure and fill the structure until the biological benchmark elevation is reached.
- f. Place three inches (3") of soil on top of the rock fill.

g. Place the first layer of live branch cuttings on top of the soil perpendicular to the contours of the slope so that approximately one third of cutting length will protrude out of the structure. The basal ends of the cuttings shall be placed in the back of the structure and should come in contact with undisturbed soil in the back of the structure.

h. Place the next two courses of logs or timbers as done in Steps 3 and 4 above. Place soil fill on top and around the first layer of live branch cuttings and fill the structure to where the next layer of live branch cuttings will be installed.

i. Repeat Steps 7 and 8 until the crib wall structure is built to the elevation specified on the Contract Drawings.

13.3.2.7 Joint Planting

a. Drive joint plantings into the ground between the openings of rock during or after rock placement so that sixty percent (60%) of the stake is below the ground surface. The contractor shall use a dead-**blow** hammer for driving the stake directly into the ground or drive a pilot hole, smaller in diameter than the joint planting, and then **drive** the joint planting into the pilot hole. Install the joint plantings in a random pattern.

b. Placement of the joint plantings shall be as indicated on the Contract Drawings and details. Joint planting **shall be installed with** buds facing upward.

c. All joint plantings split during installation may be left in place but must be supplemented with a new joint planting that remains un-split after installation.

13.3.2.8 Coir Fiber Roll

Prior to the start of work on this item, the Contractor shall submit a construction schedule, including source of supply for the coir fiber roll and plant material, to MSD for review. No work shall be performed until this schedule is approved by MSD.

a. Installation. Coir Fiber Roll Toe Protection shall be installed according to the Sequence of Construction, the plans and details, and the following specifications.

1. Excavate a trench along the slope contour and place the coir fiber roll so that approximately one-quarter to one-third ($1/4$ - $1/3$) of the face of the coir fiber roll is exposed beyond the proposed grade.

2. The coir fiber rolls shall be laced together end-to-end with biodegradable rope to create a continuous length. End-to-end lacing may be completed before or after placement to facilitate handling. Abut the ends of the coir fiber roll tightly against one another.

3. Drive the large wood stakes directly into and through the edges of the coir fiber roll every three feet (3'). Extra stakes shall be used at the ends of each coir fiber roll. Biodegradable rope shall be tied to the stakes across the coir fiber rolls in a criss-cross pattern. The stakes shall be driven in until the rope is taught and the tops of the stakes are at

least flush or up to two inches (2") below the top of the coir fiber roll. If the stakes are driven to the point of refusal before reaching this position, excess top length shall be carefully sawed off.

- b. Backfill. Backfill soil in trench and around the coir fiber roll. Gently tamp and water backfill to ensure that all voids are filled with soil. The top of the coir fiber roll (approximately 1/4 to 1/3 of the roll) shall be visible when installation is completed.

13.3.2.9 Root Wads

- a. General. Prior to the start of work on this item, the Contractor shall submit a proposed harvesting schedule, including source of supply of root wad, footer and cutoff logs, and boulders, to MSD for review. No work shall be performed until this schedule is approved by MSD.

- b. Source of Materials. Trees to be used for this construction can be salvaged from the project site provided that the trees are within the limits of disturbance and are flagged prior to clearing and grubbing.

- 1. The Contractor is responsible for supplying additional trees, at no additional cost to the Owner, in order to meet Contract quantities.

- 2. Footer logs, cutoff logs, and anchor rocks shall come from within the limits of disturbance of this Contract. If sufficient material meeting the above requirements is not available from this Contract, the Contractor shall obtain material meeting specified requirements. Trees on the project site, but outside the limits of disturbance, may not be cleared for materials.

- c. Harvesting and Transporting Root Wads. Root wads shall be harvested by pushing over trees, leaving as much of the root fan and accompanying sod and soil clumps intact as possible. Care shall be taken in transporting root wads to the construction site to minimize breakage of the root fan and loss of sod and soil clumps.

Installation. Root Wads shall be installed according to MSD, Sequence of Construction, the Construction Drawings, and the following specifications.

- 1. Cut the trench for the upstream-most footer log so that the top of the footer log is at the invert of the proposed channel. The upstream footer log will be shingled with the downstream footer log (i.e. the downstream end of each upstream footer log should extend beyond and overlap the upstream end of the downstream footer log, with the downstream end of the upstream footer log nearest the stream channel) a minimum two feet (2'). Place the footer log in the trench.

- 2. Cut the trench for the upstream-most root wad log and place in the trench so that the root wad rests on top of the footer log. Place the root wad log on top of the footer log so that the root fan makes an angle of approximately thirty to sixty degrees (30°-60°) to the channel center line and ninety degrees (90°) to the flow. The root fan shall divert the force of the impact of the stream away from the stream banks. Placement of the rootwads shall be

initially and periodically verified by MSD to ensure that the rootwads are diverting flow away from the stream banks.

3. Place anchor rocks on top of the root wad log and on top of the footer log on both sides of the rood wad log.
4. Cut the trench for the next footer log as in Step 2. Cut the trench for the next root wad log so that there is a three to four foot (3'-4') spacing between adjacent root wad fans. Install root wad, footer logs and anchor rocks as in Steps 3 and 4.
5. Cut the trench for the cutoff log. Place the cutoff log in the trench on top of the rootwad so that the cutoff log is wedged close to the fan of the root wad and protrudes beyond the face of the bole in a downstream direction toward the location of the next root fan. Two to four feet (2'-4') of the cutoff log shall protrude out of the streambank after backfilling has been completed. The cutoff log shall be angled approximately thirty to sixty degrees (30°-60°) to the channel center line such that the downstream end of the cutoff log shall be wedged against the root fan and the upstream end of the cutoff log shall rest on the adjacent upstream rootwad.
6. Place anchor rocks on top of the root wad, behind the cutoff log and also on top of the cutoff log, at the intersection of the cutoff log and the root wad log. If needed or as directed by MSD, the Contractor shall place anchor rocks on the lower section of the cutoff log.
7. Repeat Steps 2 through 7 in a downstream direction until the revetment is complete.
8. Use rocks or logs to plug any holes between the logs to prevent the backfilled earth from falling into the channel. Backfill the area behind the root wad revetment and the trenches in which the root wads, footer logs, and cutoff logs and boulders are placed.
9. Under the direct supervision of MSD, the Contractor may be required to reset up to 10% of the root wad revetment throughout the course of the project. The process will involve removing any backfill material necessary to remove the cutoff log, root wad log, footer log, and boulders as necessary. Resetting will be performed as directed by MSD, and will include restoring all materials including backfill and stabilization and replanting as necessary.
10. The above operation will be conducted so that no sediment is permitted to enter the stream. Sand bag dikes will be used to isolate the areas of the stream that could receive sediment from the operation.

13.3.2.10 Boulder Bank

- a. General. Prior to the start of work on this item, the Contractor shall submit a construction schedule, including source of supply of rocks, to MSD for review. No work shall be performed until this schedule is approved by MSD.

b. Source of Materials. If sufficient material meeting the above requirements is not available from this Contract, the Contractor shall obtain material meeting specified requirements at no additional cost to MSD.

c. Installation. Boulder bank stabilization shall be installed according to the Sequence of Construction, the plans and details, and the following specifications.

1. Boulder bank stabilization shall be constructed so that the exposed face of the rocks is flush with the proposed grade.
2. The footer bank rock shall be placed so that the top of the bottom rock is flush with the channel invert.
4. The top bank rock shall be set at the elevation specified on the Construction Drawings.
5. Each bank rock shall be placed adjacent and tight against one another. All voids shall be plugged with smaller rock. The fill material behind the boulder bank stabilization shall be placed and tamped after each layer of rock is installed.
6. On completion of rock installation, reshape slopes and stream bottom to specified elevations.

13.3.2.11 Rock Toe

a. Schedule. Prior to the start of work on this item, the Contractor shall submit a **construction** schedule, including source of supply of rocks, to MSD for review. No work shall be performed until this schedule is approved by MSD.

b. Source of Materials. If sufficient material meeting the above requirements is not available from this Contract, the Contractor shall obtain material meeting specified requirements at no additional cost to MSD.

c. Installation. Boulder Toe Protection shall be installed according to the Sequence of Construction, the plans and details, and the following specifications.

1. Boulder Toe Protection shall be constructed so that the exposed **faces of the rocks are** flush with the proposed grade.
2. The footer rock shall be placed so that the top of the rock is flush with the channel invert.
3. The boulder toe rock shall be set directly on top of the footer rock. All voids shall be plugged with smaller rock and topsoil. The fill material behind the boulder toe rock shall be placed and **tamped** after the boulder toe rock is installed.
4. On completion of rock installation, reshape slopes and stream bottom to specified elevations.

13.3.3 Clean-up

- a. During installation of **soil bioengineering applications**, all areas shall be kept neat, clean and free of all trash and debris, and all reasonable precautions shall be taken to avoid damage to existing plants, turf, structures, and private property.
- b. Final clean-up shall be the responsibility of the Contractor and consist of removing all trash and materials incidental to the project and **properly** disposing of them off-site.

13.3.4 Site Inspection

- a. MSD shall make a final inspection with the Contractor to ensure all soil bioengineering-live cutting techniques have been installed according to the specifications, plans, and details.
- b. The Contractor shall be responsible for correcting all deficiencies within ten (10) calendar days of the inspection.
- c. A final inspection of the corrected actions shall be performed by MSD and the Contractor prior to completion.

13.3.5 Maintenance

- a. Soil bioengineering-live cutting techniques shall be maintained and monitored for one year after the completion, final inspection, and approval of the installation.
- b. The Contractor shall perform the following maintenance activities:
 - 1. Replace all diseased and dead vegetation caused by factors other than stream erosion.
 - 2. Keep vegetation cleared of debris after all storm events.
 - 3. Prune all dead wood and vegetation as needed.
- c. It will be the Contractor's responsibility to supply water if there is none available on the site. Any costs associated with supplying water shall be the responsibility of the Contractor and shall be included in the unit cost installation.

13.3.6 Coir Fiber Roll

The Contractor shall maintain a one (1) year, 75% care and replacement warranty for soil bioengineering techniques.

- a. The period of care and replacement shall begin after inspection and approval of the initial installation and continue for one (1) year, with one potential replacement period.
- b. The Contractor will not be responsible for soil bioengineering that has been damaged by vandalism, fire, flooding or other activities beyond the Contractor's control.

13.4 MEASUREMENT AND PAYMENT

Payment for soil bioengineering installations shall be according to the following units. All installations will include harvesting (or purchasing), transportation, installing, maintenance and warranty, including all materials, labor equipment, tools, and incidentals necessary to complete the work as **detailed** in these specifications and on the plans.

- 13.4.1 Live Stake – per square yard.
- 13.4.2 Live Branch Layering – per linear foot.
- 13.4.3 Live Fascine – per linear foot.
- 13.4.4 Branchpacking – per linear foot.
- 13.4.5 Brush Mattress – per square foot.
- 13.4.6 Live Cribwall – per square foot.
- 13.4.6 Joint Planting – per linear foot.
- 13.4.7 Coir Fiber Roll – per linear foot of coir fiber roll installed.
- 13.4.8 Root Wads – per linear foot of root wad installed including footer/cutoff logs and boulders and resetting of root wad.
- 13.4.9 Boulder Bank – per ton of boulder bank stabilization installed including excavation, installation, and resetting of rocks.
- 13.4.10 Rock Toe – per ton of boulder toe protection installed including excavation, installation, and resetting of rocks.