

## SECTION 02220

### EXCAVATION AND BACKFILL

#### PART 1 GENERAL

##### 1.1 DESCRIPTION

###### A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment and incidentals required to perform all excavating, backfilling, filling and grading, and disposing of earth materials as shown, specified, and required for construction of structures, manholes, vaults, conduits, pipelines, roads, and other facilities required to complete the Work in every respect.
2. All necessary preparation of subgrade for slabs and pavements is included.
3. All temporary means needed to prevent discharge of sediment to water courses from dewatering systems or erosion are included.
4. No classification of excavated materials will be made. Excavation includes all materials regardless of type, character, composition, moisture, or condition thereof.

###### B. Related Sections:

1. Section 02050, Demolitions.
2. Section 02512, Bituminous Paving.
3. Section 02900, Landscaping.
4. Section 15051, Buried Piping Installation.

##### 1.2 QUALITY ASSURANCE

###### A. Tests:

1. Engage the services of a qualified testing laboratory to make tests and determine acceptability of the fill or material as listed below. Laboratory shall be acceptable to ENGINEER.
2. Field quality control testing will be performed by SD1's testing service. CONTRACTOR shall give full cooperation to SD1's testing personnel so that the required tests can be taken in an efficient and timely manner.
3. Required Tests:
  - a. Select Fill Samples: Gradation, ASTM D 422.
  - b. General Fill Samples: Gradation, ASTM D 422; Atterberg Limits, ASTM D4318
  - c. Compacted General Fill: Compaction, ASTM D 1556 and ASTM D 698, ASTM D 2922.
  - d. Compacted Select Fill, Drainage Fill, Subbase Material and Pipe Bedding: Compaction, ASTM D 1556 and ASTM D 698, ASTM D 2922, ASTM D4253, ASTM D4254.

- B. Permits and Regulations:
1. SD1 will obtain all necessary permits for work in roads, rightsofway, railroads, etc.
  2. CONTRACTOR shall obtain permits as required by local, state and federal agencies for discharging water from excavations.
  3. CONTRACTOR shall perform excavation work in compliance with applicable requirements of governing authorities having jurisdiction.
- C. Reference Standards: Comply with applicable provisions and recommendations of the following except as otherwise shown or specified.
1. ASTM A 36, Specification for Structural Steel.
  2. ASTM A 328, Specification for Steel Sheet Piling.
  3. ASTM D 422, Method for ParticleSize Analysis of Soils.
  4. ASTM D 698, Standard Test Methods for Laboratory Compaction Characteristics of Soils Using Standard Effort (12,400 ft – lbf/cu ft) (600 KN-m/cum).
  5. ASTM D 1556, Test Method for Density and Unit Weight of Soil in Place by the SandCone Method.
  6. ASTM D 2321, Practice for Underground Installation of Thermoplastic Pipe for Sewer and other Gravity – Flow Applications
  7. ASTM D 2922, In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
  8. ASTM D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
  9. ASTM D4254, Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
  10. AISC Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings.
  11. Kentucky Department of Highways (KDOH), Standard Specifications for Road and Bridge Construction, 2000 Edition.
  12. OSHA Standard, Title 29, Code of Federal Regulations, Part 1926, Section .650 (Subpart P - Excavations).

### 1.3 SUBMITTALS

- A. Excavation Plan: Prior to start of excavation operations, submit written plan to demonstrate compliance with OSHA Standard 29 CFR Part 1926.650. As a minimum, excavation plan shall include:
1. Name of competent person.
  2. Excavation method(s) or protective system(s) to be used.
  3. Copies of "manufacturer's data" or other tabulated data if protective system(s) are designed on the basis of such data.
- B. Shop Drawings: Submit for approval the following:
1. Sheeting and bracing, or other protective system(s).
  2. Dewatering system.
  3. Cofferdams.
  4. Anticipated Protection Methods.

## 5. Underpinning.

Shop Drawings shall be prepared by a licensed professional engineer recognized as expert in the specialty involved. Also submit for approval, calculations and all other pertinent information. CONTRACTOR, however, will be responsible for designing, installing, operating and maintaining the system(s) as required to satisfactorily accomplish all necessary sheeting, bracing, protection, underpinning and dewatering.

- C. Submit gradation and compaction test reports of all specified soil materials.

### 1.4 JOB CONDITIONS

- A. Subsurface Information: Refer to Supplementary Conditions for Data on subsurface conditions. Data is not intended as a representation or warranty of continuity of conditions between soil borings nor of groundwater levels at dates and times other than date and time when measured. SD1 will not be responsible for interpretations or conclusions drawn therefrom by CONTRACTOR. Data are solely made available for the convenience of CONTRACTOR.
  - 1. Additional test borings and other exploratory operations may be made by CONTRACTOR at no cost to SD1.
- B. Existing Structures: The Drawings show certain surface and underground structures adjacent to the Work. This information has been obtained from existing records. It is not guaranteed to be correct or complete and is shown for the convenience of CONTRACTOR. CONTRACTOR shall explore ahead of the required excavation to determine the exact location of all structures. They shall be supported and protected from damage by CONTRACTOR. If they are broken or damaged, they shall be restored immediately by CONTRACTOR at his expense.
- C. Existing Utilities: Locate existing underground utilities in the areas of Work. If utilities are to remain in place, provide adequate means of protection during all operations.
  - 1. Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, consult piping or utility owner and ENGINEER immediately for directions as to procedure. Cooperate with SD1 and utility owner in keeping services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.
  - 2. In general, service lines to individual houses and businesses are not shown; however, CONTRACTOR shall assume that a service exists for each utility to each house or business.
  - 3. Do not interrupt existing utilities serving facilities occupied and used by SD1 or others, except when permitted in writing by ENGINEER and then only after acceptable temporary utility services have been provided.
  - 4. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies for shutoff of services if lines are active.

- D. Protection of Persons and Property: Barricade open excavations occurring as part of the Work and post with warning lights. Operate warning lights during hours from dusk to dawn each day and as otherwise required.
  - 1. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by earthwork operations.
  
- E. Dust Control: Conduct all operations and maintain areas of activity, including sweeping and sprinkling of roadways, to minimize creation and dispersion of dust. Calcium chloride may be used to control serious or prolonged dust problems, subject to approval of ENGINEER.

## PART 2 PRODUCTS

### 2.1 SOIL MATERIALS

- A. Select Fill:
  - 1. Place select fill where shown or specified below and around structures, pipelines, roads, tanks, walks, and other work.
  - 2. Use well graded sand and gravel, free from organic matter. A well-graded select fill shall have a uniformity coefficient greater than 6 for sand and greater than 4 for gravel and have a coefficient of gradation between 1 and 3 for sand and gravel. Not more than 70 percent by weight shall pass through a No. 40 sieve; not more than 10 percent by weight shall pass through a No. 200 sieve; and 100 percent shall pass
  - 3. Advise ENGINEER in writing of source and, if required, submit a sample of the material for approval.
  
- B. Subbase Material:
  - 1. Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, or natural or crushed sand, approved by ENGINEER.
  - 2. Comply with the gradation conforming to Crushed Stone Base in KYTC Standard Specifications for Road and Bridge Construction, Latest Edition.
  
- C. Drainage Fill: Gradation shall conform to the requirements for Free Draining Bedding and Backfill in KYTC Standard Specifications for Road and Bridge Construction, Latest Edition.
  
- D. General Backfill and Fill Materials: Provide approved soil materials for backfill and fill, free of rock thicker than 6 inches or larger than 24 inches maximum in any dimension, debris, waste, frozen materials, vegetable and other organic matter and other deleterious materials. Previously excavated materials meeting these requirements may be used for backfill. All rock shall be excluded from fill within 24 inches of the pipe.
  
- E. Riprap: Provide rock, broken concrete (if no reinforcing steel is present), or stone of sizes such that at least 85% of the total material by weight is larger than a 6-inch but less than an 18-inch square opening. At least 50% of the total material by weight shall be

larger than a 12-inch square opening. The material smaller than a 6-inch square opening shall consist predominantly of rock and shall be free of soil.

F. Pipe Bedding Material:

1. Place around pipe and compact for pipe bedding material.
2. Fill shall be clean natural or washed sand and gravel, crushed gravel or crushed stone, free from bituminous or cementitious substances and flat or flaky particles in an amount to cause caking, packing, yielding or uneven support for the pipe. Lime sand shall not be acceptable. All material shall be of such sizes that one-hundred percent (100%) passes the one and one half (1 ½) inch screen, 40% or less passes the No. 40 sieve, and ten (10) percent or less passes the No. 200 sieve.
3. Fill shall not consist of any organic soil or stone larger than 1½-inch in any dimension.

G. Control Density Fill:

1. Use for trench backfill where shown on the Drawings.
2. Description:
  - a. Flowable fill shall consist of a mixture of cement, sand, fly ash, water and other materials approved by SD1.
3. Materials and Mixing Proportioning:
  - a. Cement: 30 lbs.
  - b. Fly Ash, Class F: 300 lbs. Do not allow the loss or ignition for Class F fly ash to exceed twelve (12) percent.
  - c. Natural Sand (S.S.D): 3,000 lbs.
  - d. Water (Maximum): 550 lbs. Water used for the mixture shall be potable and free of oil, salts, acid and other impurities that would have an adverse effect on the quality of the backfill material.
4. Properties:
  - a. Average Compressive Strength:
    - 1) 28 days: 50 to 100 psi
  - b. For applications that require early opening to traffic or placement of pavement as soon as possible, provide a mixture with the following properties:
    - 1) Mixture bleeds freely within 10 minutes
    - 2) Mixture shall support a 150-pound person within three (3) hours.

H. Flash Fill:

1. Use for trench backfill where shown on the Drawings.
2. Description:
  - a. Be readily flowable to form around pipes, cables and other embedments in trenches.
  - b. Achieve a quick initial set to permit paving within 4 hours of placement.
  - c. Achieve an initial strength capable of bearing traffic within 4 hours of placement.
  - d. Achieve an ultimate strength of no more than 100 psi so that material can be re-excavated if necessary.

3. Materials:
  - a. Cement: None.
  - b. Fly ash shall meet ASTM C-618, Class C or Class F, except that requirement for moisture and pozzolanic activity are waived for Class F fly ash.
  - c. Sand shall be natural, recycled, or manufactured. Other filler materials may be used as a substitute with approval.
  - d. Water used for the mixture shall be potable and free of oil, salts, acid and other impurities that would have an adverse effect on the quality of the backfill material.
4. Properties:
  - a. Resistance to Penetration (avg. at 4 hours): 400 psi.
  - b. Coefficient of Permeability:  $2.6 \times 10^{-5}$  cm/sec.
  - c. Unconfined Compressive Strength:
    - 1) 3 Hours: 20 psi (1.44 tsf).
    - 2) 28 Days: 70 psi (5.0 tsf).
    - 3) 91 Days: 100 psi (7.2 tsf).
  - d. Atterberg Limits: Non plastic.
  - e. pH (at one month): 11.16.
  - f. Thermal Resistivity: 45 C-cm/w.
  - g. Color: Tan.
5. Mixing Proportioning:
  - a. ASTM C-618 Fly Ash: 400 lbs.
  - b. Sand: 2930 lbs.
  - c. Water: 430 lbs.
  - d. Unit Weight (Fresh Weight): 135 lbs/cu. ft.
6. Product Name:
  - a. Flashfill by Roth Ready Mix Concrete Co.
  - b. Or equal.

## PART 3 EXECUTION

### 3.1 INSPECTION

- A. CONTRACTOR shall examine installation site, verify elevations, and observe conditions under which work is to be performed and notify ENGINEER of unsatisfactory conditions. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.
- B. Provide ENGINEER with sufficient notice and with means to examine the areas and conditions under which excavating, filling, and grading are to be performed. ENGINEER will notify CONTRACTOR if conditions are found that may be detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in an acceptable manner.

### 3.2 SITE PREPARATION

- A. Clear all areas to be occupied by permanent construction or embankments of all trees, brush, roots, stumps, logs, wood and other materials and debris. Clean and strip subgrades for fills and embankments of vegetation, sod, topsoil and organic matter. All waste materials shall be removed from site and properly disposed of by CONTRACTOR. Burning will not be permitted.

### 3.3 TEST PITS

- A. Where shown or ordered by ENGINEER, excavate and backfill, in advance of construction, test pits to determine conditions or location of existing facilities. Perform all work required in connection with excavating, stockpiling, maintaining, sheeting, shoring, backfilling and replacing pavement for the test pits.
- B. Payment for test pits ordered by ENGINEER not included in section 0300 will be paid for under a change order per Article 10 of the General Conditions.
- C. No separate payment will be made for test pits made by CONTRACTOR for his own use.

### 3.4 EXCAVATION

- A. Perform all excavation required to complete the Work as shown, specified and required. Excavations shall include earth, sand, clay, gravel, hardpan, boulders, bedrock, pavements, rubbish and all other materials within the excavation limits.
- B. Refer to Section 02222 for Rock Removal.
- C. Excavations for structures and pipelines shall be open excavations. Provide excavation protection system(s) required by ordinances, codes, law and regulations to prevent injury to workmen and to prevent damage to new and existing structures or pipelines. Unless shown or specified otherwise, protection system(s) shall be utilized under the following conditions.
  - 1. Excavation Less Than 5 Feet Deep: Excavations in stable rock or in soil conditions where there is no potential for a cave-in may be made with vertical sides. Under all other conditions, excavations shall be sloped and benched, shielded, or shored and braced.
  - 2. Excavations More Than 5 Feet Deep: Excavations in stable rock may be made with vertical sides. Under all other conditions, excavations shall be sloped and benched, shielded or shored and braced.
  - 3. Excavation protection system(s) shall be installed and maintained in accordance with drawings submitted under Article 1.3 above.
- D. Where the structure or pipeline is to be placed below the ground water table, well points, cofferdams or other acceptable methods shall be used to permit construction of said structure or pipeline under dry conditions. Dry conditions shall prevail until concrete has

reached sufficient strength to withstand earth and hydrostatic loads and until the pipelines are properly jointed, and backfilled. In addition, protect excavation from flooding until all walls and floor framing up to and including grade level floors are in place and backfilling has begun. Water level shall be maintained below top of backfill at all times.

- E. Pumping of water from excavations shall be done in such a manner to prevent the carrying away of unsolidified concrete materials, and to prevent damage to the existing subgrade. See also additional requirements in section 15051 BURIED PIPING INSTALLATION.
- F. The elevation of the bottom of footings shown shall be considered as approximate only and ENGINEER may order such changes in dimensions and elevations as may be required to secure a satisfactory footing. All structure excavations shall be hand-trimmed to permit the placing of full widths, and lengths of footings on horizontal beds. Rounded and undercut edges will not be permitted.
- G. When excavations are made below the required grades, without the written order of ENGINEER, they shall be backfilled with compacted gravel or concrete, as directed by ENGINEER, at the expense of CONTRACTOR.
- H. Excavations shall be extended sufficiently on each side of structures, footings, etc., to permit setting of forms, installation of shoring or bracing or the safe sloping of banks.
- I. Subgrades:
  - 1. General Requirements: The backfill shall be maintained at  $\pm 3\%$  from optimum moisture content. The compacted fill shall remain firm and intact under all construction operations. Mud, muck, and other soft or unsuitable materials shall be removed.
  - 2. Subgrade Requirements for Roadways: Compact to the degree specified in the KYTC Standard Specifications for Road and Bridge Construction, Latest Edition.
  - 3. Subgrade Requirements for Pipeline Trench Bottoms, Floor Slabs and Concrete Pads: Compact to at least 95% of the maximum Standard Proctor dry unit weight as determined by ASTM D 698.
  - 4. Subgrade Requirements for Footing Foundations: Compact to at least 98% of the maximum Standard Proctor dry unit weight as determined by ASTM D 698 (unless otherwise noted).
  - 5. Soft Subgrades: For subgrades which are otherwise solid, but which become soft or unsuitable on top due to construction operations, remove the soft and unsuitable material and replace with suitable backfill and recompact to the specified density.
  - 6. Finished Elevation of Stabilized Subgrades: Do not place above subgrade elevations shown.
- J. Stability of Excavations:
  - 1. Sides of Excavations: Slope to comply with codes and ordinances of agencies having jurisdiction.



2. Shoring and Bracing: Provide shoring and bracing where sloping is not possible either because of space restrictions or stability of material excavated.
  3. Safety: Maintain sides and slopes of excavations in a safe condition until completion of backfilling.
  4. Caving: If caving occurs outside the excavation area, backfill the resulting hole in accordance with the requirements of this section after removing loose material.
- K. Pipe Trench Preparation: Trench construction shall be per SD1 pipe bedding and trench condition details as follows
1. No more than 200 feet of trench may be opened in advance of pipe laying.
  2. Trench width shall be minimized to greatest extent practical but shall conform to SD1's standard trench details and the following:
    - a. Flexible Pipe: Sufficient to provide room for installing, jointing and inspecting piping, but a minimum of pipe barrel OD plus two feet for 36" and less diameter pipe. For pipe that is greater than 36" in diameter, the trench width shall be the OD of the pipe plus four feet.
    - b. Rigid Pipe: Sufficient to provide room for installing, jointing and inspecting piping, but a minimum of pipe barrel OD plus two feet for 36" and less diameter pipe. For pipe that is greater than 36" in diameter, the trench width shall be: **OD + 2\*(OD/6)**.
    - c. Enlargements at pipe joints may be made if required and approved by ENGINEER.
    - d. Sufficient for shoring and bracing, or shielding and dewatering.
    - e. Sufficient to allow thorough compaction of bedding material adjacent to bottom half of pipe.
    - f. Do not use excavating or compaction equipment, which requires the trench to be excavated to excessive width.
  3. Depth of trench shall be as shown. If required and approved by ENGINEER, depths may be revised.
  4. Bedding material shall be carefully placed over the full trench width before the pipe is laid to a depth of at least 6-inches and compacted in maximum of 6-inch lifts over the full trench width. Where pipe is laid in rock excavation, depth of pipe bedding below the pipe shall be at least 6-inches for pipe 24-in. and smaller and 9-inches for pipe 30-in. and larger. After laying pipe, the balance of the bedding material and backfill shall be placed as described herein.
- L. Material Storage: Stockpile satisfactory excavated materials in approved areas, until required for backfill or fill. Place, grade and shape stockpiles for proper drainage.
1. Locate and retain soil materials away from edge of excavations.
  2. Dispose of excess soil material and waste materials as specified hereinafter.
- M. Where ENGINEER considers the existing material beneath the bedding material unsuitable, CONTRACTOR shall remove same and replace it with compacted select fill or compacted pipe bedding material.

### 3.5 UNAUTHORIZED EXCAVATION

- A. All excavation outside the lines and grades shown, and which is not approved by ENGINEER, together with the removal and disposal of the associated material shall be at CONTRACTOR'S expense. Unauthorized excavations shall be filled and compacted with select backfill by CONTRACTOR at his expense.

### 3.6 AUTHORIZED UNDERCUTS

- A. Subgrades for concrete structures and trench bottoms shall be firm, dense, and thoroughly compacted and consolidated; shall be free from mud and muck; and shall be sufficiently stable to remain firm and intact under the feet of the workers.
- B. If in the course of excavation as determined by the ENGINEER, unstable soil is encountered at the point of the bottom of the required excavation, the CONTRACTOR shall be authorized to undercut sufficiently to remove all the unstable soil to the limits specified by the ENGINEER.
- C. The CONTRACTOR shall refill the undercuts with select backfill or pipe bedding material and compact same to the requirements set forth in paragraph 3.4.I, unless other means of refill are specified or ordered by the ENGINEER.
- D. The cost of removing and disposing of the unstable material and providing refill material shall be reimbursable to the CONTRACTOR at the contract unit price bid or at a mutually agreeable negotiated unit price between the CONTRACTOR and SD1

### 3.7 DRAINAGE AND DEWATERING

- A. General:
  - 1. Prevent surface and subsurface water from flowing into excavations and from flooding adjacent areas.
  - 2. Remove water from excavation as fast as it collects.
  - 3. Maintain the ground water level below the bottom of the excavation to provide a stable surface for construction operations, a stable subgrade for the permanent work, and to prevent damage to the Work during all stages of construction.
  - 4. Provide and maintain pumps, sumps, suction and discharge lines and other dewatering system components necessary to convey water away from excavations.
  - 5. Obtain ENGINEER'S approval before shutting down dewatering system for any reason.
- B. Standby Requirements for Dewatering: Provide standby equipment to ensure continuity of dewatering operations.
- C. Disposal of Water Removed by Dewatering System:

1. All dewatering flows are to be settled in siltation basins or directed through filtering devices before discharge to stabilized sites, such as streams or sewers; not onto exposed soils, stream banks, or any other site where the flow could cause erosion.
2. Silt from construction operations shall not be permitted to enter the storm sewer system. When construction occurs near storm sewer inlets, erosion control measures such as inlet filters and hay bales shall be used to prevent silt from entering storm sewers.
3. Dispose of all water removed from the excavation in such a manner as not to endanger public health, property, or any portion of the Work under construction or completed.
4. Dispose of water in such a manner as to cause no inconvenience to SD1, ENGINEER, or others involved in work about the site.
5. Convey water from the construction site in a closed conduit. Do not use trench excavations as temporary drainage ditches.
6. CONTRACTOR shall be responsible for complying with all regulatory agency rules pertaining to dewatering and obtaining permits, if required.
7. See also additional requirements in section 15051 BURIED PIPING INSTALLATION.

### 3.8 SHEETING, SHORING AND BRACING

#### A. General:

1. Used material shall be in good condition, not damaged or excessively pitted. All steel or wood sheeting designated to remain in place shall be new. New or used sheeting may be used for temporary work.
2. All timber used for breast boards (lagging) shall be new or used, meeting the requirements for Douglas Fir Dense Construction grade with a bending strength not less than 1500 psi or Southern Pine No. 2 Dense.
3. All steel work for sheeting, shoring, bracing, cofferdams etc., shall be designed in accordance with the provisions of the "Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings", of the AISC except that field welding will be permitted.
4. Steel sheet piling shall be manufactured from steel conforming to ASTM A 328. Steel for soldier piles, wales and braces shall be new or used and shall conform to ASTM A 36.
5. Maintain shoring and bracing in excavations regardless of time period excavations will be open. Carry down shoring and bracing as excavation progresses.
6. Unless otherwise shown, specified, or ordered, all materials used for temporary construction shall be removed when work is completed. Such removal shall be made in a manner not injurious to the structure or its appearance or to adjacent Work.
7. Provide permanent steel sheet piling or pressure creosoted timber sheet piling wherever subsequent removal of sheet piling might permit lateral movement of soil under adjacent structures. Cutoff tops as required and leave permanently in place.
8. The clearances and types of the temporary structures, insofar as they affect the character of the finished Work, and the design of sheeting to be left in place, will be

subject to the approval of ENGINEER; but CONTRACTOR shall be responsible for the adequacy of all sheeting, shoring, bracing, coffer-damming, etc.

9. Safe and satisfactory sheeting, shoring and bracing shall be the entire responsibility of CONTRACTOR.

B. Sheeting Left in Place:

1. Steel sheet piling shown to be left in place shall consist of rolled sections of the continuous interlocking type unless otherwise approved. The type and design of the sheeting and bracing shall conform to the above specifications for all steel work for sheeting and bracing. Steel sheeting designated to be left in place shall be new.
2. Steel sheet piling to be left in place shall be driven straight to the lines and grades as shown or directed. The CONTRACTOR shall determine the grade to which the sheet piling shall be driven. The piles shall penetrate into firm materials with secure interlocking throughout the entire length of the pile. Damaged piling having faulty alignment shall be pulled and replaced by new piling.
3. The type of guide structure used and method of driving for steel sheet piling to be left in place shall be subject to the approval of ENGINEER. Jetting will not be permitted.
4. Cut off piling left in place to the grades shown or ordered by ENGINEER and remove the cut offs from the site.
5. Clean wales, braces and all other items to be embedded in the permanent structure, and ensure that the concrete surrounding the embedded element is sound and free from air pockets or harmful inclusions. Provisions shall include the cutting of holes in the webs and flanges of wale and bracing members, and the welding of steel diaphragm waterstops perpendicular to the centerline of brace ends which are to be embedded.
6. Subsequent to removal of the inside face forms, and when removal of bracing is permitted, cut back steel at least 2 inches inside the wall face and patch opening with cement mortar. Concrete shall be thoroughly worked beneath wales and braces, around stiffeners and in any other place where voids may be formed.
7. Portions of sheeting or soldier piles and breast boards which are in contact with the foundation concrete shall be left in place, together with wales and bracing members which are cast into foundation or superstructure concrete.

C. Removal of Sheeting and Bracing:

1. Remove sheeting and bracing from excavations unless otherwise ordered in writing by ENGINEER. Removal shall be done so as to not cause injury to the Work. Removal shall be equal on both sides of excavation to ensure no unequal loads on pipe or structure.
2. Defer removal of sheeting and bracing, where removal may cause soil to come into contact with concrete, until the following conditions are satisfied:
  - a. Concrete has cured a minimum of 7 days.
  - b. Wall and floor framing up to and including grade level floors are in place.

### 3.9 TRENCH SHIELDS

- A. Excavation of earth material below the bottom of a shield shall not exceed the limits established by ordinances, codes, laws and regulations.
- B. When using a shield for pipe installation:
  - 1. Any portion of the shield that extends below the mid-diameter of an installed rigid pipe (i.e. RCCP) shall be raised above this point prior to moving the shield ahead for the installation of the next length of pipe.
  - 2. The bottom of the shield shall not extend below the mid-diameter of installed flexible pipe (i.e. Steel, DI, PVC, etc.) at any time and shall be raised above this point prior to moving the shield ahead for the installation of the next length of pipe.
- C. When using a shield for the installation of structures, the bottom of the shield shall not extend below the top of the bedding for the structures.
- D. When a shield is removed or moved ahead, extreme care shall be taken to prevent the movement of pipe or structures or the disturbance of the compacted bedding for pipe or structures. Pipe or structures that are disturbed shall be removed and reinstalled as specified.

### 3.10 GENERAL REQUIREMENTS FOR BEDDING, BACKFILL, FILL AND COMPACTION

- A. Furnish, place and compact all fill and backfill required for structures and trenches and to provide the finished grades shown and specified, including but not limited to restoration of access roads, construction benches, etc. Unless otherwise specified, backfill and fill may be obtained from onsite sources. Additional materials, if required, shall be furnished from offsite sources at no additional cost to SD1.
- B. Backfill excavations as promptly as Work permits, but not until completion of the following:
  - 1. Acceptance by ENGINEER of construction below finish grade including dampproofing, waterproofing, perimeter insulation, trench construction, and pipe and bedding installation.
  - 2. Inspection, testing, approval, and recording of locations of underground utilities.
  - 3. Removal of concrete formwork.
  - 4. Removal of shoring and bracing.
  - 5. Removal of trash and debris.
  - 6. Permanent or temporary horizontal bracing is in place on horizontally supported walls.
  - 7. Placement of settlement plates.
- C. Keep excavations dry during backfilling operations. Bring backfill around structures and piping up evenly on all sides.

- D. Do not allow levels of backfill against concrete walls to differ by more than 2 feet on either side of walls unless walls are adequately braced or all floor framing is in place up to and including grade level slabs.
- E. Place select backfill material above pipe encasements and as bedding material for pipelines that pass under structures, concrete pavements, or other pipelines. General backfill material may be used above pipe bedding material in other areas. Method of bedding pipe shall be as specified in Section 02610 and as shown on the Drawings.
- F. Place all bedding in pipe trenches in horizontal layers not exceeding 6 inches in depth up to a point 12-inches or more above the top of the pipe and thoroughly compact each layer along the full trench width before the next layer is placed.
- G. Prior to the installation of pipes which are to be installed in fill sections, place the fill as described herein, until a minimum height of 2 feet above the pipe is reached, unless otherwise required in other Sections. The fill for the trench width shall then be excavated and the pipe installed, bedded, and backfilled. The remainder of the fill shall then be placed.
- H. Control the water content of backfill and fill material during placement within the range necessary to obtain the compaction specified. In general, the moisture content of the fill shall be within 3 percent of the optimum moisture content for compaction as determined by laboratory tests. Perform all necessary work to adjust the water content of the material to within the range necessary to permit the compaction specified. Do not place backfill or fill material when free water is standing on the surface of the area where the backfill or fill is to be placed. No compaction of backfill or fill will be permitted with free water on any portion of the material to be compacted.
- I. Do not place or compact backfill or fill in a frozen condition or on top of frozen material. Remove backfill or fill containing organic materials or other unacceptable material and replace with approved backfill material.
- J. Perform Compaction of bedding, backfill and fill with equipment suitable for the type of material placed and which is capable of providing the densities required. CONTRACTOR shall select compaction equipment and submit it and his proposed procedure to ENGINEER for approval.
- K. Compacted bedding, backfill, and fill shall be compacted by at least two coverages of all portions of the surface of each lift by compaction equipment. One coverage is defined as the condition obtained when all portions of the surface of the material have been subjected to the direct contact of the compactor.
- L. Test the effectiveness of the equipment selected by CONTRACTOR at the commencement of compaction by construction of a small section of trench, backfill or fill within the area where material is to be placed. If tests on this section show that the specified compaction is not obtained, CONTRACTOR shall increase the number of

coverages, decrease the lift thicknesses or obtain a different type of compactor. No additional cost to SD1 shall be incurred.

- M. Perform backfill around structures using the specified procedures, except that within 10 feet of foundations and underground structures, light compaction equipment shall be used, with the gross weight of the equipment not exceeding 7,000 pounds. Provide equipment that is capable of the required compaction within restricted areas next to structures and around piping.

### 3.11 PIPE BEDDING

- A. Bedding Pipe: Bed pipe as specified below. Piping refers to the main line pipe as well as any service laterals or connections to the mainline pipe.
  1. Trench excavation, backfill, bedding materials and compaction shall conform to the requirements of this section 02220.
  2. Excavate trenches below the pipe bottom by the amount specified below.
  3. Remove all loose and unsuitable material from the trench bottom in accordance with 3.6, Authorized Undercuts.
  4. Use pipe bedding material as specified in 2.1.F.
  5. Where pipe is installed in a trench excavation, pipe bedding shall be carefully placed and compacted over the full trench width before the pipe is laid. Depth of pipe bedding below the pipe shall be at least 6 inches for pipe 24-in. and smaller and 9 inches for pipe 30-in. and larger. After laying pipe, the balance of the bedding shall be placed as described herein.
  6. Carefully and thoroughly compact all pipe bedding with equipment that achieves the degree of compaction specified in 3.14, Compaction Specifications.
  7. Excavate for bell holes in bedding carefully so as not to disturb the surrounding compacted material and lay pipe so that the bell bears uniformly on the compacted trench bedding material beneath the pipe.
  8. If ENGINEER or SD1 witness bedding not being installed correctly, ENGINEER or SD1 may require approval of the bedding condition prior to laying the pipe. If a conflict exists obtain clarification from ENGINEER before proceeding.
  9. Continue placement of bedding material around pipe. Place all bedding and backfilling in pipe trenches in horizontal layers not exceeding 6 inches in depth and thoroughly compact each layer before the next layer is placed. Bedding material shall be sliced or worked-in along the length of the pipeline during each 6-inch layer lift and then compacted.
  10. No pipe shall be brought into position until the preceding length has been bedded and secured in its final position.
  11. Bedding and initial backfill continues to 12 inches above the top of the pipe.
  12. See Sewer Trench Compaction Detail that follows this section.

#### 3.11.1 Normal Backfill

- A. After the pipe sections have been embedded up to a point 12-inches or more above the top of the pipe, the pipe sections have been encased in concrete, or the structures or

appurtenances have been constructed, as specified on the drawings, the remainder of the trench or excavated area shall be backfilled using trench or structure excavated material if it meets the requirements set forth under 2.1.D. General Backfill and Fill Materials. If the material does not meet these requirements, the trench or structure excavated material shall be wasted and suitable imported material shall be used for backfill.

- B. Backfill shall be placed in horizontal loose lifts not exceeding 8 inches in thickness and shall be mixed and spread in a manner assuring uniform lift thickness after placing. Backfill shall then be compacted as specified under 3.11 Compaction Specifications up to existing ground level or finished grade level if same has been established.

### 3.11.2 Rock Backfill

- A. Where the trench is located in areas from which rock had to be excavated in a quantity other than isolated stones, the excavated rock may be used as part of the backfill above a point 2 feet or more above the top of the pipe, or above a point 1 foot above pipe encasement, but shall not be used under pavement areas, unless specifically authorized by the ENGINEER.
- B. The rock fragments used in the backfill shall not exceed rock thicker than 6 inches or larger than 24 inches maximum in any dimension, shall not be dropped into the trench directly over the pipe centerline and shall be used with sufficient smaller dimensioned material so that voids between larger fragments shall be filled. Compaction shall meet the requirements specified under 3.11 Compaction Specifications up to existing ground level or finished grade level if same has been established.
- C. Rock shall not be used in the top 12-inches of the backfill, except across creeks, gullies, ravines or areas designated by the ENGINEER, where the rock may be used to the existing ground level as specified on the drawings.

### 3.12 COMPACTION SPECIFICATIONS

- A. Requirements based on material types are as follows:
  - 1. Select Fill, Drainage Fill and Pipe Bedding: For fill and bedding beneath structures and foundations, compact granular materials that exhibit a well-defined moisture density curve to at least 98 percent of the standard proctor maximum dry density (ASTM D698). For all other fill and bedding, compact granular materials that exhibit a well-defined moisture-density curve to at least 95 percent (ASTM D698). Moisture-condition fill materials to within a range of two (2) percent below to three (3) percent above optimum moisture content (ASTM D698). Compact granular materials that do not exhibit a well-defined moisture-density curve to at least 85 percent relative density (ASTM D4253 and D4254) beneath structures and foundations, and to at least 75 percent relative density (ASTM D4253 and D4254) for all other areas.



2. Subbase Material: Compact granular materials that exhibit a well-defined moisture-density curve to at least 100 percent (ASTM D698). Moisture-condition subbase material to within one (1) percent of optimum moisture contents (ASTM D698). Compact granular materials that do not exhibit a well-defined moisture density curve to at least 85 percent relative density (ASTM D4253 and D4254).

3. General Fill and Backfill: Compact materials that exhibit a well-defined moisture density curve to at least 98 percent of the standard proctor maximum dry density (ASTM D698) beneath structures, foundations and the top one (1) foot below pavements, and at least 95 percent (ASTM D698) in all other areas. Moisture-condition fill materials to within a range of two (2) percent below to three(3) percent above optimum moisture content (ASTM D698). Compact granular or rock materials that do not exhibit a well-defined moisture-density curve to at least 85 percent relative density (ASTM D4253 and D4254) beneath structures and foundations, and to at least 75 percent relative density (ASTM D4253 and D4254) for all other areas.

B. If the specified densities are not obtained because of improper control of placement or compaction procedures, or because of inadequate or improperly functioning compaction equipment, or because of soil moisture content, the CONTRACTOR shall perform whatever work is required to provide the required densities. This work shall include complete removal of unacceptable bedding, backfill or fill areas, and replacement and recompaction until acceptable densities are provided.

C. CONTRACTOR shall repair, at his own expense, any Settlement that occurs within the construction area. He shall make all repairs and replacements necessary within 30 days after notice from ENGINEER or SD1.

### 3.13 EMBANKMENTS

A. To the maximum extent available, use excess earth obtained from structure bench and trench excavations for construction of embankments. Obtain additional material from borrow pits as necessary. After preparation of the embankment area, level and roll the subgrade so that surface materials of the subgrade will be compact and well bonded with the first layer of the embankment. All material deposited in embankments shall be free from rocks or stones, more than 6 inches thick or larger than 24 inches in maximum dimension, brush, stumps, logs, roots, debris, and organic or other objectionable

materials. Construct embankments in horizontal layers not exceeding 8 inches in uncompacted thickness. Spread and level material deposited by excavating and hauling equipment prior to compaction. Thoroughly compact each layer by rolling or other method acceptable to the ENGINEER to at least 98 percent of the maximum density within two (2) to three (3) percent of optimum moisture content as determined by ASTM D 698 beneath structures and foundations, and 95 percent (ASTM D698) in all other areas. If the material fails to meet the density specified, compaction methods shall be altered. Wherever a trench passes through a fill or embankment, the fill or embankment material shall be placed and compacted to an elevation 24 inches above the top of the pipe before the trench is excavated.

### 3.14 STRUCTURE FILL

- A. Provide structure fill in the following locations:
  - 1. Support for structure foundations where CONTRACTOR excavates below design subgrade shall be provided at CONTRACTOR'S expense.
  - 2. Support below and around piping and foundations as directed by ENGINEER.
  - 3. Subgrade for roads and pavements.
  - 4. Restoration of construction benches and access roads.
  - 5. Where shown or directed by ENGINEER.
- B. Subgrade surface shall be level, dry, firm and subject to ENGINEER'S approval. Do not place fill if any water is on the surface of area to receive fill. Do not place or compact fill in a frozen condition or on top of frozen material.
- C. Place fill in horizontal loose lifts of 8 inches maximum thickness. It shall be mixed and spread in a manner to assure uniform lift thickness after placing.
- D. Compact each layer of fill before placement of the next lift.
- E. Do not use fill containing topsoil, rubble, debris, wood or other organic matter. Fill containing unacceptable material shall be removed and disposed of.
- F. The water content of the fill being compacted shall be within the range of two (2) percent below to three (3) percent above the optimum moisture content of the material. CONTRACTOR shall wet or dry the fill materials during placement to achieve water contents needed for effective compaction.
- G. Perform compaction of fill with equipment suitable for the type of fill material being placed. Select equipment, which is capable of providing the densities, required and submit selection of the equipment to ENGINEER for approval.
- H. Compact each layer of fill material by at least two complete coverages of all portions of the surface of each lift using approved compaction equipment. One coverage is defined as the condition reached when all portions of the fill lift have been subjected to the direct contact of the compacting surface of the compactor.

- I. The minimum density to be obtained in compacting the structural fill shall be 98 percent of the standard Proctor maximum dry density (ASTM D698) beneath structures and foundations, and 95 percent (ASTM D698) in all other areas. If the field and laboratory tests indicate unsatisfactory compaction, CONTRACTOR shall provide the additional compaction necessary to obtain the specified degree of compaction. All additional compaction work shall be performed by CONTRACTOR at no additional cost to SD1 until the specified compaction is obtained.
- J. Structure fill necessary to replace subgrade materials disturbed and softened as a result of CONTRACTOR'S operations or to backfill unauthorized excavation shall be provided, placed and compacted at CONTRACTOR'S expense.

### 3.15 GRADING

- A. General: Uniformly grade areas within limits of grading under this Section, including adjacent transition areas. Smooth subgrade surfaces within specified tolerances, compact with uniform levels or slopes between points where elevations are shown, or between such points and existing grades.
- B. Grading Outside Building Lines: Grade areas adjacent to building lines to drain away from structures and to prevent ponding. Finish surfaces free from irregular surface changes, and as follows:
  - 1. Turfed Areas or Areas Covered with Gravel, Stone, Wood Chips, or Other Special Cover: Finish areas to receive topsoil or special cover to within not more than 1 inch above or below the required subgrade elevations.
  - 2. Walks: Shape surface of areas under walks to line, grade and crosssection, with finish surface not more than 1 inch above or below the required subgrade elevation.
  - 3. Pavements: Shape surface of areas under pavement to line, grade and crosssection, with finish surface not more than 1/2 inch above or below the required subgrade elevation.
- C. Grading Surface of Fill under Building Slabs: Grade smooth and even, free of voids, compacted as specified, and to required elevation. Provide final grades within a tolerance of 1/2 inch when tested with a 10 foot straightedge.
- D. Compaction:
  - 1. After grading, compact subgrade surfaces to the depth and percentage of maximum density for each area classification.

### 3.16 PAVEMENT SUBBASE COURSE

- A. General: Place subbase material, in layers of specified thickness, over ground surface to support pavement base course.
  - 1. See other Sections of Division 2 for paving specifications.

- B. Grade Control: During construction, maintain lines and grades including crown and crossslope of subbase course.
- C. Shoulders: Place shoulders along edges of subbase course to prevent lateral movement. Construct shoulders of acceptable soil materials, placed in such quantity to compact to thickness of each subbase course layer. Compact and roll at least a 12 inch width of shoulder simultaneously with compacting and rolling of each layer of subbase course.
- D. Placing: Place subbase course material on prepared subgrade in layers of uniform thickness, conforming to indicated cross-section and thickness. Maintain optimum moisture content for compacting subbase material during placement operations.
  - 1. When a compacted subbase course is shown to be 6 inches thick or less, place material in a single layer. When shown to be more than 6 inches thick, place material in equal layers, except no single layer more than 6 inches or less than 3 inches in thickness when compacted.

### 3.17 DISPOSAL OF EXCAVATED MATERIALS

- A. Material removed from the excavations which does not conform to the requirements for fill or is in excess of that required for backfill shall be hauled away from the project site by the CONTRACTOR and disposed of in compliance with ordinances, codes, laws and regulations at no additional cost to SD1.

### 3.18 RESTORING AND RESURFACING EXISTING ROADWAYS AND FACILITIES

- A. Restore pavement per roadway trench detail. . Maintain the surface of the paved area over the trench in good and safe condition during progress of the entire Work, and promptly fill all depressions over and adjacent to the trench caused by settlement of backfilling. The permanent replacement pavement shall be equal to that of the existing roadways unless otherwise specified.
- B. Pavement, gutters, curbs, sidewalks or roadways disturbed or damaged by the CONTRACTOR'S operations shall be restored by him at his own expense to as good condition as they were previous to the commencement of the Work and in accordance with applicable local and state highway specifications.

### 3.19 TEMPORARY FENCING

- A. Furnish and install a temporary fence surrounding excavations and work area. Fence shall have openings only at vehicular, equipment and worker access points.
- B. The fence shall be a snow fence type enclosure, 48 inches high. Fence shall be constructed of vertical hardwood slats measuring 1 1/2 by 1/4inch interwoven with strands of horizontal wire, or shall be of equivalent plastic construction. Posts shall be of steel, either U, Y, T or channel section, and shall have corrugations, knobs, notches or studs placed and constructed to engage a substantial number of fence line wire in the

proper position. Posts shall have tapered anchors weighing 0.67 pounds or more, each firmly attached by means of welding, riveting or clamping. Posts shall have a nominal weight of 1/3 pound per linear foot exclusive of the anchor. Each post shall be furnished with a sufficient number of galvanized wire fasteners or clamps, of not less than 0.120inch in diameter for attaching fence wire to the post.

### 3.20 ENVIRONMENTAL PROTECTION AND RESTORATION

- A. CONTRACTOR shall be responsible for complying with all regulatory requirements pertaining to environmental protection and restoration. CONTRACTOR shall follow all erosion control design provisions shown in the Erosion Prevention and Sediment Control Plan, drawings, and specifications. CONTRACTOR shall provide, install, and maintain additional erosion and sediment control measures as necessary to retain disturbed sediments on-site.
- B. All disturbed areas of the site shall be stabilized. Stabilization shall begin within 7 days on areas of the site where construction activities have permanently or temporarily (for 30 days or more) ceased. When snow cover causes delays, stabilization shall begin as soon as possible. Stabilization practices include seeding, mulching, placing sod, planting trees or shrubs, and using geotextile fabrics and other appropriate measures.

### 3.21 FIELD QUALITY CONTROL

- A. Quality Control Testing During Construction: SD1's testing service must inspect and approve subgrades and fill layers before construction work is performed thereon. Tests of subgrades and fill layers shall be taken as follows:
  - 1. Footing Subgrade: For each strata of soil on which footings will be placed, conduct at least one test to verify required design bearing capacities. Subsequent verification and approval of each footing subgrade may be based on a visual comparison of each subgrade with related tested strata, when acceptable to ENGINEER.
  - 2. Paved Areas and Building Slab Subgrade: Make at least one field density test of subgrade for every 2000 square feet of paved area or building slab, but in no case less than 3 tests. In each compacted fill layer, make one field density test for every 2000 square feet of overlaying building slab or paved area, but in no case less than 3 tests.
  - 3. Compacted bedding material beneath and around pipe in trenches: Make at least one field density test of compacted bedding at the start of the project to ensure CONTRACTOR's method of compacting the bedding is meeting the compaction requirements. SD1 shall periodically call for tests of bedding compaction as the Work progresses and if the CONTRACTOR's pipe placement operations differ from proper procedures.

- B. If testing service reports or inspections show subgrade, fills, or bedding compaction are below specified density, CONTRACTOR shall remove any unacceptable materials as necessary and replace with specified materials and provide additional compaction at the CONTRACTOR's sole expense until subgrades, bedding, and backfill are acceptable as specified herein. The costs for the retesting of these subgrade, fills, or bedding materials that did not originally meet the specified density shall be paid by the CONTRACTOR.

+ + END OF SECTION + +