1 General
1.1 This guideline provides the design criteria, minimum quality and materials for the excavation and backfilling of utility piping trenches.
1.2 Materials and installations shall be in accordance with the following industry and association standards.
   - AASHTO Standards
   - ASTM – Material & Testing Specifications
   - AWWA – Water Works
   - OSHA Regulations (Standards – 29CFR) Part 1926 Subpart P – Excavations, in addition to other related OSHA Standards
   - City of West Lafayette Standards, Specifications & Details – Latest Edition
1.3 Design Conditions: The Engineer shall determine the appropriate trench depths, widths and sidewall slopes and clearly indicate them on the Drawings.

2 Description of Materials
2.1 Fill and Backfill:
   2.1.1 Suitable earth removed from the excavation, free of rocks, boulders, stones, bricks, batts, plaster, mortar or other debris.
   2.1.2 All backfill shall be free from cinders, ashes, refuse and organic material.
   2.1.3 Backfill should consist of natural materials such as loam, clay, sand, gravel or other similar materials where appropriate. Frozen soil may not be used for backfill.
2.2 Lightly Consolidated Backfill:
   2.2.1 The use of ordinary backfill, as defined above, placed with 85% degree of compaction to support the trench conditions and protect the pipe. This condition is achieved by placing the backfill material in 12 inch layers and lightly compacting after each layer.
   2.3 Sand for backfill will contain less than 10% by weight of loam and clay passing a ¾” sieve with no more than 5% by weight remaining on a US No. 4 sieve. Sand is graded from fine to course.
   2.3.1 Well graded sand is the preferred material, and shall be used unless otherwise stated or approved by the Owner’s Representative.
   2.4 Gravel for backfill will contain only minimal amounts of loam and clay, consisting of a generally uniform particle size not exceeding 2 inches, #53 aggregate.
   2.5 Crushed stone for backfill will contain limestone or ledge-rock material which all passes a ½ inch sieve, but 25% or less passing a US No. 100 sieve.
   2.6 Compacted Sand or Granular Material describes the use of sand, gravel or crushed stone, placed in layers and compacted after each layer to achieve a consistent compaction rate measuring approximately 95% or greater for the Standard Proctor Test, AASHTO T-99 or ASTM D698, Test Method for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures using 5.5 LB Rammer and 12 inch Drop.
   2.6.1 If required AASHTO T-180 or ASTM D1557 can also be used if considered appropriate to the backfill material.
   2.6.2 Sand is the preferred material, and shall be used unless otherwise stated or approved by the Owner’s Representative.
2.7 Backfill under roads & sidewalks
   2.7.1 All backfill under new or existing roadways, sidewalks etc. that are eighteen inches (18”) above the pipe shall be approved #53 aggregate or flowable fill.
2.8 Backfill under precast trenches & tunnels
   2.8.1 All backfill under precast trenches, duct banks, half-tile and/or concrete utility tunnels shall be flowable fill.
   2.8.2 All backfill adjacent to precast trenches, concrete utility tunnels and other underground concrete structures subject to vehicular loading shall be flowable fill.
2.9 Backfill under existing utilities
   2.9.1 Where existing utilities are undermined and compaction underneath cannot be verified, backfill with flowable fill.
2.10 Backfill for pipe leak repairs
   2.10.1 All backfill for leak repair excavations shall be clean sand.
   2.10.2 If involving a paved area, the fill shall meet requirements above.
   2.10.3 If involving a grassy or landscaped area, fill with sand up to 12” below surface, and Purdue Grounds will install finish landscaping.
2.11 Pipe Bedding
   2.11.1 Use coarse sand 30% passing a No. 50 sieve and 3% or less passing a No. 100 Sieve.
   2.11.2 After excavating the trench and prior to laying the pipe, a 6 inch minimum layer of sand shall
be placed and compacted evenly along the base of the trench.

2.11.3 The pipe shall be surrounded by sand, and covered by a 12 inch minimum layer of sand compacted evenly along the pipe.

2.12 Pipe installed under new or existing tunnels shall be encased in flowable fill.

2.13 Topsoil shall comply with Purdue University soil guidelines.

2.14 All concrete patches shall be to Purdue Class 4A LS Specifications, copies of which are on file and all other applicable sections of these specifications.

2.15 Sidewalks, curbs, gutters, and floor slabs shall be replaced to match existing.

3 Installation Guidelines

3.1 Existing Conditions

3.1.1 Contractor shall be deemed to have inspected the site and satisfied himself as to actual grades and levels and the true conditions under which the work is to be performed.

3.2 Protection

3.2.1 Furnish, place and maintain all supports, shoring and sheet piling which may be required for the sides of the excavation or for protection of adjacent existing improvements. The adequacy of such systems shall be the complete responsibility of the Contractor.

3.2.2 Furnish and install all shoring and bracing as required to insure the existing structures such as piping and valve pits remain fully supported by undisturbed soil at all times. It shall be the sole responsibility of the Contractor to design, install and remove excavation shoring in such a manner as to insure that the existing structures are not damaged.

3.3 Excavation

3.3.1 The work site shall be prepared in advance of the work to be done. Where the excavation is in a high public access area (including roads) advanced notice should be given to the owners of the adjacent property and other affected parties. In such cases the length of open trench and excavation shall be minimized by staging the works to minimize disruption to the public where possible.

3.3.2 Adequate barricades and warning signs shall be posted around the site at all times, alerting the public to the hazardous conditions and restricting site access to authorized works personnel only.

3.3.3 All trenches shall be excavated in accordance with AWWA C600 and OSHA 1926 Subpart P. Make excavations to dimensions, elevations and sidewall slopes as indicated on Drawings.

3.3.3.1 Owner will not pay for excavations carried below indicated grades without Owner’s/Engineer’s written authorization.

3.3.3.2 Where unauthorized excavations are made below indicated elevations under slabs restore to proper elevations as specified for compacted backfill; and if under footings, restore with compacted engineered fill.

3.3.3.3 Excavation for formed concrete shall be sufficient width to allow for convenient construction and removal of forms.

3.3.3.4 Excavation for below grade walls shall be sufficient to allow for application of waterproofing and drainage materials indicated.

3.3.4 In conditions where very minimal trench width is required due to the cost of excavating in difficult or expensive areas, the trenches may be shored to enable the minimum trench width plus the width required for shoring to be adopted as the total trench width.

3.3.5 Excess soil from the excavation must be placed away from the trench to ensure no runoff from the soil will be directed into the excavation. Alternatively the soil may be stockpiled as specified by the Owner’s Representative.

3.3.6 Excess excavated material and material determined unsuitable for use as fills or topsoil shall be disposed of off the site.

3.3.7 Where unmarked utility lines or other underground obstructions or piping may be uncovered within the work area, notify the Owner/Engineer or the agencies or service utility companies having jurisdiction thereof, and take necessary measures to prevent interruptions of service if live.

3.3.7.1 Should such lines or services be damaged, broken or interrupted through the Contractor’s own negligence, those services shall be repaired immediately and restored by him at his own expense.

3.3.7.2 Abandoned lines, meters and boxes, obstructions or piping, shall be removed, plugged or capped in accordance with the requirements and approval of the agencies affected, or as directed by the Owner/Engineer.

3.4 Backfilling

3.4.1 The placement of fills shall be done under the supervision of the Soils Engineer.

3.4.2 Bedding and backfill for pipe shall
consist of a six (6") inch layer of sand placed and compacted in the trench to provide uniform bedding for the conduit.

3.4.2.1 The entire trench around the pipe shall be evenly backfilled with sand as the bedding in six (6") inch layers and compacted into place to a minimum height of twelve (12") inches above the top of pipe.

3.4.2.2 This layer of material shall be to 95% or greater Standard Proctor, AASHTO T-99 (AASHTO T-180) or ASTM D698 (ASTM D1557) or equivalent acceptable test and test results shall be provided for the Owner’s Representative as evidence of compliance.

3.4.3 Above the layer of compacted sand, Backfill shall be placed in maximum twelve (12") inch lifts and compacted in placed, up to the level indicated on the Drawings.

3.4.4 Prior to commencing compaction, soils shall be brought to optimum moisture content. Thoroughly mix each lift before compaction to assure uniform distribution of water content. Owner’s Representative shall approve the moisture content, and method of adjusting the moisture content.

3.4.5 Backfill under new or existing roadways, sidewalks etc. to specified depth shall be approved #53 aggregate placed in eight (8") inch lifts and compacted to a 95% density. Flowable fill is acceptable.

3.4.6 Compaction

3.4.7 All fills shall be compacted using equipment capable of compacting each lift its full depth. Moisture during compaction operations shall be maintained at optimum content.

3.4.8 Hydraulic compaction of backfill is not permitted without approval from the Owner’s Representative. Even with approval, at no time shall water be added to any backfill placed in a trench in freezing or potentially freezing conditions or at any time where the trench base and sides form an impenetrable clay boundary which would prohibit the infiltration of water into the surrounding soil.

3.4.9 The compacting equipment shall be approved equipment of such design, weight and quantity to obtain the required density in accordance with soil compacting specifications. Water distributors equipped with a suitable sprinkling device shall be used to add moisture to the soil if required.

3.4.10 Compaction operations shall be continued until the fills are compacted to not less than 95% of the maximum density as determined in accordance with AASHTO T-99 (AASHTO T-180) or ASTM D698 (ASTM D1557).

3.4.10.1 Any areas inaccessible to a roller shall be consolidated and compacted by mechanical tampers.

3.4.10.2 The equipment shall be operated in such a manner that hardpan, cemented gravel, clay or other chunky soil material will be broken up into small particles and become incorporated with the material in the layer.

3.4.11 Excavation shall be sized so that compaction equipment has sufficient operating clearance to achieve specified compaction throughout all areas of fill.

3.5 Grading

3.5.1 All areas covered by the Project, including excavated and filled areas and adjacent transition areas, shall be uniformly graded so that finished surfaces are at the elevation noted. Areas to receive future topsoil shall be graded to allow for such material.

3.5.2 Finished surfaces and surfaces to receive paving and aggregate base shall be reasonably smooth, compacted, and free from irregular surface drainage and shall not vary more than 0.10 foot from the established grade.

3.5.3 Ditches, gutters and swales shall be finished to permit proper surface draining.

4 Testing Guidelines

4.1 Quality Control

4.1.1 The Owner/Engineer will engage and pay for the services of a recognized Testing Laboratory specializing in Soil Mechanics for the making of tests of material to determine their suitability for fills, maximum density and optimum water content, the preparation of the materials for fills, the continuous inspection and supervision of the excavating, the placing of the fills, and the making of in-place density test for each compacted layer of fills.

4.1.2 The testing firm shall have a bona fide representative present to observe and test the entire engineered fills operation.

4.1.3 The backfill material shall be tested at regular intervals, in all critical places and around all fittings and valves.

4.1.4 A report should be produced and submitted to the Owner’s Representative which contains information on the compaction achieved at each fitting and valve and for every 300 feet approximately at each layer and on both sides of the pipe.
4.1.4.1 Where the length of the new pipeline is less than 300 feet, a compaction test shall be performed in at least two locations and reported.

4.1.4.2 The As-Built drawings shall also contain the locations of the compaction tests. Submit testing plan for approval

4.1.5 An average of two (2) tests per lift of each area is required. However, the exact number of tests will depend on the weather and at the discretion of the Soils Engineer. Testing firm shall test and approve all materials used in engineered fills operation.

4.1.6 Should tests indicate that the required density was not attained, the Contractor shall remove fills to depths required and as determined by the test. Repeat tests and operations until required density is attained.

4.1.7 The Owner/Engineer, upon the recommendation of the Testing Laboratory, will have the power of rejection of materials, equipment or operating procedures which are not suitable to produce the results specified.

4.1.8 The Contractor shall cooperate with the Testing Laboratory and shall allow the Soil Engineer ample time to conduct tests. Operation of equipment shall be discontinued when the operation interferes with testing.

4.2 Guarantee

4.2.1 The Contractor shall be responsible for one year from the date of acceptance of the project by the Owner for the grade, backfill and compaction on the works completed under these Specifications.

4.2.2 Acceptance of the work and payment for the same shall not release the Contractor from any responsibility.