**SECTION 31 23 16.13**

**TRENCHING**

**BASED ON DFD MASTER SPECIFICATION DATED 6/25/2021**

This section has been written to cover most situations that you will encounter. Depending on the requirements of your specific project, you may have to add material, delete items, or modify what is currently written. The Division of Facilities Development expects changes and comments from you.

Use “Track Changes” when editing and providing preliminary review submittals.

# PART 1 - GENERAL

**SCOPE**

The work under this section shall consist of providing all work, materials, labor, equipment, and supervision necessary to complete trenching for utilities and other work, as required in these specifications, on the drawings and as otherwise deemed necessary to complete the work. Included are the following topics:

PART 1 - General

Scope

Related Work

Reference Standards

Quality Assurance

Submittals

Permits/Fees

PART 2 - Materials

Geotextile Fabric

Crushed Stone Chips

Crushed Stone Screenings

Bedding Sand

Crushed Stone

Utility Cover Material

Controlled Backfill

Earth Backfill

Flowable Fill

Cement Slurry Grout

Utility Marker Balls

PART 3 - Execution

Preparation

Connections to Existing Utilities

Dewatering

Drainage Protection

Excavation

Unstable Trench Bottom

Support of Existing Utilities

Insulation for Existing Utilities

Bedding & Utility Cover Material

Backfill and Compaction

Flowable Fill Backfill

Grading

Grading Around Trees

Clean Up

#### RELATED WORK

***Note to the designer: The designer must determine if this work will impact other related work or Contractors and should revise these specifications accordingly to only include those Sections that apply to the project.***

Applicable provisions of Division 1 govern work under this Section.

Related work specified elsewhere:

Section 02 32 00 – Geo Technical Investigation

Section 30 05 00 – Common Work Results for All Exterior Improvements

Section 31 25 00 – Erosion Control

Section 31 20 00 – Earthmoving

Section 31 23 19 – Dewatering

Section 31 25 00 – Erosion Control

Section 33 11 00 – Water Utility Distribution Piping

Section 33 30 00 – Sanitary Sewerage Utilities

Section 33 40 00 – Storm Drainage Utilities

Section 33 60 10 – Hydronic Heating and Steam Utilities

Section 33 61 10 – Chilled Water and Condenser Water Utilities

00 00 00 – (Section Title)

**REFERENCE STANDARDS**

American Society for Testing and Materials (ASTM):

D422 Standard Test Method for Particle Size Analysis of Soils

D4318 Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils

D698 Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort

D1557 Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort

D2922 Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods

D3017 Standard Test Methods for Water Content of Soil and Rock in Place by Nuclear Methods

E329 Standard Specifications for Agencies Engaged in Construction Inspection, Testing, or Special Inspection

**QUALITY ASSURANCE**

***Note to the designer: A/E to determine the type, and frequency of quality assurance geotechnical testing required on each project. Provide listing of quality assurance geotechnical testing requirements in this article. If Contractor is not responsible for testing modify this section accordingly. If no testing is required on the project remove this section in its entirety. If Contractor is required to perform testing, complete the table below and specify the type and frequency of required tests.***

The Contractor shall conduct sampling, testing, and analysis as required by this section and elsewhere in the Contract Documents either by retaining the services of an independent construction materials testing consultant or with internal certified testers. The materials testing personnel shall meet the requirements of ASTM E329.

The Contractor’s construction materials testing personnel shall complete material testing as outlined in Table 31 23 16.13-1:

***Table 31 23 16.13-1***

|  |  |  |
| --- | --- | --- |
| Material | Test Required | Test/Sample Frequency |
| I.E. Granular Fill | *I.e. D2922-01 Standard Test Method for Density of Soil and Soil Aggregate in Place by Nuclear Methods* | *I.e. 1 test/500 lf trench* |
| Bedding/Initial Cover | D2922 Standard Test Method for Density of Soil and Soil Aggregate in Place by Nuclear Methods | 1 test / 500 lf trench |
| Backfill Material  | D2922 Standard Test Method for Density of Soil and Soil Aggregate in Place by Nuclear Methods | 1 test / 500 lf trench |

**SUBMITTALS**

***Note to the designer: Determine the submittals required for the project. Modify the content of this section and Submittals Log accordingly.***

Provide grainsize analysis for bedding and backfill materials.

Provide manufacturers product information for geotextile fabric.

Provide written plan(s) for Support of Existing Utilities for excavations that will expose multiple large utilities at the same time or expose utility or building structures including tunnels, box conduits, manholes and pits. Show anticipated loads and verification that proposed supports are adequate.

##### Provide copies of all material field testing reports completed for the project to the DFD Project Representative and the AE within 48 hours of completing the individual tests. Along with each individual test result, provide a running spreadsheet of all individual test results.

##### Permits/Fees

***Note to the designer: List required permits. Modify this article and list permits obtained by DFD, Agency or AE. Attach those permits in appendix to the project manual.***

Contractor shall be responsible for obtaining all permits necessary to complete trenching work. Contractor shall pay all fees associated with obtaining permits. These include, but are not limited to permits to work within right-of-way.

**PART 2 – MATERIALS**

Note to the designer: Edit bedding material requirements as necessary to account for local variations in material availability. Comply with the substantive requirements of the materials described below.

#### geotextile fabric

#### Woven or non-woven fabric shall meet the requirements of the WisDOT SSSHC Section 645.2.1 and 645.2.2, Geotextile Fabric Type SAS.

#### crushed stone CHIPS

**Pipe 18” Diameter or Less:**

Clean material meeting the requirements of “3/8” Crushed Stone Chips” as defined in Section 8.43.2(a)1 of the SSSWC, except that the gradation shall be as shown herein. If used for pipe bedding, Crushed Stone Chips shall also be used for cover material.

 Sieve Sizes Percent Passing by Weight

 1/2 inch 100%

 3/8 inch 85 – 100%

 No. 4 10 – 30%

 No. 8 0 – 10%

 No. 16 0 – 5%

**Pipe Over 18” Diameter:**

Clean material meeting the requirements of “3/4” Crushed Stone Chips” as defined in Section 8.43.2(a)2 of the SSSWC, except that the gradation shall be as shown herein. If used for pipe bedding, Crushed Stone Chips shall also be used for cover material.

 Sieve Sizes Percent Passing by Weight

 1 inch 100%

 3/4 inch 90 – 100%

 3/8 inch 20 – 55%

 No. 4 0 – 10%

 No. 8 0 – 5%

#### crushed stone screenings

Crushed stone shall be free of organic material, concrete, asphalt and other debris. Material shall meet the requirements of “Crushed Stone Screenings” as defined in Section 8.43.2(b) of the SSSWC. If used for pipe bedding, Crushed Stone Screenings shall also be used for cover material.

 Sieve Sizes Percent Passing by Weight

 1/2 inch 100%

 No. 4 75 – 100%

 No. 100 10 – 25%

**bedding sand**

Sand shall meet the requirements of “Bedding Sand” as defined in Section 8.43.2(c) of the SSSWC. If used for pipe bedding, Bedding Sand shall also be used for cover material.

 Sieve Sizes Percent Passing by Weight

 1 inch 100%

 No. 16 45 – 80%

 Material finer 2 – 10%

 Than No. 200

**UTILITY bedding sand (DIRECT bury Steam/CONDENSATE pipe and Pits)**

Sand shall meet the requirements of “Bedding Sand” as defined in Section 8.43.2(c) of the SSSWC. If used for pipe bedding, Bedding Sand shall also be used for cover material.

 Sieve Sizes Percent Passing by Weight

 No. 8 100%

 No. 16 80-95%

 No. 30 50-80%

 No. 50 20-50%

 No. 100 10-20%

 Material finer than

Than No. 200 1-10%

**CRUSHED STONE**

When crushed stone is required to affect soil stability or drainage it shall meet the gradation requirement below.

 Sieve Sizes Percent Passing by Weight

 2-1/2 inch 100%

 2-inch 90-100%

 1-1/2 inch 35-70%

 1-inch 0 – 15%

 ½ inch 0 – 5%

**UTILITY COVER MATERIAL**

Material that is to be used around and over the pipe and above the pipe bedding shall be termed utility cover material. The utility cover material for pipe shall be the same as the bedding material.

**CONTROLLED BACKFILL**

Granular material, meeting the following above all direct buried utilities:

 Sieve Size Percent Passing by Weight

 1 inch 100

 3/4 inch 85 - 100

 3/8 inch 50 - 80

 No. 4 35 - 60

 No. 10 25 – 50

 No. 40 15 - 30

 No. 200 5 - 15

EARTH BACKFILL

Sand/gravel non-cohesive non-expansive, free of vegetable matter, clay , rubbish, rock larger than 2 inches, boulders, concrete, paving, masonry debris, waste, frozen materials, other inorganic and deleterious materials. Existing material meeting these requirements can be reused.

**FLOWABLE FILL**

Controlled low strength material (CLSM) or flowable slurry fill.

 Cement: Any Type, 100 lb/cu. yd & 50 lb. per cu. yd.

 Aggregate: None required for slurry fill, sand for utility support.

 Strength: 50 – 100 psi @ 28 days.

 Fly Ash: Any class in quantity equal to cement

Density: 50 to 80 pounds per cubic foot.

Thoroughly mix in a clean ready mix truck; run mixer at mixing speed for one minute just prior to placement to insure an even mixture.

**Cement Slurry Grout**

Portland cement based grout having a slump of 10”-12” and the following mix proportion (per CY):

Type 1 Portland Cement 100#

Class C Fly Ash 300#

Fine Aggregate 2700#

Water 400#

Air Entraining Admixture 35 oz

Similar mix designs that are suitable for the intended use will be considered.

**UTILITY LOCATOR MARKER BALLS**

EMS XR/RFID programable direct bury utility marker balls as manufactured by 3M or approved equal. Markers shall be omnidirectional and suitable for direct bury. Markers shall have a temperature range of -4°F to 122°F. Markers shall be individually programmable, reprogrammable, and readable to a depth of 5 feet below grade. Markers shall have passive antenna design and work without external power source.

**PART 3 - EXECUTION**

**PREPARATION**

General Contractor shall excavate and backfill the following utilities in accordance with this section:

-Steam box conduits, sump & dewatering discharge piping, and pits.

-Underground chilled water, compressed air, raw water, lake water, fuel piping, condenser water, hot water, steam and condensate direct bury piping

-Underground primary/signal vaults and duct banks

-Storm sewer and sanitary sewer piping.

-Water main

-Direct buried power and signal conduits

-Building services for underground utilities listed above.

Review drawings and prepare work plan and schedule. Coordinate any necessary interruptions in utility service with DFD Project Representative, in accordance with other specification sections.

Test pits, potholes or other means used to verify the location of existing underground facilities that are shown on the plans are considered incidental to utility installation.

***Note to the designer: Include the last sentence in the paragraph below if stockpiling of excavated and/or imported materials is allowed in the staging area or project area.***

Remove topsoil from work area. Saw cut and remove pavement from the work area. Remove excavated materials throughout the day. Deliver imported materials as needed throughout the day. *[Locate bedding, backfill and spoil piles in accordance with all governing safety requirements, and do not interfere with public travel, adjacent landowners or other construction activities.]*

The same trench may not obstruct more than one street at one time without an approved traffic control plan and posted detour in accordance with Section 30 05 00 Common Work Results for All Exterior Work.

**CONNECTIONS TO EXISTING UTILITIES**

Connect to existing utilities in accordance with the requirements of other pertinent specification sections.

#### dewatering

Dewatering shall be completed in accordance with Section 31 23-19 – Dewatering.

Provide erosion control in accordance with Section 31 25 00 – Erosion Control.

**drainage protection**

Prevent surface drainage from entering utility excavations and trenches. Shape area to direct water away from excavation or trench with diversions such as berms, or ditches. If drainage must cross the excavation or trench, use culverts or other structure to minimize water entering the excavation or trench.

***Note to the designer: Excavations for tunnels, steam pits and box conduits may require extra protection from surface drainage. Include the following paragraph for those systems.***

*[Provide a dewatering sump with pump and emergency generator power in each excavation from the first day of excavation until the excavation is backfilled. Provide a sump with a pump and emergency generator power in each tunnel, new and existing steam pits from the first day of excavation until the excavation is backfilled and the permanent sump pumps are installed.]*

#### excavation

***Note to the designer: Include the text in brackets for tunnel, box conduit and pit construction only.***

Excavate to elevations and dimensions necessary to complete construction. Excavations shall be sufficiently deep to provide for bedding beneath pipes and structures and as otherwise required to complete the work as shown. Excavations shall be sufficiently wide to provide for compaction equipment along the side of the pipe and the sidewall of trench or inside wall of trench box, shield or shoring. *[Provide additional space for tunnel, box conduit and pit water proofing system application as needed.]*

The Contractor shall provide all trench soil retention, trench boxes, sheeting and/or bracing needed to protect the work, existing property, utilities, pavement, and existing improvements, and to provide safe working conditions in the trench. Removal of any trench soil retention, sheeting and/or bracing from the trench shall not disturb pipe bedding and cover on new or existing utilities. Sheeting and bracing shall be removed unless specific permission to leave it in place is given by the DFD Project Representative.

Contractor shall not excavate soil or impact the area of influence for structure foundations or footings. Notify DFD Project Representative and A/E immediately if foundations or footings are undermined, cracked, damaged or appear unstable.

Unless noted on the drawings, the Contractor shall remove all vegetation along the full width of the trench before beginning excavation. Vegetation and soil containing organic material, rock or boulders larger than 6 inches in diameter shall not be used for trench backfill. Unless otherwise specified, surplus material shall be the property of the Contractor, and shall be disposed of at Contractor’s cost.

***Note to the designer: Specify the type and height of fence that is acceptable for this project location. Edit GR article 18 Fence to be consistent with this section.***

Trench excavation shall be backfilled when the Contractor is not working in the trench. If trench cannot be backfilled due to progression of work, fence shall be installed and extend the full length of open trench on all sides. *[Fence shall be 6-foot high, 9 gauge chain link fence fabric mounted on freestanding panels or galvanized steel fence posts.]*

**UNSTABLE TRENCH BOTTOM**

Notify DFD Project Representative if trench bottom consists of unstable soil, organic material, debris or other undesirable material. When this condition arises, the excavation shall be carried to such depth as directed by the A/E. Undercut backfill shall be shall be installed and mechanically compacted to replace the excavated materials to trench bottom subgrade.

**SUPPORT OF EXISTING UTILITIES**

***Note to the designer: Include the text in brackets for excavations that will expose multiple and/or large utilities at the same time or expose utility or building structures including tunnels, box conduits, manholes and pits.***

Contractor shall support all tunnels, conduits, sewers, structures, piping, wiring and cables that are exposed due to trenching and excavations. Support systems shall maintain current horizontal alignment, prevent vertical deflection and stabilize exposed piping, tunnel, duct package or conduit crossing the trench or running lengthwise in or along the trench. *[Support system shall be designed by an engineer licensed in the State of Wisconsin.]*

**INSULATION FOR EXISTING UTILITIES**

Contractor shall provide temporary insulation over exposed utilities to prevent damage/corrosion, wasted energy and or freezing.

**bedding AND UTILITY cover material**

Excavate trench to depth and alignment of proposed utility lines and grades, allowing for required amount of bedding material. Excavation shall be reasonably free of water prior to placement of bedding material. Bedding material shall be shaped to conform to bell of pipe, fittings and structures.

If unstable soils are adjacent to bedding and cover material in trench wrap bedding and utility cover material in geotextile fabric. Where sheet piling/shoring is abandoned between unstable soil and trench wall geotextile fabric may be omitted.

Bed pipes and place utility cover material for the utility and pipe type being installed in accordance with detail drawings and the depth and compaction requirements specified in table 31 23 16.13-2 . After placing pipe, support during placement and compaction of initial utility cover material.

Compaction of utility cover material for pipe and fittings shall be accomplished using hand tools and vibratory plate or tamping type walk behind compactors.

**BACKFILL AND COMPACTION**

***Note to the designer: Include the text in brackets for tunnel, box conduit and pit construction only.***

Backfilling shall not begin until *[construction below grade has been approved, underground utilities systems have been inspected, tested and approved, concrete forms removed and the]* excavation is cleaned of trash and debris.

After initial cover material is placed and compacted, backfill and compact trenches using the material specified in Table 31 23 16.13 – 2. Take care to minimize settlement and avoid damage to new and existing structures, pipes, utility lines and other features during backfill placement and compaction. Place backfill simultaneously on all sides of structures. Moisture condition backfill material as necessary to achieve density required for given use. Do not place material on frozen surfaces or use frozen material.

Backfill trenches from the top of utility cover material to subgrade below pavements, base course, and topsoil as required by the drawings. Where final restoration will be delayed backfill trench to match existing grade and maintain surface drainage patterns. Wedge around structures that extend above existing grade with compacted soil or pavement to match the existing surface.

It is the responsibility of the Contractor to provide all necessary compaction equipment and other grading equipment that may be required to obtain the specified density. Vibratory plate or tamping type walk behind compactors will be required whenever backfill is placed adjacent to structures, pipes, utility lines and other features.

Flooding or jetting of backfill material for compaction purposes is not allowed.

***Note to the designer: A/E shall edit materials based on availability of materials. Required Materials must match a defined material from Part 2 of this section or elsewhere in the specifications.***

***Table 31 23 16.13-2***

| Location | RequiredMaterial | Maximum Compacted Lift Thickness | Minimum Proctor Compaction | Minimum RelativeDensity (a) |
| --- | --- | --- | --- | --- |
| Bedding Material Beneath Utility Structures | Crushed Stone Chips or Crushed Stone | 12” | 95% Modified | 70% |
| Bedding Materials Beneath Utilities | Crushed Stone Chips, Crushed Stone Screenings, or Bedding Sand (as required in Division 33) | 6” | 95% Modified | 70% |
| Utility Cover – Areas Over Bedding Materials to 12” Over Utilities | Crushed Stone Chips, Crushed Stone Screenings, or Bedding Sand (as required in Division 33) | 6” | 95% Modified | 70% |
| Areas Between Top Soil and Utility Cover | Earth Backfill | 12” | 90% Modified | 50% |
| Areas Between Utility Cover and Crushed Aggregate Base course Beneath Existing or Proposed Pavement (Roads, Drives, Walks) | Controlled Backfill | 12” | 95% Modified | 60% |
| Areas with 10’ of an Existing or Proposed Building or Structure Footing or Slab | Controlled Backfill | 12” | 95% Modified | 60% |
| Turf Areas | Earth Backfill | 12” | 88 % Modified | 50% |

1. Minimum relative density as determined by ASTM D-4253-00 for coarse-grained soils with less than 15% by mass passing the No. 200 sieve. Applicable only when minimum proctor compaction cannot be achieved.

**Utility locator marker balls shall be placed during backfill operations. GPC shall have the markers procured, programmed, and identified as to where they are to be installed 72 hrs. prior to backfilling operations. GPC shall place the markers at the indicated station number and cover. Markers are to be installed 12” to 18” below finish grade. Once markers are installed GPC shall have a private locator verify the location and program data in the markers is accurate. GPC shall provide DFDM with a Google Earth file of markers with marker data embedded. If verification shows the markers are not in the correct location or the data is incorrect, or they are unreadable the GPC shall excavate them correct the error(s) and revalidate until the markers are complete and correct. This rework shall be completed at no additional expense to the owner.**

**FLOWABLE FILL BACKFILL**

If the configuration of new and existing utilities in the trench prevents the placement of backfill or the effective use of compaction equipment or if suitable backfill materials are unavailable flowable fill will be allowed for backfill as directed by the DFD Project Representative. Flowable fill material information shall be submitted and approved by A/E prior to use. Concrete shall not be used for trench backfill.

**GRADING**

Grade areas disturbed during trench excavation and backfilling and adjacent areas as necessary to establish new grades shown on plans as soon as practicable after backfilling. If new grades are not shown on plans, grade areas to tie into the surrounding area without abrupt changes in elevations or slopes and provide drainage away from structures.

New grades are designed to produce desired configuration of site and do not represent a balance between cut and fill.

Grades for earthwork shall not deviate more than 1 inch from plan elevations unless otherwise directed by DFD Project Representative.

**GRADING AROUND TREES**

Limit excavation, fill or grading near trees or other vegetation to the extent possible. No excavation, trenching or backfilling shall occur within the fenced tree protection zone of existing trees without authorization from DFD Project Representative. If tree roots are encountered during trenching cut roots cleanly and squarely.

**CLEAN UP**

Remove excess bedding, backfill and spoil material from the site as soon as possible after backfilling is complete, but no later than 1 calendar day after backfilling is complete.

Thoroughly clean all drainage ways, roads, parking lots sidewalks and paved surfaces and remove and dispose all debris and mud.

**END OF SECTION**