

STANDARD SPECIFICATIONS
SECTION 02315
EARTHWORK FOR PIPELINE CONSTRUCTION

PART 1 GENERAL

1.1 DESCRIPTION

- A. Section includes requirements for excavation, backfill, grading, and related items for pipeline construction.

1.2 DEFINITIONS

A. Trench Zones.

1. Pipe Embedment Zone: Area surrounding pipe in trench, consisting of Bedding Zone, Haunching Zone, and Initial Backfill Zone defined herein.
 - a. Bedding Zone: Area from pipe bottom to firm subgrade, extending full width of trench and providing support for pipe shown in Standard Details.
 - b. Haunching Zone: Area from pipe bottom up to as far as springline and extending full width of trench shown in Standard Details.
 - c. Initial Backfill Zone: Area from top of Haunching Zone up to as far as 1 foot above top of pipe and extending to full width of trench shown in Standard Details or specified herein.
2. Final Backfill Zone: Area from top of Pipe Embedment Zone to finished grade, extending full width of trench shown in Standard Details.
3. Additional Excavation: Excavation below trench bottom to remove unsuitable material such as rock, cobble, soft or organic soil, when Contract Manager determines that material is unsuitable to support pipe.

B. Backfill Material.

1. Trench Backfill: Native or Borrow Material placed in trench excavation and meeting specifications herein.
2. Borrow Material: Suitable material used for Trench Backfill provided from locations outside limits of trench excavation and meeting specification requirements herein.
3. Structural Fill: Compacted Trench Backfill meeting specification requirements herein, to minimize future settlement and provide support or bearing for structures to be constructed upon or within fill.

C. Pipe.

1. Rigid Pipe: Reinforced Concrete Pipe (RCP), Cast Iron Soil Pipe, Cast Iron Pipe, Prestressed Concrete Cylinder Pipe (PCCP), Asbestos Cement Pipe, Vitrified Clay Pipe, and Concrete Sewer Pipe.
 - a. Pipes relying primarily on inherent strength to support external vertical load.
2. Flexible Pipe: Ductile Iron Pipe (DIP), Polyvinyl Chloride (PVC) Pipe, and Type K Copper Pipe, Steel Pipe, and High Density Polyethylene (HDPE) Pipe.

- a. Pipe deriving its supporting strength primarily from passive pressures induced as pipe flexes outward against material in Pipe Embedment Zone.
- D. Controlled Blasting: Blasting method used to fracture and excavate rock to required limits for trench while minimizing overbreak and fracturing.
- E. Paved Areas: Areas over which paving exists or is to be placed under this Project or areas designated on Drawings to receive future paving. See Section 02950.
- F. Wetland Areas: Non-tidal Wetlands and Non-tidal Wetlands Buffer Zones.

1.3 QUALITY ASSURANCE

A. Inspection and Testing.

- 1. Field Density Compaction Tests shall be in accordance with ASTM D1556, ASTM D2922, or ASTM D2937 at minimum rate of 1 test for each 200 feet of fill and at every structure and valve box in Type I areas.
 - a. Test fill to a minimum depth of 5.0 feet from the surface on sewer main and sewer service connections. Test fill on water main, water service connections, pressure sewer and pressure sewer service connections to a minimum depth of 3.0 feet from the surface or 1.5 feet above the top of the pipe, whichever is greater.
 - b. When field-testing indicates differences in soil types, reference and/or verify test results using one-step field proctors or laboratory proctors in accordance with AASHTO T99.
 - c. Reexcavate and recompact failed test areas, at 25 foot intervals, the entire trench depth and length until retests meet above referenced standards.
- 2. Placing Trench Backfill and earthwork is subject to continuous inspection by WSSC.
 - a. Allow time for WSSC to perform tests after completion of each layer of fill in designated area.
 - b. Provide safe access and equipment to cut out smooth-surfaced spot locations designated by Contract Manager for testing.
 - c. WSSC may perform gradation and other tests on Trench Backfill.

B. Finished Grade Settlement Limitations.

- 1. Guarantee backfilled trench excavation areas designated on Drawings will not pond or settle in excess of following limitations.

<u>Designations</u>	<u>Settlement Limitations</u>	<u>Locations</u>
Type I	0.05 foot	Paved areas and public rights of way
Type II	with positive drainage	Unimproved areas
Type III	0.10 foot	Nonpaved improved areas
Type IV	0.00 foot	Wetlands or wetlands buffer

- 2. Remove and replace Trench Backfill which settles in excess of above limitations with suitable material.

3. Remove and replace piping, structures, paving, landscaping, and other site improvements damaged by settlement or repair.

1.4 SUBMITTALS

- A. Submit following Section 01330.
 1. Blasting Data: Submit working drawings and data to show blasting design and monitoring, for information only.
 - a. Submit request and obtain written permission from Contract Manager before using explosives.
 2. Dewatering, Sheet piling, and Shoring: Submit working drawings showing sheet piling and shoring, and method of dewatering, for structure excavations deeper than 8 feet and larger than 400 square feet.
 3. Borrow Material Samples: Submit samples of Borrow Material, except for Borrow Aggregate.
 - a. Size: Minimum of 30 pounds in sturdy cloth or plastic bags.
 - b. In addition to sample identification required in Section 01330, clearly label each sample showing type and material designation, intended use, name and address of supplier, and location where material is mined or manufactured.
- B. Delivery of Borrow Material.
 1. Submit prior notification of source, designation, quantity, and intended use for all Borrow Material.
 2. Submit delivery tickets with each load of Borrow Material.
 - a. Name and location of supplier.
 - b. Type and amount of material delivered, including ASTM's and the Commission's material designations.
- C. Submit following Section 01450.
 1. Certificate of Compliance: When recycled concrete is used, submit letter from governing jurisdiction approving its use.
 2. Certified Test Reports: Borrow Aggregate.
 - a. In addition to requirements of Section 01450, include information showing type and material designation, intended use, name and address of supplier, and location where material is mined or manufactured.
- D. Flowable Fill: See Section 03300.
- E. Submit Soil's Compaction Reports as follows:
 1. Certified by Professional Engineer registered in State of Maryland.
 2. Field Density Compaction Test Results.
 3. Commission Project Number.
 4. Soils Technician's Name and Employer.
 5. Owner's name and owner's Contractor.
 6. Test Number.
 7. Date of Test.

8. Location of Test (sewer and/or water station, lot number and street name).
9. Retest results of previous tests (and number), if required.
10. Depth of Test.
11. Dry Density.
12. Moisture Content.
13. Maximum Density/Optimum Moisture Curve Relationship Chart following ASTM D698.
14. Test Results.
15. One Step Proctor Determination (when taken).
16. Additional Comments.
17. Submit test results to the CM within 2 weeks of test.

PART 2 PRODUCTS

2.1 MATERIALS

A. Detectable Warning Tape.

1. Description.
 - a. Size: Six inch width, minimum 5 mils thickness.
 - b. Printing: Two lines, minimum 3/4 inch high lettering on each line, repeated continuously along length of tape at intervals no greater than 3 feet.
 - 1) Water: CAUTION - WATER LINE BURIED BELOW
CALL WSSC 301-206-4002
 - 2) Sewer: CAUTION - SEWER LINE BURIED BELOW
CALL WSSC 301-206-4002
 - 3) Cathodic Protection: CAUTION – CATHODIC PROTECTION
CALL WSSC 301-206-4002
 - c. Colors:
 - 1) Tape:
 - a) Blue for water.
 - b) Green for sewer.
 - c) Yellow for cathodic protection.
 - 2) Lettering: Black.
2. Approved Manufacturers:
 - a. Lineguard, Inc, Type III Detectable Tape.
 - b. Pro-Line Safety Products, No. 5012 (Type A Double Safe).
 - c. Reef Industries, Terra Tape D.
 - d. Empire Level Manufacturing Corporation, Magnatec.

B. Trench Backfill.

1. General Trench Backfill Requirements.
 - a. Outside Wetland Areas: Free of organic or frozen material, waste metal products, unsightly debris, toxic material, or other deleterious materials and at moisture content permitting compaction to density specified.

- b. Within Wetlands Areas: Previously excavated native material which can include organic matter, but free of frozen material, waste metal products, unsightly debris, toxic material, or other deleterious materials.
 - c. Material Excavated from Trench and Meeting These Requirements: Use when approved by Contract Manager; otherwise excavate, haul, and place Borrow Material.
2. General Borrow Material Requirements.
- a. Outside Wetland Areas: Meet General Trench Backfill Requirements for Outside Wetland Areas, stated herein.
 - b. Within Wetland Areas: Soil material meeting requirements of ASTM D2488, material classification types SM, SC, ML, CL, OL and PT, which can include organic matter, but be free of frozen material, waste metal products, unsightly debris, toxic material, or other deleterious materials.
 - c. Acceptance of Borrow Material from any location outside limits of trench excavation, shall not be construed as approval of entire Borrow Material site, but only insofar as material continues to meet specified requirements, herein.
3. Borrow Aggregate.
- a. Standard Sizes of Aggregate: ASTM C33, coarse aggregate.
 - b. Dry Concrete Sand: ASTM C33, fine aggregate.
 - c. Surge Stone: 3 inch to 7 inch stones.
 - d. Crushed stone, crusher run (CR-6), or bank run gravel.
 - 1) Aggregate Test Requirements:
 - a) Maximum Sodium Sulfate Soundness (ASTM C88): 12 percent.
 - b) Maximum Los Angeles Abrasion (ASTM C131): 50 percent.
 - c) Maximum Flat and Elongated (ASTM D4791) for crushed stone only: 15 percent.
 - 2) Gradations: Conform to Table of Borrow Aggregate Gradations.

Borrow Aggregate Gradations
 (Based on Table "901-A", January 2001 MSHA Standard Specifications for
 Construction and Materials)

Sieve Size	Percent Passing Each Sieve by Weight				
	¹ Bank Run Gravel Number 1	² Bank Run Gravel Number 2	³ Crushed Stone Number 3		⁴ Crusher Run Number 4 (CR-6)
			Design Value	Tolerance	Design Value
2-1/2 inch	100	100			
2 inch			100	-2	100
1-1/2 inch			95-100	±5	90-100
1 inch	85-100	90-100			
3/4 inch			70-92	±8	60-90
1/2 inch	60-100	60-100			
3/8 inch			50-70	±8	
Number 4			35-55	±8	30-60
Number 10	35-75	35-90			
Number 30			12-25	±5	
Number 40	20-50	20-55			
Number 200	3-20	5-25	0-8	±3	0-15

¹MSHA - Base Bank Run Gravel

³MSHA - Base Graded Aggregate

²MSHA - Subbase Bank Run Gravel

⁴MSHA - Crusher Run Aggregate

4. Flowable Fill: Section 03300.
5. Recycled Concrete: Free of waste metal products, unsightly debris, toxic material or other deleterious materials and meeting Gradation and Aggregate Test Requirements for Borrow Aggregate, as stated herein.
6. Bentonite: 100 percent high-swelling granular sodium Bentonite, with maximum moisture content of 12 percent.
 - a. Approved Manufacturers:
 - 1) American Colloid Company.
 - 2) Wyo-ben Inc.

- 3) Bentonite Corporation.
7. Structural Fill: Meet material requirements of Trench Backfill and compaction requirements stated herein.
8. Backfill Requirements for Different Types of Pipes.
 - a. Additional Excavation Area Below Pipe Embedment Zone for Outside and Within Wetland Areas:
 - 1) Borrow Aggregate meeting requirements of ASTM C33, coarse aggregate size number 3 or 4 and/or surge stone.
 - 2) Use geotextile to separate pipe embedment zone material and aggregate in additional excavation area when migration of fines is a concern.
 - b. Pipe Embedment Zone Backfill Requirements for Outside and Within Wetland Areas: Specified below for each pipe material.
 - 1) Type K copper pipe and standard asphaltic coated or polyethylene encased DIP 24 inch and smaller, following Standard Detail M/8.1a:
 - a) Specified in General Trench Backfill Requirements for Outside Wetland Areas.
 - b) Containing no rock or gravel larger than 1-1/2 inches in greatest dimension.
 - c) Liquid limit: Not to exceed 30.
 - d) Plasticity index: Not to exceed 6.
 - e) Dry density: Not less than 105 pounds for each cubic foot as determined by ASTM D698.
 - 2) Standard Asphaltic Coated or Polyethylene Encased DIP, Larger than 24 inch:
 - a) Pipe embedment zone: Following Standard Detail M/8.1a:
 - (1) Borrow Aggregate:
 - (a) Gradation number 1, bank run gravel or
 - (b) Gradation number 3, crushed stone as specified herein containing no rock or gravel larger than 1-1/2 inches in greatest dimension.
 - 3) PVC Gravity Sewer Pipe, following Standard Detail M/8.1c:
 - a) Borrow Aggregate ASTM C33, coarse aggregate size number 67 as specified herein.
 - 4) RCP, following Standard Detail M/8.0:
 - a) Borrow Aggregate for Bedding Zone and Haunching Zone.
 - (1) Circular RCP: ASTM C33, coarse aggregate size number 4 and containing no rock or gravel larger than 1-1/2 inches in greatest dimension or coarse aggregate size number 57.
 - b) Initial Backfill Zone: Specified in General Trench Backfill Requirements for Outside Wetland Areas.
 - (1) Containing no rock or gravel larger than 1-1/2 inches.
 - (2) Liquid limit: Not to exceed 30.
 - (3) Plasticity index: Not to exceed 6.
 - (4) Maximum dry density: Not less than 105 pounds for each cubic foot as determined by ASTM D698.

- 5) PVC and HDPE Pipe for Pressure Sewer System, following Standard Detail PS/1.0:
 - a) Borrow Aggregate ASTM C33, coarse aggregate size number 8 as specified herein.
- 6) PVC AWWA C900/C905 Pipe, following Standard Detail.
 - a) Pipe with 10 feet or less cover:
 - (1) Specified in General Trench Backfill Requirements for Outside Wetland Areas.
 - (a) Containing no rock or gravel larger than 3/4 inch in greatest dimension.
 - (b) Liquid limit: Not to exceed 30.
 - (c) Plasticity index: Not to exceed 6.
 - (d) Maximum dry density: Not less than 105 pounds for each cubic foot as determined by ASTM D698.
 - (2) Bedding Zone: May use Borrow Aggregate meeting ASTM C33, coarse aggregate size number 67.
 - b) Pipe with greater than 10 feet cover:
 - (1) Borrow Aggregate ASTM C33, coarse aggregate size number 67 specified herein.
- c. Final Backfill Zone Materials Outside Wetland Areas:
 - 1) Specified in General Trench Backfill Requirements.
 - 2) Containing no rock or gravel larger than 3 inches from top of Pipe Embedment Zone to 2 feet above.
 - 3) From 2 feet above Pipe Embedment Zone to finished grade, no rocks larger than 8 inches in greatest dimension, unless contained in sufficient matrix of soil to avoid point to point contact, except:
 - a) Type I areas, under existing paving, top 30 inches below pavement base course unless indicated otherwise in Trench Detail for Paved Areas located under ATTACHMENTS: Borrow Aggregate, gradation number 3 or 4 crushed stone. Flowable fill and recycled concrete may be used instead of Borrow Aggregate, as specified below:
 - (1) Flowable fill, unless otherwise shown on Drawings, from top of Pipe Embedment Zone to below pavement base course, if approved by roadway governing jurisdictions.
 - (2) Recycled concrete for PVC pipe only, as specified below.
 - (a) Allow at least 12 inch separation between top of PVC pipe and recycled concrete.
 - (b) Do not use recycled concrete if PVC pipe crosses or is within 10 feet or 5 pipe outside diameters horizontally, whichever is greater, to existing Non-PVC pipe.
 - b) Type I areas, under future paving and within 5 feet of structure, and Type III areas: Top 12 inches below proposed pavement base course or finished grade containing no rocks or gravel larger than 3 inches.
- d. Final Backfill Zone Materials Within Wetland Areas: Specified in General Trench Backfill Requirements, herein.

- C. Backfill Requirements For Structures.
 - 1. Granular Bedding for Precast or Cast-in-place Structures:
 - a. Granular Bedding Borrow Aggregate: ASTM C33, coarse aggregate size number 4.
 - b. Borrow Aggregate for Additional Excavation Area Below Granular Bedding: ASTM C33, coarse aggregate size number 3 or 4 and/or surge stone.
 - 2. Granular Bedding for On-Grade Slabs: Borrow Aggregate meeting ASTM C33, coarse aggregate size number 4.
 - 3. Backfill for Precast or Cast-in-place Structures: Trench Backfill in Final Backfill Zone, unless otherwise shown on Drawings.
 - a. Flowable fill may be used instead of Trench Backfill material for circular shape precast and cast-in-place concrete manholes.
- D. Trench Erosion Checks.
 - 1. Wood for Trench Erosion Checks: Follow Standard Details.
- E. Sheeting, Shoring, And Bracing Materials.
 - 1. Timber, steel, or combination thereof, designed as required to retain earth around structure, prevent cave-in and settlements, and to fulfill MOSH safety requirements.
 - a. Timber: Structural grade with minimum working stress of 1,100 psi.
 - b. Steel Sheet Piling: ASTM A328, continuous interlocking type.
 - c. Struts, Bracing, and Other Accessories Required for Sheet Piling System: ASTM A36.

PART 3 EXECUTION

3.1 EXCAVATION

- A. General: Excavate to lines and grades indicated on Drawings.
 - 1. On-grade Slabs and Pavements: Sufficient to allow for fills, base, and waterproofing materials.
 - 2. Planting Areas: Sufficient to allow for topsoil.
 - 3. Formed Concrete: Sufficient to allow for convenient construction and removal of forms, and for application of waterproofing and curing materials.
- B. Test Pit Excavation: Perform with caution and to prevent damage to facility.
 - 1. Special Requirements: Section 02510, Section 02530 and Section 02533.
- C. Material Storage and Disposal of Unsuitable Material.
 - 1. Material deemed unsuitable by the CM and/or Owner's Geotechnical Engineer, in the bottom of the trench shall be removed and replaced with gravel backfill below subgrade. Depth and width of removal shall be as directed by the CM and/or Owner's Geotechnical Engineer.
 - 2. Separate and protect excavated material which is suitable Trench Backfill from contamination by unsuitable excavated material or by other sources.
 - 3. Stockpile suitable materials in location to avoid contamination and prevent erosion.

4. See Section 01110 for off-site disposal of excess excavated material and unsuitable material.
- D. Unauthorized Excavation: Where excavations are made below indicated elevations under slabs, footings, pipes, structures, or outside maximum trench pay widths, restore to proper elevations with materials specified herein at Contract Manager's direction.
- E. Trench Excavation.
1. Excavate trenches to width and depth following Standard Details, Drawings, or specified herein.
 - a. Sides of trenches within Pipe Embedment Zones: Practically plumb.
 - b. Trench widths within Pipe Embedment Zone for Rigid Pipe shown on Standard Details are maximum widths.
 2. Remove rock, when encountered, to minimum depth of 6 inches below pipe barrel and pipe bell and structures.
 - a. Excavate trench bottom to conform with shape and dimensions of proposed pipe or structure.
 - b. Excavate bell holes in trench bottom to permit proper assembling of joints.
 - c. Support pipe or structure uniformly and continuously, upon specified material.
 3. Where material not meeting requirements of Trench Backfill and deemed unsuitable by Contract Manager is encountered either contiguous to or within proposed limits of excavation, Contract Manager may direct additional excavation and removal of unsuitable material.
 4. Perform excavation in immediate vicinity of adjacent and crossing facilities by means that will not damage facility.
 - a. Excavate within 1 foot of existing pipelines or conduits by hand.
 - b. Repair or replace damage caused to existing facilities, pipelines, or conduits.
 5. Proceed with trench excavation no more than 75 feet in advance of placing of Trench backfill.
 - a. Contract Manager may require backfilling and subsequent re-excavation on trenches left open in advance of pipe installation.
 - b. Protect or enclose trenches left open overnight, or during periods when Contractor's personnel are not present and mark to prevent danger to public or others.
 6. Excavate sides of trenches in improved public areas and adjacent to other utilities or structures practically plumb.
 - a. When crossing under existing pipes or conduits, plumb sides of trench from 1 foot above top of existing pipes or conduits to bottom of trench.
 - b. With Contract Manager's permission, sides of trenches in other areas may be sloped from 1 foot above top of pipe to finished grade.
 7. Trench Sheet piling, Shoring, and Bracing: Place so as not to interfere with construction work and be entirely independent of footings and structures.
 - a. Method, design and adequacy of sheet piling, shoring and bracing: Meet requirements of MOSH.
 - 1) Repair damage related or caused by excavation.

- 2) Sheeting, shoring, and bracing: Before placement, use means acceptable to Contract Manager for its removal as backfill progresses.
- b. Sheet and shore as required to assure safe working conditions, maintain required excavation dimensions for proper construction, and to prevent accidents, cave-ins, and damage to adjacent structures, facilities, and surfaces.
 - 1) In excavations over 4 feet in depth, where the Commission personnel are required to enter, sheeting and shoring shall meet requirements of MOSH for Type "C" soil conditions.
- c. Remove sheeting, shoring, bracing and wood forms concurrently with backfilling operations, except in Pipe Embedment Zone and where sheeting is used as 1 side of form for concrete.
 - 1) Accomplish removal in manner that precludes settlement of backfill, cave-in of excavation sides, and prevents damage to adjacent surfaces.
 - 2) Promptly fill voids left or caused by removal.
 - 3) Compact contiguous areas concurrent with removal of trench sheeting.
- d. Follow Standard Details where sheeting is used for trench width between interior faces of sheeting.
- e. Sheeting may be left in place, provided that following are met:
 - 1) Positive verification that no voids exist between sheeting and trench wall.
 - 2) Upper wales and horizontal braces are removed or excavation is backfilled with sand.
 - 3) Existing voids are filled following Trench Backfill requirements.
 - a) Sheeting left in place: Cut off minimum of 1-1/2 feet below finished grade or at Contract Manager's direction.
- 8. Trench Boxes or Mules: Use of trench boxes will be permitted in areas where excavation sidewalls are suitable and where sheeting, shoring, and bracing are not required to maintain excavation dimensions.
 - a. Structural box design: To withstand pressures imposed thereon.
 - 1) Trench boxes and steel plates and their use: Meet requirements of MOSH.
 - b. Location:
 - 1) Do not extend trench box below top of Pipe Embedment Zone during or after placement of Pipe Embedment Zone material.
 - 2) Remove steel plates used below trench box in Pipe Embedment Zone simultaneously with placement of Pipe Embedment Zone material and before its compaction.
 - c. Box size:
 - 1) Height: Sufficient to assure safe working conditions.
 - 2) Length: To accommodate size and lengths of pipe being installed.
 - 3) Width: For trench opening not more than maximum permitted in Standard Details.

F. Rock Excavation.

- 1. When blasting, control fly rock and material to prevent injury or damage to persons or properties.
 - a. Use blasting mats in areas where overburden has been removed before blasting, or as required to control fly rock.

- b. Equipment used for drilling holes shall have positive means of dust control and meet OSHA and other applicable regulations and agencies requirements in asbestos-bearing rock area.
- 2. Blasting unless otherwise directed by Contract Manager:
 - a. No closer than 10 feet to existing water, gas, sewer or conduit utilities unless such facilities have been completely exposed, definitely located, and then backfilled before blasting.
 - b. No closer than 2 feet from definitely located existing utilities, 10 inch or smaller diameter.
 - c. No closer than 5 feet from utilities larger than 10 inch diameter.
- 3. Use controlled blasting techniques.
 - a. Modify blasting round as necessary to achieve best obtainable results and to keep air blast over pressure, vibrations, and noise within limits herein specified.
 - 1) Exercise care in drilling and blasting operations to minimize over break and blast damage of adjacent unexcavated ground.
 - 2) Produce satisfactory excavated surface by determining proper relationships of burden, spacing, depth of charge, amount and type of explosive, hole size and delay pattern, and other necessary considerations to achieve required results.
- 4. Vibration and Air Blast Control.
 - a. Control operations to ensure:
 - 1) Peak particle velocity will not exceed 2 inches per second measured adjacent to any structure in vicinity of blasting operations or following limits for concrete:

<u>Inches Per Second</u>	<u>Age of Concrete</u>
0.25	12 - 24 hours
0.5	24 - 48 hours
1.0	48 hours - 5 days
2.0	5 plus days
 - 2) Impact or impulsive noise from blasting operations will not exceed 140 db peak sound pressure level measured at nearest structure or property line.
 - b. Peak particle velocity definition: Maximum of 3 velocity components of a vibration measured at any point in 3 mutually perpendicular directions by Contract Manager approved seismograph, capable of producing permanent record and capable of internal dynamic calibration.
 - c. Furnish seismograph instruments, qualified personnel to operate instruments, interpret results for all blasting operations, and submit copy of results to Contract Manager.
 - d. Record air blast over pressure with peak impact recording instrument having linear frequency response, and submit copy of results to Contract Manager.
- 5. Repair or replace facilities damaged by blasting operations.
- 6. Replace rock which is not broken to meet backfill requirements with suitable Trench Backfill, as specified herein.

G. Dewatering and Drainage.

1. If water is encountered in excavation, install and maintain dewatering system of sufficient capacity to remove it during excavation, pipe placement, and backfill.
 - a. For structures:
 - 1) Until concrete footings have been poured and cured,
 - 2) Walls or other portions of structure are erected to grade,
 - 3) Or until excavation has been backfilled.
 - b. Do not allow sediment-laden water to flow into watercourses, drainageways, or over land without first filtering it through approved desilting device. See Section 01570.
2. Choose methods of dewatering excavations including, but not limited to, sump pumps, wellpoints, deep wells, drainage blankets, and tight sheeting.
 - a. Continuously inspect dewatering system to ensure it is functioning properly.
 - b. Ensure system does not disturb or degrade final subgrade for new pipe or structure and does not cause damage or settlement to adjacent surfaces or structures.
 - c. Modify system as required, and repair or restore damage or disturbance caused by system.
 - d. Install necessary temporary surface drainage and keep it operating, until permanent drainage or finish grading has been completed.
 - e. Do not allow damming or ponding of water in gutters or storm drains.
3. Remove dewatering devices upon completion of work.

3.2 BACKFILL OPERATIONS

A. Placing Trench Backfill.

1. Backfill trench excavations with soils material excavated therefrom, provided this material meets requirements of Trench Backfill herein and at Contract Manager's approval.
2. Do not place, spread, or compact frozen or thawing material or place specified materials upon frozen or thawing ground or during unfavorable weather conditions.
 - a. When work is interrupted by rain, do not resume backfill operations until field tests indicate moisture content and density of materials are within specified limits.
 - b. Rework and recompact after thawing compacted layers which have been frozen before next layer is placed.
3. Mix each lift before compaction to ensure uniform distribution of water content and distribute rocks of permissible sizes through material.
4. Place Trench Backfill and utilize compaction equipment that will not damage structures, pipe, and appurtenances.
 - a. Place and compact Trench Backfill around pipe and structures evenly to preclude unbalanced pressure.
 - b. Compaction with large rollers or heavy equipment will not be permitted within 5 feet of structures.
 - c. Repair damage done during backfill operations or replace at Contract Manager's direction.

5. Place Trench Backfill in uniform lifts of 8 inches maximum in uncompacted thickness, unless otherwise specified herein.
 - a. Spread each layer uniformly and evenly.
 - b. Perform compaction using compacting rollers, pneumatic or vibratory compactors.
6. When Borrow Material is utilized, place in uniform lifts of 8 inches maximum in uncompacted thickness.
 - a. Backhoe buckets permitted for gravel compaction.
7. Backfill Structural Fill areas in uniform lifts of 8 inches maximum in uncompacted thickness and compact to not less than 95 percent of maximum dry density, following ASTM D698, at moisture content within 2 percent optimum for material.
8. Meet following conditions when flowable fill is used instead of Trench Backfill material when specified herein for Type I areas under existing paved areas and for circular precast or cast-in-place concrete manholes.
 - a. Prevent floatation during placement of flowable fill.
 - b. Install 12 inches minimum of Trench Backfill material around valves, valve boxes, and fire hydrants.
 - c. Place flowable fill at maximum of 10 foot lifts.
 - 1) Cure flowable fill at least 4 hours before placing additional lift of flowable fill.
 - 2) Cure final lift at least 24 hours before placing additional compacted Trench Backfill material or paving.
 - d. For circular precast or cast-in-place concrete manholes, when specified herein, place flowable fill equally around entire manhole from 1 foot above uppermost pipe entering manhole.
 - 1) Backfill trench with flowable fill from top of Pipe Embedment Zone to below pavement base course.
 - 2) Outside Type I areas backfill minimum 12 inches Trench Backfill material above flowable fill.

B. Placing Trench Backfill for Pipes.

1. In new subdivision work where water and sewer house connections are to be placed in same trench at different times, backfill and compact above sewer house connection as specified up to proposed finished grade.
 - a. When installing water house connection, re-excavate as required, install water pipe, backfill, and compact as specified.
2. Detectable Warning Tape
 - a. Use blue detectable warning tape for water mainline and water house connections.
 - b. When water and sewer are installed in same trench use only blue detectable tape.
 - c. Use green detectable warning tape for gravity sewer mainline, gravity sewer house connections, and pressure sewer piping for both grinder pump systems and force mains.
 - 1) Detectable warning tape will not be required when both manholes in gravity sewer mainline reach are within limits of existing or proposed paved areas.

- d. Place tape directly over centerline of pipe, between 18 to 30 inches below finished surface and with minimal number of splices.
 - 1) Overlap tape minimum 6 inches at splices and intersections.
- 3. On steep slopes, place trench erosion checks following Standard Details, at locations shown on Drawings or at Contract Manager's direction.
- 4. When pipelines cross under existing utilities, place and compact Trench Backfill around and between existing pipelines or conduits, using manual tampers to ensure proper compaction and to avoid damage to pipes or conduits.
 - a. When indicated on Drawings, place and compact Borrow Aggregate to limits following Standard Detail.
 - b. Flowable fill may be used instead of Borrow Aggregate specified herein.
- 5. When connecting to existing pipelines, backfill under and around excavated and undermined existing pipes with Trench Backfill compacted as structural fill:
 - a. Backfill existing Rigid Pipe to pipe springline with Borrow Aggregate ASTM C33, coarse aggregate size number 67, or same Borrow Aggregate as used at connecting or adjacent pipe.
 - b. Backfill existing Flexible Pipe to 1 foot above top of pipe:
 - 1) DIP 24 inch and smaller and Type K Copper Pipe: Trench Backfill.
 - 2) DIP larger than 24 inch: Borrow Aggregate.
 - a) Bank run gravel, gradation number 1,
 - b) Or crushed stone, gradation number 3.
 - 3) PVC Gravity Sewer Pipe: Backfill with:
 - a) Borrow aggregate, ASTM C33.
 - b) Coarse aggregate, size number 67 or size number 8.
 - 4) PVC AWWA C900/905 PVC Pipe:
 - a) Pipe with 10 feet or less cover:
 - (1) Trench Backfill containing no rock or gravel larger than 3/4 inch.
 - (2) Or Borrow Aggregate meeting ASTM C33, coarse aggregate size number 67 for Bedding Zone.
 - b) Pipe with greater than 10 feet cover:
 - (1) Borrow Aggregate meeting ASTM C33, coarse aggregate size number 67 for Bedding Zone.
- 6. Place and compact specified Trench Backfill in following Zones to width and depth following Standard Details and Drawings, unless otherwise specified.
 - a. Additional excavation area below Pipe Embedment Zone: Place as Trench Backfill and compact as Structural Fill.
 - b. Pipe Embedment Zone: Place and compact Trench Backfill as Structural Fill.
 - 1) DIP, 24 inch and smaller and PVC AWWA C900/905: If additional excavation below trench bottom is required to remove unsuitable material, install minimum 6 inches of compacted Trench Backfill between pipe and additional excavation material.
 - 2) PVC Pipe: Compact using manual tampers.
 - 3) All sizes of DIP with polyethylene encasement: Place Trench Backfill around pipe without damaging pipe coating and polyethylene encasement.
 - a) Do not drop Trench Backfill directly on pipe; use deflecting boards or other temporary protection.

- b) Do not permit workers to walk on or place tools on pipe.
- 4) Sewer pipe connections to manholes or structures: Bentonite when required, following Section 02530, Standard Details or Drawings.
- 5) Pipe Embedment Zone within Wetland Areas: Extend from trench bottom to 6 inches above pipe, full width of trench.
- 6) Pipe to have concrete encasement: Place concrete around pipe within Pipe Embedment Zone, to limits shown on Standard Details.
- c. Final Backfill Zone: Place Trench Backfill and compact following these designation types.
 - 1) In Type I areas under existing paved areas:
 - a) Compact to not less than following percents of maximum dry densities at moisture content within 2 percent of optimum for material, as determined by listed ASTM method.
 - (1) MSHA highways: 92 percent, except for top foot will be 95 percent following ASTM D1557.
 - (2) All other paved areas: 95 percent, except for top foot will be 100 percent following ASTM D698.
 - 2) In Type I areas under future paved areas and within public rights of way: Compact to not less than 95 percent of maximum dry density following ASTM D698 at moisture content within range where density can be obtained based on moisture density curves taken on existing soil.
 - 3) In Type II: Compact in layers to form thoroughly dense refill free of voids and to preclude settlement within limits specified herein.
 - 4) In Type III areas: Place in 12 inch maximum lifts and compact to not less than 90 percent of maximum dry density, following ASTM D698, at moisture content within range where density can be obtained.
 - 5) In Type IV areas: Place in 12 inch lifts.

C. Placing Trench Backfill for Structures.

- 1. Place and compact specified backfill material to width and depth following Standard Details, Drawings, and specified herein.
 - a. Additional excavation area, below Granular Bedding: Place and compact Trench Backfill as Structural Fill.
 - b. Granular Bedding, under structure: Place and compact specified herein.
 - c. Place and compact Trench Backfill as Structural Fill to top of structure or to finished grade, following Drawings or Standard Details.

D. Finished Grade.

- 1. Slope surface to drain, to provide positive drainage in Type I, II, and III areas.

3.3 RESTORATION

- A. Restore and restabilize surface features and facilities damaged or destroyed during construction at least to condition existing before construction, following Section 01770, and other applicable Specification Sections.