

## SECTION 02221

### TRENCHING, BACKFILLING AND COMPACTING

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. This section addresses excavation and trenching; including subsurface drainage, dewatering, preparation of subgrade, pipe bedding, backfilling, compacting, and finish grading for underground storm sewers or other pipelines, lateral lines and appurtenances.
- B. Related Work Specified Elsewhere
  - 1. Controlled Low-Strength Material (CLSM, such as FLO-FILL) backfill: Section 02222.
  - 2. Cast-in-place concrete: Section 03300.
- C. Measurement and Payment Procedures
  - 1. For public funded capital improvement projects, measurement and payment procedures will be determined on a project by project basis.
  - 2. For privately funded development projects, Owner will determine measurement and payment requirements.

##### 1.02 REFERENCES

- A. American Society for Testing and Materials (ASTM):
  - 1. ASTM D448 – Classification for Sizes of Aggregate for Road and Bridge Construction.
  - 2. ASTM D698 – Laboratory Compaction Characteristics of Soil Using Standard Effort
  - 3. ASTM C1479 – Practice for Installation of Precast Concrete Sewer, Storm Drain and Culvert Pipe using Standard Installations.
  - 4. ASTM D2321 – Practice for Underground Installation of Flexible Thermoplastic Pipe for Sewers and Other Gravity Flow Applications.
  - 5. ASTM D2922 –Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
  - 6. ASTM D4253 – Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
  - 7. ASTM D4254 – Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
- B. Colorado Department of Transportation Standard Specifications for Road and Bridge Construction (CDOT)
  - 1. CDOT Section 703 - Aggregates

##### 1.03 SUBMITTALS

- A. Provide for each granular material:
  - 1. Name and location of source.
  - 2. Sample gradation.
- B. Provide copies of all laboratory and field test reports within 24 hours of the completion of the test.

**1.04 QUALITY ASSURANCE**

- A. See Section 01010-1.08.

**PART 2 PRODUCTS**

**2.01 STABILIZATION MATERIAL**

- A. If the existing soil in the trench bottom is judged to be unsuitable by the Inspector, a minimum of the top 6-inches of the pipe subgrade shall be removed and replaced with a stabilization material.
1. Stabilization material shall be crusher-run rock, conforming to ASTM D448, or CDOT Section 703, gradation #357 as shown below; or an approved equal.

Table with 2 columns: Size, Percent Passing. Rows include 2-1/2", 2", 1", 1/2", #4.

- B. Geotextile filter may be used in conjunction with stabilization material, with the prior written approval of the City.
1. Acceptable types of geotextile filter and their manufacturers are:
a. Mirafi 500 X, by "Celanese".
b. Bidim C-28 and C-34.
c. True Tex M G-100, by "True Temper".
d. Fibretex Grade 150, by "Crown Zellerbach".
e. Or an approved equal.

**2.02 BEDDING ZONE MATERIALS**

- A. Pipe shall be bedded in a uniformly graded material, conforming to CDOT Section 703, gradation #67 as shown below, unless otherwise noted on the construction drawings.

Table with 2 columns: Size, Percent Passing. Rows include 1", 3/4", 3/8", #4, #8.

- 1. Reference Standard Drawing SW-1.

**2.03 GROUND WATER BARRIERS**

- A. If clay is used for ground water barriers, it shall meet the following soil classification.
1. GC - clayey gravel, gravel-sand-clay mixtures.
2. SC - clayey sands, sand-clay mixtures.
3. CL - inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, clean clays.
B. Concrete used in ground water barriers shall meet the requirements of Section 03300, except that the minimum compressive strength shall be a minimum of 2000 psi. after 28 days.

## **2.04 TRENCH BACKFILL MATERIAL**

- A. Trench backfill material shall be in accordance with City of Loveland Standard Drawing SW-1.
- B. Trench backfill material shall be either satisfactory soil excavated from the trench, or imported soil.
  - 1. Satisfactory trench backfill, shall be free from frozen matter, stumps, roots, brush, other organic matter, cinders or other corrosive material, debris, and any rocks or stones which are larger than 6-inches, in any dimension.
    - a. Rocks or stones that are larger than 3 inches, in any dimension, shall not be placed within one foot of the pipe or within the pavement section.
  - 2. If imported soil is used for trench backfill, it shall meet the requirements for satisfactory trench backfill above.

## **PART 3 EXECUTION**

### **3.01 PREPARATION**

- A. Topsoil, vegetative matter, and other organic material shall be stripped from areas which are to be disturbed by construction, and stockpiled. Stripped material in excess of the quantity required for site restoration shall be removed from the site and disposed of at a site selected by the Contractor.
  - 1. Topsoil shall be segregated from non-organic trench excavation material, and debris.

### **3.02 CONSTRUCTION STAKING**

- A. Construction staking shall be performed under the supervision of a licensed land surveyor.
- B. All survey notes and construction staking notes shall be entered into bound, hard cover field books. Electronic format is acceptable only if printable on the current City system.
- C. Adequate staking shall be provided to establish acceptable horizontal and vertical control.
- D. Offsets shall be staked so that vertical and horizontal alignment may be checked.
- E. All survey data, which is developed by the Contractor or the Developer's Engineer in performing surveys which are required by the work, shall be available to the Inspector for examination throughout the construction period.

### **3.03 CONSTRUCTION REQUIREMENTS**

- A. Drainage and groundwater.
  - 1. Contractor shall obtain all necessary groundwater discharge permits prior to starting dewatering operations and provide a copy to the Inspector before construction begins.
  - 2. Any water which is encountered in the trench shall be removed to the extent necessary to provide a firm subgrade, to permit connections to be made in the dry, and to prevent the entrance of water into the pipeline.
  - 3. Surface runoff shall be diverted as necessary to keep excavations and trenches free from water during construction.
  - 4. The excavation or trench shall be kept free from water until the structure, or pipe, to be installed therein, is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result.

5. Water shall be prevented from entering storm pipe which is already in service and has been previously accepted by the City.
6. Do not drain dewatering groundwater into sanitary sewer.
7. The pipe under construction shall not be used for dewatering, without the written approval of the City.

B. Sequencing.

1. Pipeline installation shall be performed within 100 linear feet of trench excavation.
  - a. If construction is occurring in an open field, this distance may be amended at the City's discretion.
2. Initial trench backfill shall be performed within 50 linear feet of pipeline installation.
  - a. If construction is occurring in an open field, this distance may be amended at the City's discretion.
3. Backfilling and compaction of the trench shall be in progress to within one manhole of that portion of the line that is being constructed, unless authorized by the City.
4. Where excavation is a hazard to automotive or pedestrian traffic, the amount of open trench and the time duration of that opening is to be minimized at the City's discretion.

C. Underground Obstructions.

1. The Contractor shall field verify all Record Drawing information obtained from the City.
2. Contractor shall notify each utility owner and request utilities to be field located by surface reference at least 48 hours prior to trenching or excavating.
3. The Contractor shall expose and verify the size, location, and elevation of underground utilities and other obstructions, sufficiently in advance of construction to permit changes to be made to the Construction Drawings.
  - a. In the event there is a conflict, the Contractor shall notify the City and the affected utility companies.
  - b. In the event there is a conflict, the proposed work may be modified, at the City's discretion.
4. Existing improvements, adjacent property, utilities, trees, and plants that are not to be removed shall be protected from injury or damage resulting from the Contractor's operations.
5. If the Contractor removes any underground obstructions, the area in which the underground obstruction was located shall be restored to the original condition or better.
6. Provide clearance between sewers and water main as follows:
  - a. Maintain 10-foot horizontal between the outside of pipes for water main and 6-foot horizontal between the outside of pipes for sanitary sewers.
  - b. Maintain 18-inch vertical separation between the outside of pipes.
7. When 18-inch vertical separation between sewer and water main cannot be maintained, provide special pipe crossing as follows:
  - a. Advise Design Engineer of pipe conflict.
  - b. Lower water main in accordance with plan detail or as directed.
  - c. Provide 18-inch vertical separation between pipes.
  - d. Construct sewer using pipe material and joints equal to water main at the crossing point.
  - e. Center pipe lengths at the crossing point.
  - f. Provide special foundation material for both pipes.
  - g. Place insulation as directed.
  - h. See Section 02722-3.04H for added requirements.

D. Trenching

1. Trenches shall be excavated by open cut methods, except where boring or tunneling is shown on drawings, or accepted by the City. Excavate trench to alignment and grade as staked.
2. Trench Width at Pipe Zone:

- a. Center trench on pipe alignment
  - b. Minimum Width: Not less than the greater of either, Pipe O.D. + 16 inches, or pipe O.D. times 1.25 + 12 inches as specified in ASTM D2321 for plastic storm sewer. Follow ASTM C1479 for concrete storm sewer (pipe O.D. times 1.33 minimum).
  - c. Not withstanding 2b above the maximum Width: Pipe O.D. + 36 inches (except rock excavation).
  - d. The City Engineer requires submittal of pipe strength redesign should wider trench, trench box or sheeting be used.
3. Care shall be used when operating mechanical equipment in locations where it may cause damage to trees, buildings, culverts, or other existing property, utilities, or structures above or below ground.
  4. Mechanical equipment shall be operated in such a manner that the bottom elevation of the trench can be maintained with uniform trench widths and vertical sidewalls of the bedding zone.
    - a. Contractor shall follow the most current regulations concerning excavations set forth by OSHA; 29 CFR Part 1926.
  5. Trench alignment shall be sufficiently accurate to permit pipe to be aligned properly with an 8 inch minimum clearance between the pipe and the sidewalls of the trench or trench box.
    - a. The trench sidewall shall not be undercut in order to obtain clearance.
  6. Contractor shall over-excavate a minimum of six inches below the bottom of the pipe wherever the trench bottom is rock, or other unsuitable material.
    - a. Over-excavation shall be backfilled and compacted with acceptable Granular Material.
  7. Preparation of trench bottom.
    - a. Trench bottom shall be graded uniformly to provide clearance for each section of pipe.
    - b. Loose material, water, and foreign objects shall be removed from the trench.
    - c. The Contractor shall provide a firm subgrade, which is suitable for application of bedding material.
    - d. Wherever unstable material is encountered in the bottom of the trench, said material shall be over-excavated to a depth suitable for construction of a stable subgrade, as determined by the licensed Geotechnical Engineer (PE).
      - 1) The depth suitable for construction shall be determined by the licensed Geotechnical Engineer (PE).
      - 2) The over-excavation shall be backfilled with stabilization material and compacted as required by the Inspector.
      - 3) Reference paragraph Stabilization Material.
  8. Stockpiling excavated materials.
    - a. Suitable material for backfilling shall be stockpiled in an orderly manner, and stored a minimum of 5 feet from the edge of the trench.
    - b. Contractor shall be responsible for disposal of excess excavated materials not suitable or not required for backfilling.
    - c. Excavated material shall not be stockpiled against or over existing structures or appurtenances.

#### E. Pipe Bedding

1. Placement and compaction.
  - a. Reference Standard Drawing SW-1.
  - b. Bedding material shall be distributed and graded to provide uniform and continuous support beneath the storm sewer main and all laterals at all points between bell ends or pipe joints.
    - 1) Pipe shall not be supported by the bells.
    - 2) A minimum of 6 inches of bedding shall be placed prior to the installation of the storm main and services.
  - c. To prevent lateral displacement, granular bedding material shall be deposited and compacted uniformly and simultaneously on each side of the pipe especially the haunch and worked in by hand.
  - d. Granular bedding material shall be consolidated and compacted under and around the pipe.

F. Ground Water Barriers

1. Ground water barriers shall be constructed in such a manner as to impede passage of water through bedding material for the full depth of the granular bedding material and the full width of the trench.
  - a. Ground water barriers shall be approximately four (4) feet long and spaced not more than 400 feet apart.
  - b. Ground water barriers shall extend to a point two (2) feet above the existing ground water level.
    - 1) If the ground water barrier is near an irrigation ditch, pond, stream, or other waterway, the barrier shall extend to a point one (1) foot above the 100-year water level.
  - c. Material for ground water barriers shall be specified in Part 2, paragraph "Ground Water Barriers".

G. Backfilling and Compaction

1. All trench backfill shall be compacted.
  - a. Backfill of pipe and appurtenances and around manholes shall be compacted with equipment and in a manner which is capable of producing the required results.
2. Backfill material shall be deposited in uniform horizontal layers which may not exceed six (6) inches (compacted depth), in all areas.
  - a. Other thicknesses may be used with the approval of the Inspector.
3. Methods and equipment which are appropriate for the backfill of material shall be employed.
  - a. Backfill equipment or backfilling methods which damage the pipe shall not be used.
4. Compaction shall not be performed by jetting or water settling.
5. No compaction on storm mains or laterals shall be done with a drop hammer compactor.
6. Sheeting removal (if the Contractor elects to use sheeting).
  - a. Do not remove sheeting prior to backfilling.
  - b. Use effective methods to protect the construction, other structures, utilities and properties during sheeting removal.
  - c. Voids left by sheeting removal shall be filled with dry sand.
  - d. Sheeting which is left in place shall be cut off at an elevation 18 inches below the finish grade of unpaved areas, or 12 inches below the subgrade of paved areas.
  - e. Follow ASTM C1479 and D2321 for sheeting cutoff and removal.
7. Topsoil shall be replaced to the original depth over all areas which are to be reseeded.
8. Excess excavated materials and materials not suitable for backfill shall be disposed in a manner acceptable to the City.

H. Field Quality Control

1. Field moisture/density control.
  - a. Field tests will be conducted to determine compliance of moisture/density testing methods with specified density in accordance with ASTM D2922 (Tests for Density of Soil and Soil-Aggregate In Place by Nuclear Methods).
  - b. Moisture/density tests are the responsibility of the Contractor, and shall be performed by a private Geotechnical Consultant.
    - 1) The method of testing of the compacted material and the validity of the results shall be the responsibility of the Geotechnical Consultant certifying the testing.
    - 2) Test results shall be submitted to the City by the Contractor or the Geotechnical Consultant the day of the tests.
      - a) Copies of the field work sheets are acceptable.
    - 3) Summarized test results shall be submitted to the City prior to the initial acceptance of the storm system.
    - 4) The City may elect to perform backfill density testing for compliance of the work within the public rights-of-way.

- c. Results of all moisture/density tests shall be submitted to and approved by the City prior to acceptance of the storm sewer main, and available on the job site on the day of the test.
  - d. Moisture/density tests shall be performed at a depth of two (2) feet above the top of the pipe bedding and in two (2) foot vertical increments up to the finish grade.
  - e. Moisture/density tests shall be performed at a minimum of 200 linear feet, as measured along the length of the pipe, or as determined by the City.
  - f. Moisture/density tests in the vicinity of manholes shall be performed at a maximum of one (1) foot away from the manhole section.
    - 1) A test shall be made in all four directions from the manhole.
    - 2) A minimum of one test shall be performed for every two (2) feet of backfill material.
  - g. Moisture/density tests shall be performed below the finished subgrade, and a minimum of one time for each lateral line installation.
  - h. All failed test areas shall be recompacted and retested at Contractor's expense.
2. Compaction shall be to the following minimum densities:
- a. Ground water barrier material: 95% of maximum density (ASTM D698).
  - b. Pipe bedding.
    - 1) Compacted granular material: 80% of relative density (ASTM D4253 & D4254).
  - c. Trench backfill.
    - 1) Under paved roadways, sidewalks and other areas which are to be paved: 95% of maximum density.
    - 2) Gravel roadways: 95% of maximum density.
    - 3) Fields and landscaped areas: 90% of maximum density.
    - 4) All other locations: 95% of maximum density.
3. Moisture content.
- a. All compacted backfill shall be within a minimum of 2% (+/-) of the optimum moisture content of the soil as determined by ASTM D698.
  - b. Water shall be added to the material, or the material shall be harrowed, disked, bladed, or otherwise worked to ensure uniform moisture content, as specified.
  - c. Expansive soils may require higher moisture content, as determined through laboratory tests performed by a geotechnical engineer.
4. Proof Roll – A proof roll will be required over all trench backfill under paved roadways. This will be accomplished by driving a fully loaded water truck over the trench with the wheels over the centerline of the pipe. The inspector will mark all areas of failure to be removed and recompacted, or removed with road base brought in for replacement.

### **3.04 MAINTENANCE AND CORRECTION**

- A. Contractor shall maintain and repair all trench settlement and make necessary repairs to pavement, sidewalks or other structures which may be damaged as a result of trench settlement.
  - 1. Contractor shall warrant work for a period of two (2) years after final completion and acceptance of the work.
- B. Contractor may perform such maintenance and repairs by subcontract.
  - 1. If the Contractor chooses to subcontract the warranty work, the Contractor shall submit to the City, a copy of the subcontract, or the work authorization, as evidence of the Contractor's faithful intention to perform any repairs which may become necessary during the two (2) year warranty period. The subcontractor shall be approved by the City.

**END OF SECTION**