

Design, Construction, and Construction Oversight of Civil Work

STD.2501

Scope

This standard describes the requirements by which all civil engineering features of onshore facilities shall be designed. These requirements shall apply to the civil construction and installation of facilities including, but not limited to, plant facilities, compressor and pump stations, meter stations and remote valve sites, or other sites being constructed to Company standards. Site shall be prepared in compliance with all applicable federal, state, and local requirements. Where overlapping or contradictory regulations are encountered, the more stringent shall apply.

This standard also provides requirements related to construction and construction oversight that are meant to be included in the form of notes on drawings or in the job specifications generated as part of the design effort. This standard shall direct the work of civil engineers, whether they work for Enterprise Products Company (Company) or an outside design firm, the work of Company construction oversight personnel and, in very general terms, the work of Civil Constructors.

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1.0 REFERENCES

Except as amended by this standard, the latest approved editions of the following regulations, codes, and standards shall form an integral part of this standard. In case of conflict between documents, contact the Company-assigned project lead for resolution.

1.1. American Association of State Highway and Transportation Officials (AASHTO)

AASHTO LRFD	Bridge Design Specifications
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1.2. American Society of Testing and Materials (ASTM)

ASTM A74	Standard Specification for Cast Iron Soil Pipe and Fittings
ASTM A716	Standard Specification for Ductile Iron Culvert Pipe
ASTM A746	Standard Specification for Ductile Iron Gravity Sewer Pipe
ASTM C33	Standard Specification for Concrete Aggregates
ASTM C76	Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C150	Standard Specification for Portland Cement
ASTM C1628	Standard Specification for Joints for Concrete Gravity Flow Sewer Pipe, Using Rubber Gaskets
ASTM C443	Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
ASTM C507	Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe
ASTM C877	Standard Specification for External Sealing Bands for Concrete Pipe, Manholes, and Precast Box Sections
ASTM C1433	Standard Specification for Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers
ASTM D698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using standard Effort (12,400 ft-lb/ft ³ (600 kN-m/m ³), (Standard Proctor Test)
ASTM D977	Standard Specification for Emulsified Asphalt
ASTM D1241	Standard Specification for Materials for Soil Aggregate Subbase, Base, and Surface Courses
ASTM D1557	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lb/ft ³ (2,700 kN-m/m ³))
ASTM D6572	Standard Test Methods for Determining Dispersive Characteristics of Clayey Soils by the Crumb Test

ASTM F2306	Standard Specification for 12 to 60 in. Annular Corrugated Profile-Wall Polyethylene (PE) Pipe and Fittings for Gravity-Flow Storm Sewer and Subsurface Drainage Applications
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1.3. Department of Homeland Security (DHS)

6 CFR 27	Chemical Facility Anti-Terrorism Standards
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1.4. National Oceanic and Atmospheric Administration (NOAA)

Technical Report NWS 25	Comparison of Generalized Estimates of Probable Maximum Precipitation With Greatest Observed Rainfalls
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1.5. Pipeline and Hazardous Materials Safety Administration (PHMSA)

49 CFR 192	Transportation of Natural and Other Gas by Pipeline
49 CFR 195	Transportation of Hazardous Liquids by Pipeline

1.6. U. S. Environmental Protection Agency (EPA)

40 CFR 112	Oil Pollution Prevention
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1.7. Other References

TX-DOT	(Specifications), Item 249, Type A, Grade 1
TX-DOT	(Specifications), Item 272

1.8. Company Standards, Standard Drawings, and Manuals

Section 3.4	Safety Policies Manual – Excavation and Trenching
STD.0504	Facility Record Drawing Management – Record Drawing CAD Standard
STD.1004	Spacing for Equipment, Buildings, and Facilities
STD.2600	Fencing
STD.2800	Foundation Design
STD.2802	Concrete Construction
STD.2900	Geotechnical Engineering Investigation
STD.5603	Secondary Containment, Tank Farm Design, and Auxiliary Equipment
STD.8711	Disposition of Non-Operational Pipelines and Facilities
STD-CIDT-2611	Standard Ditch Design (See Appendix D of this standard)
STD-CIDT-2723	Chain Link Fence Detail (See Appendix I of this standard)
STD-CIDT-2724	Bollards and Guard Post Details (See Appendix K of this standard)
STD-CIDT-2761	Concrete General Notes

STD-CIDT-2820	Benchmark Detail (See Appendix B of this standard)
STD-CIDT-2823	Culvert Design (See Appendix E of this standard)
STD-CIDT-2824	Road Design with Vertical and Horizontal Clearances (See Appendix H of this standard)
STD-CIDT-2825	Radius of Curvature for Tractor and Semi-Trailer (See Appendix G of this standard)
STD-CIDT-2826	Cut & Fill Slope Detail (See Appendix C of this standard)
STD-CIDT-2827	Storm Sewer and Junction Box (See Appendix F of this standard)
STD-CIDT-2828	Plant Design Coordinate System (See Appendix A of this standard)
STD-CIDT-2829	Septic Tank and Absorption Field (See Appendix J of this standard)

2.0 DEFINITIONS

ADA – Americans with Disabilities Act

AHJ – Authority Having Jurisdiction

BOD₅ – Design five day biochemical oxygen demand

Category I Fill – Is defined herein to be soil free of muck, debris, topsoil, and vegetation, having a liquid limit of less than 40 and preferably less than 35. Plasticity index shall be less than 20 and preferably greater than eight.

Category II Fill – Is defined herein to be soil that is free of muck, debris, topsoil, and vegetation.

Category III Fill – Is defined herein to be soil free of muck, debris, topsoil, and vegetation and have a liquid limit between 30 and 50. Plasticity index shall be greater than 15 and with more than 30 percent of the material passing a No. 200 sieve.

Contractor – In this standard, the term Contractor shall be used to identify the primary company (the successful bidder) and any of the sub-contract companies or individuals authorized by the Contractor to do work at the construction site, or at offsite locations as described in the Contractor's scope of work.

Company – Enterprise Products Company and affiliates

Company's Representative – Unless otherwise noted, and for all matters related to physical site preparation or construction, the Company's Representative shall be the Project Manager (PM) or the PM's designee.

FEMA – Federal Emergency Management Agency

OSSF – On-site sewage facility

PVC – Polyvinyl chloride

Topsoil – Soil containing appreciable amounts of organic matter

3.0 GENERAL DESIGN REQUIREMENTS

- (1) This standard provides information pertinent to site selection and civil design. Specific information is included on site selection, horizontal and vertical control, drainage and fencing.
- (2) Civil engineering features shall be designed in strict accordance with this standard and with the documents referenced in Section 1.0 as directed in various sections of this standard. Any conflicts with the requirements of these documents and this standard shall be brought to the attention of the Company-assigned Project Manager.

- (3) Company standards STD.2802 and STD-CIDT-2761 shall be referenced on the drawings for concrete material properties and construction requirements.

4.0 SITE SELECTION

- (1) Site layout and spacing shall be performed in accordance with Company standard STD.1004.
- (2) Site selection should be based on all costs associated with developing a particular site. Some of the major costs and concerns associated with developing a site are:
- (a) Land Cost
 - (b) General Soils Conditions
 - (c) Need for Blasting
 - (d) Access Roads and Bridges
 - (e) Dock Access
 - (f) Bringing utilities to site (electric power, water, sewers, telephone, communication)
 - (g) Grading and fencing
 - (h) Environmental considerations
- (3) Plants and stations should be located adjacent to all-weather, public roads. When it is not feasible to locate adjacent to a public road, which may occur for remote gathering stations, private roads may be used provided that road use and access agreements between the Company and private owner are obtained.
- (4) Siting Constraints Based on Surrounding Land Use – when selecting a site, the following should be considered:
- (a) Public buildings or public use area (churches, schools, hospitals and playgrounds) or any private development having similar occupancy levels (motels, shopping centers, office buildings, etc.) should be avoided if possible.
 - (b) Free of overhead power lines if at all possible, except along property lines and the primary power feed to the facility. In the case of onsite power lines, they shall be routed away from any buildings or equipment and, in no circumstance, shall they be located over any buildings or equipment. Underground service is preferred.
 - (c) An investigation shall be made of the potential for flooding if the site is near streams, rivers, drainage, or low areas.
- (5) Other factors to be considered in selecting a site are:
- (a) Proximity to pipelines, especially foreign pipelines and their related easements.
 - (b) Ease of access
 - (c) Proximity to railroads, as railroad rights-of-way may impact land availability,
 - (d) Soil conditions (load bearing and stability, fill materials)
 - (e) Topography (required cut and fill, drainage)
 - (f) Availability of required utilities (purchase power, water, sewer, communications)
 - (g) Environmental permit and noise requirements, and if sour gas is present, the proximity to the public and wind direction
 - (h) Any other easements that would encumber the property

5.0 GEOTECHNICAL INVESTIGATION

5.1. Subsurface Investigation

As quickly as possible after a site is selected and a preliminary layout approved, a geotechnical investigation shall be conducted in accordance with Company standard STD.2900.

- (1) Borings should be taken, at a minimum, at the location of equipment foundations, vertical reactor foundations and any other equipment foundations where soil pressure under the foundation under design wind conditions will be significantly greater than the weight of the equipment and foundation divided by the foundation footprint area.
- (2) Borrow areas should be identified and the soils of the borrow area tested for suitability for their intended use. This applies especially to borrow intended for use in containment berms around chemical or petroleum product storage tanks. Such berms should not be constructed with dispersive clays.
- (3) The geotechnical investigation should also identify potential problems, such as expansive soils, which may pose problems for the long term integrity and serviceability of more lightly loaded foundations and pavements.

6.0 CHEMICAL FACILITY ANTI-TERRORISM STANDARDS

The owner of any facility that will store any Department of Homeland Security Chemical of Interest at or above the applicable Screening Threshold Quantity must submit a CSAT Top-Screen to the Department of Homeland Security.

7.0 ENVIRONMENTAL CONSIDERATIONS

Federal, state, and local emissions, noise level, and air quality requirements shall be identified and permits obtained prior to final purchase of the site.

7.1. Environmental Protection

7.1.1. General

- (1) The control of environmental pollution that could result from construction operations requires consideration of land, water, and air quality at the site.
- (2) All applicable federal, state, and local laws and regulations concerning environmental pollution control or abatement shall be followed. All necessary permits shall be obtained and the work shall be in compliance with such permits concerning environmental protection.

7.1.2. Protection of Land Resources

- (1) Land resources adjacent to the project boundaries shall be preserved in their present condition or restored to a natural appearance if disturbed.
- (2) Care shall be taken to not injure or destroy trees or shrubs adjacent to the project site. Construction activities shall be confined to the area shown on the drawings.
- (3) Construction wastes shall not be buried on the project site and/or surrounding land.

7.1.3. Protection of Water Resources

- (1) Site construction shall not adversely affect the existing water quality within or adjacent to the project site. No construction wastes or other harmful materials will be permitted to enter these water resources.

- (2) Surface drainage from cuts and fills shall be protected by an effective erosion and sediment control plan or shall be graded to maintain erosion within acceptable limits. Measures to effectively prevent or limit soil erosion and/or contamination shall be maintained until permanent drainage and erosion control facilities are completed.

7.1.4. Control of Air Pollutants

- (1) Fire shall be kept small in size and shall burn no oils, asphalt materials, or anything other than wood or natural plant growth.
- (2) The project site and access roads should be maintained in such a manner as to minimize dust or other problems that could be considered a hazard or nuisance to others.

8.0 HORIZONTAL AND VERTICAL CONTROL

8.1. Plant Design Coordinate System

- (1) Both horizontal and vertical control shall be based on a facility datum established by the Company. Elevation 100.00 shall be defined and clearly noted on the construction drawings. North 1000.00, East 1000.00 shall be defined as the southwest property corner.
- (2) The direction of the coordinate system shall be parallel to the layout of facilities that are normally parallel to a major property line.
- (3) The standard coordinate system shall be on a 100'-0" grid. Smaller sites may utilize a 50'-0" grid if clarity is enhanced.
- (4) If not already established and provided by the Company, the Contractor shall establish a grid system covering the facility site using north and east coordinates in accordance with the requirements below.
- (5) Design elevations and coordinates shall be expressed in feet with respect to this datum.
- (6) Construction drawings shall show coordinates and elevations rounded off to the nearest hundredth of a foot.
- (7) See plant design coordinate system detailed in Company Standard Drawing STD-CIDT-2828 in Appendix A of this standard.

8.2. Site Topographic Survey

- (1) A topographic survey will be conducted. The survey shall provide the applicable FEMA flood map panels, and shall address the current floodplain status of the site.
- (2) Normal contour intervals for sites shall be 1ft for relatively flat sites, 2 ft or more for hilly and rolling sites. Contour interval selection should be based on the steepness and size of the site.
- (3) Information shall be obtained to locate power poles, existing pipelines, utilities or other significant site features and to determine site drainage patterns, including flow lines of streams and inverts of roadside ditches and culverts adjacent to the site. Elevations and width of roads adjacent to the site shall also be included.
- (4) The location and elevation of the benchmarks utilized for the survey shall be fixed and identified in the survey record documents. Elevation of the benchmarks shall be recorded with respect to NAVD88 and horizontal position shall be recorded with respect to the NAD83 state plane coordinate system.
- (5) Offsite benchmarks utilized in the survey to establish NAVD88 elevations and NAD83 coordinates shall be recorded in the survey record documents.
- (6) On most projects, the layout of the site shall be known with some degree of confidence, including the origin and orientation of the plant grid and location of the major structures. For such projects,

the location and elevation of on-site benchmarks shall be also recorded with respect to the plant grid coordinate system.

- (7) While the plant coordinate system shall be defined per section 8.1(1) of this standard, an accurate elevation shall also be recorded with respect to NAVD88.

8.3. Permanent Site Benchmarks and Monuments

- (1) The number of benchmarks installed at each site is at the discretion of the Company's Project Engineer and will vary depending upon the type of facility installed. In general, no less than three benchmarks should be installed at each site, with up to four at large mainline compressor stations.
- (2) The benchmarks should be located on a line parallel to the main coordinate system, out of the way of planned construction and in a readily accessible but protected location.
- (3) See benchmarks detailed in Company Standard Drawing STD-CIDT-2820 in Appendix B of this standard.

9.0 DRAINAGE SYSTEMS

9.1. General

- (1) This section is applicable to water generated from rainfall, fire water, and uncontaminated process drains. Site design shall usually provide for removal of storm water by surface drainage methods. Underground storm sewers shall be avoided unless circumstances make surface drainage impractical.
- (2) Contour grading should be limited to that required to augment natural drainage whenever possible. Natural drainage patterns should be maintained at property lines. Culverts and other storm sewer piping should be installed only where necessary to maintain surface access across drainage areas.
- (3) Site storm water collection and discharge systems shall be designed in accordance with established standards and methods of the local AHJ. In some instances, this may require the inclusion of a detention pond to reduce peak discharge into the receiving waterway or drainage feature. In the absence of locally established standards, or where the following paragraph of this standard is more stringent, the requirements of the following paragraph shall be applied.
- (4) For large sites where catch basins and storm sewer piping are installed to handle runoff, the facilities should be sized using the Rational Method (to determine the quantity of surface runoff based on site topography) and the Manning Formula (to determine pipe flow capabilities).

9.2. Rainfall Rate

The design basis for drainage systems should be those required by the local AHJ unless Company standards would require the accommodation of higher flow rates (other than the discharge flow rate to the receiving off-site drainage way). Company minimum standards are that the design basis for drainage systems (with the exception of culverts) shall be the rainfall rate based on a storm frequency return interval of not less than 10 years. Rates for sites located in the U.S. may be obtained from either the NOAA Technical Report NWS 25 or from U.S. Meteorological Survey publications. The design time of concentration shall be no greater than 10 minutes. Culverts shall be designed based on a return interval of not less than 25 years.

9.3. Runoff Calculations

- (1) Surface runoff from rainfall shall be calculated by the Rational Formula:

Q = CIA		
Where:		
Q	=	Rate of runoff, cu ft/sec
C	=	Runoff coefficient
I	=	Rainfall intensity, in/hr
A	=	Drainage area, acres

- (2) Runoff Coefficients

Type of Surface	Runoff Coefficient C
Paved surfaces and roof areas	0.85 - 1.00
Gravel and macadam surfaces	0.35 - 0.70
Slightly pervious bare earth	0.50 - 0.85
Slightly pervious earth, turfed	0.30 - 0.70
Moderately pervious bare earth	0.25 - 0.50
Moderately pervious earth, turfed	0.00 - 0.20

9.4. Grading Design

9.4.1. Cut and Fill Slopes

- (1) No permanently exposed cut or fill slopes shall be steeper than 3:1 (horizontal:vertical), unless allowed in the Design Basis or Geotechnical Report.
- (2) Embankments made on existing sloping surfaces with slopes steeper than 5:1 shall have the existing surface benched. The bench should be at least 5 ft wide and less than 5 ft in height. A shear key at least 10 ft wide and 2 ft deep should be provided at the toe of the slope.
- (3) See cut and fill slopes detailed in Company Standard Drawing STD-CIDT-2826 in Appendix C of this standard.

9.4.2. Finished Grade Slopes

- (1) Nominal slope of finished grade across site shall not be less than 1 percent. Maximum slope shall not exceed 3 percent.
- (2) Surfaces shall slope away from all building and equipment foundations at 5 percent for the first 20 feet, and then gently slope afterwards.

9.5. Ditch Design

- (1) Ditches shall be designed for the sum of storm and process water, or the sum of process water and the flow rate of the fire water system to be installed, whichever is greater. If the fire water system is unknown, the design quantity shall be 500 gpm of firewater for an area of 10,000 sq ft and an additional 100 gpm for each 4,000 sq ft of process area. Quantities of areas within tankage firewalls or other controlled release areas shall not be included.

- (2) Ditches shall normally be trapezoidal in cross section, with a minimum bottom width of two feet. The side slope shall normally be 2.5:1 (horizontal:vertical), but may be as steep as 1.5:1 if space is limited and soil conditions permit. Vee ditches may be used for short laterals. Minimum gradient shall be 0.005 ft/ft. Ditches that attain a depth greater than 1 foot may need to be concrete lined depending on rainfall amounts, soil type, etc. (normally inside a large facility).
- (3) Shallow swales may be used within or adjacent to process units. Minimum gradient shall be 0.02 ft/ft for unlined gutters, 0.003 ft/ft for lined gutters. Minimum depth shall be 3 inches; maximum depth shall be 1 ft.
- (4) The maximum velocity in unlined ditches of low capacity (with a cross sectional area of less than 4 square feet and a depth of less than 1 foot) should not exceed the following:

Fine sand or silt	2.5 ft/sec
Coarse sand to sandy loam	2.5 ft/sec
Sandy clay	3.5 ft/sec
Clay	5.0 ft/sec

- (5) See standard ditch design detailed in Company Standard Drawing STD-CIDT-2611 in Appendix D of this standard.

10.0 STORM DRAINAGE

10.1. Culverts

- (1) Storm drainage consists of grass lined ditches with reinforced concrete pilot channels, concrete lined channels, circular culvert pipe, horizontal elliptical culvert pipe, and box culvert placements.
- (2) Circular reinforced concrete culvert pipe shall conform to ASTM C76. Horizontal elliptical reinforced concrete culvert pipe shall conform to ASTM C507. Pre-cast reinforced concrete box sections shall conform to ASTM C1433.
- (3) Culvert pipe diameters and wall thickness shall be as specified on the drawings.
- (4) Circular reinforced concrete culvert pipe joints shall be made with neoprene gasketed two piece connecting bands conforming to ASTM C443. Horizontal elliptical reinforced concrete culvert pipe and pre-cast reinforced concrete box sections shall have joints made conforming to ASTM C877. Cement free mortar joints, if used, shall conform to ASTM C150. Aggregate shall conform to ASTM C 33.
- (5) All culverts shall be placed on a firm, uniformly compacted soil bed free of rocks and other foreign matter. The bed shall be trimmed and shaped to maintain straight pipe alignment.
- (6) When a firm foundation is not encountered due to soft, spongy, or otherwise unsuitable material, such material shall be removed and suitable material substituted and compacted as directed by the Purchaser.
- (7) Category I fill shall be used to back-fill around culverts. Back-fill shall be hand compacted placed in 4 inch loose lifts. No machine compacted fill shall be placed until 2 feet of hand compacted material has been placed over the culvert.
- (8) Trench bracing, sheathing, or shoring shall be used in order to ensure the stability of any excavation as required for safety and conformance with all applicable federal, state, and local requirements.

10.2. Culvert Design

- (1) Culverts shall be sized to pass the 10 year storm flow with a non-submerged inlet. The culvert shall be checked for the 50 year storm with ponding at the entrance not to exceed the top of the adjacent subgrade. All design features such as headwalls, endwalls, transition structures, energy dissipaters, etc., shall be selected on the basis of culvert performance.
- (2) Culverts shall be corrugated metal pipe, reinforced concrete pipe, or reinforced concrete box, as required for vehicular load and depth of fill above the culvert.
- (3) The minimum design loads for culverts under roads shall include the earth pressure on the culvert and an axle load of 32,000 pounds. Construction and maintenance vehicle loadings shall be evaluated where applicable.
- (4) The preferred minimum diameter of culverts shall be 18 inches. Smaller diameter culverts may be used where specific site conditions make this impractical.
- (5) Where installation of multiple culverts is required, the minimum clear distance between pipes shall be as follows:

Pipe Diameters	Minimum Clear Distance
12 in. to 24 in.	12 in.
27 in. to 72 in.	1/2 diameter
78 in. to 120 in.	36 in.

- (6) Culverts shall have a minimum slope of 0.002 ft/ft.
- (7) Riprap, in the form of 4 inches and larger rock, or some other form of protection, shall be used at outfalls of culverts unless specific site conditions make its use unwarranted
- (8) See culvert design detailed in Company Standard Drawing STD-CIDT-2823 in Appendix E of this standard.

10.3. Storm Sewer Design

- (1) Storm sewers shall be designed for the sum of storm and process water, or the sum of process water and the flow rate of the fire water system to be installed, whichever is greater. If fire water system is unknown, the design quantity shall be 500 gpm of firewater for an area of 10,000 sq ft and an additional 100 gpm for each 4,000 sq ft of process area. Quantities of areas within tankage firewalls or other controlled release areas shall not be included.
- (2) Minimum allowable velocity at design flow shall be 3 ft/sec for storm sewers. Maximum allowable velocity at design flow shall be 8 ft/sec. Where large quantities of sediment or sludge are expected, minimum allowable velocity at design flow shall be increased to minimize deposition.
- (3) Minimum cover for storm sewers shall be 18 inches or maximum depth of frost line, whichever is greater. Under roads, cover shall be as required by the road design basis. The preferred slope for storm sewers is 0.01 ft/ft. The minimum slope shall be 0.005 ft/ft.
- (4) See storm sewer detailed in Company Standard Drawing STD-CIDT-2827 in Appendix F of this standard.

10.4. Areas Requiring Containment

The ground surface around tanks and other areas requiring containment of potential spills shall be designed in accordance with Company Standard STD.5603.

10.5. Erosion Control

- (1) Appropriate erosion control measures shall be incorporated into the design of the facility site, using both mechanical and vegetative means, as appropriate. Mechanical means include alterations to the shape of the land to control runoff and the installation of protective covers to prevent erosion. Vegetative means include the planting of grasses, shrubs, and trees to curb erosion. Consideration shall be given to preserving as much natural vegetation as possible that does not interfere with construction or with future operations. Disturbed areas should be revegetated to reduce erosion, where possible, following construction.
- (2) Erosion control measures should take into account the exposure to which the measures will be subjected. For example, if it is anticipated that an area will be subjected to occasional chemical or petroleum contact, then vegetative erosion controls would not be appropriate.

11.0 SITE SURFACING

11.1. Gravel and Crushed Stone

- (1) Compacted Portland cement treated base courses shall contain a minimum of 5 percent cement.
- (2) Gravel for shoulders, access roads and temporary construction features shall conform to ASTM D1241, Type I, Gradation C or D. River run gravel is acceptable.
- (3) The base course shall be compacted to 95 percent or greater maximum dry density as measured by ASTM D698. During the compaction, all irregularities, depressions, or weak spots that develop shall be corrected by removing all undesirable material by excavation, adding suitable material, reshaping, and re-compacting as required.
- (4) Crushed rock is normally used for surfacing. The extent of the area to receive crushed rock shall be described in the Design Basis.
- (5) Crushed rock shall be applied in a lift of thickness required to achieve a compacted thickness of 4 inches. It shall be watered lightly after it is applied and compacted to 90 percent of the maximum dry density as determined per ASTM D1557.

Suggested Gradation of Crushed Rock	
U.S. Sieve Size (ASME E11)	Percent Passing
3/4 in	100%
1/2 in	90% - 100%
3/8 in	40% - 70%
No. 4	5% - 25%
No. 8	0% - 10%
No. 16	0% - 5%

12.0 ROADS AND PARKING LOT

12.1. Surfacing

The type of surfacing to use for roads and parking lots shall be described in the Design Basis.

12.2. Grade Limitations

The preferred maximum grade for roads is 5 percent, but, if unusual circumstances exist, grades of up to 10 percent may be used. Ramps shall be in accordance with federal/state ADA requirements where applicable, or elsewhere limited to a 10 percent grade.

12.3. Geometry

- (1) The minimum radius of curvature for tractor and semi-trailer combination traffic is 75 ft, measured to the road centerline; for other traffic, it is 35 ft.
- (2) See standard radius of curvature for tractor and semi-trailer detailed in Company Standard Drawing STD-CIDT-2825 in Appendix G of this standard.
- (3) The minimum roadway width for asphalt roads shall be 12 ft, with 3 ft of gravel shoulder on each side. The gravel base shall be 18 ft in width. If the road is to be surfaced with caliche or crushed stone, the minimum width shall be 18 ft.
- (4) See standard road design detailed in Company Standard Drawing STD-CIDT-2824 in Appendix H of this standard.

12.4. Clearances

- (1) Overhead clearance, measured from the crown of the road shall be a minimum of 22 ft 6 in for primary access roads and 16 ft 0 in for secondary roads
- (2) Horizontal clearance, measured from the edge of the road shoulders, shall be a minimum of 5 ft for all structures, equipment, or piping.
- (3) See clearances detailed in Company Standard Drawing STD-CIDT-2824 in Appendix H of this standard.
- (4) See vertical clearances for pipe supports in Company Standard Drawing STD-PIDT-4623.

13.0 FENCING

The site shall be completely enclosed by a chain link fence in accordance with Company STD.2600.

14.0 SANITARY WASTE TREATMENT

14.1. Treatment System

Sanitary sewers shall collect waste from toilet facilities, lavatories, building floor drains, etc. Sewage shall be conveyed either to a public sewage system (if available) or to an OSSF.

14.2. Flow Rate

The capacity of the OSSF shall be based on the number and type of sanitary facilities provided, with the daily volume of sewage being calculated on the basis of 30 gal/person/shift. BOD5 shall be 0.05 lb/person/8-hr shift. The number of persons being served will be stated in the Design Basis.

14.3. On-Site Sewerage Facilities

- (1) On site-sewerage facilities may be of any type approved by the local AHJ, subject to Company minimum standards. In many locations, this will be a septic tank/absorption field system or else an aerobic treatment system
- (2) In most states, a permit must be obtained prior to construction of an on-site sewerage facility. Most states require that the application be prepared by either a civil engineer licensed in the state or a certified sewage system designer. Some require that the application be submitted by the credentialed individual who prepared the design.

14.3.1. Septic Tank and Absorption Field

- (1) The functional design of the septic tank and absorption field shall comply with the minimum requirements of the local AHJ.

- (2) Subject to approval and requirements of state regulations and the local AHJ, an example of a design of the septic disposal field is as follows:
 - (a) The septic tank shall be constructed of either precast or cast-in-place concrete. The bottom and floor of the tank shall be integral. The tank access manway and clean-out opening shall project at least 6 inches above finished grade.
 - (b) The subsurface absorption field shall be constructed of 4 in, plain-end vitreous clay, concrete tile, or perforated PVC, carefully laid to level grade. Minimum coverage of laterals shall be 18 inches and minimum width of lateral ditches shall be 12 inches. Minimum spacing between adjacent edges of laterals shall be 5 ft. For clay or concrete tile, openings between joints shall be approximately $\frac{1}{4}$ inch, and the top half of each joint shall be covered with a 3 inches wide strip of 25# roofing felt to prevent the intrusion of backfill material. Perforated PVC pipe shall be laid with perforations on the bottom. Four inches of ungraded, washed gravel shall be placed above and below all lateral drain tile or pipe.
- (3) See septic tank and absorption field detailed in Company Standard Drawing STD-CIDT-2829 in Appendix J of this standard.

14.3.2. Aerobic Treatment System

- (1) The functional design of the aerobic treatment system shall comply with the minimum requirements of the local AHJ.
- (2) The aerobic treatment system shall be designed by a certified sewerage system designer.

14.4. Flow Rates in Sanitary Sewer Pipes

Minimum velocities in sanitary sewer pipes shall be 2.5 ft/sec. Velocities shall not exceed 6 ft/sec.

15.0 FIRE AND SPILL CONTAINMENT DIKES

15.1. Dike Capacities

- (1) The volume capacity of a diked compound surrounding tanks of flammable and combustible liquid storage shall be determined in accordance with STD.5603.
- (2) Diked areas which are to store water for firefighting shall be sized to provide a volume of water equal to the flow rate in gallons per hour of the fire water system to be installed times a duration of 4 hours plus the volume of the impoundment area at a depth of 2 feet plus a regionally appropriate allowance for ice.

15.2. Dike Material and Geometry

Fire and spill dikes shall be of earth, concrete, or steel. Other requirements are stated in Company standard STD.5603 and in Sections 7.0, 8.0 and 16.0 of this standard.

15.3. Drainage of Diked Compounds

In an area of potential spills, provisions shall be made to divert clean storm and draw off water to the ditch system if storm water discharge permits allow.

16.0 MISCELLANEOUS ITEMS

16.1. Slabs

- (1) Concrete slabs should be considered in the following locations (exclusive of slabs used as foundations):
 - (a) At vehicular and personnel entrances to buildings.
 - (b) At laydown areas for equipment maintenance.

- (c) At any other areas that may require a high strength surface.
- (2) Design of concrete slabs shall be as directed in Company standard STD.2800. Slabs subject to spills and wash water shall be a minimum of 4 inches thick. Those designed to collect spills shall be provided with a raised curb at least 4 inches tall.
- (3) Walkways and pedestrian paths at grade shall be 4 inches thick and reinforced with 6x6 – W 2.9 X W 2.9 welded wire fabric or equivalent.
- (4) Walkways and pedestrian paths should have an elevation at least 3 inches above surrounding grade.

16.2. Sumps and Pits

- (1) Below-grade sumps or pits should be constructed of either pre-cast or cast-in-place concrete. The bottom and floor of the sumps or pits shall be designed and constructed to be liquid-tight to prevent underground leakage.
- (2) Pipe penetrations through sump walls shall be either cast-in-place with anti-seep collars or fittings or grouted using non-shrink epoxy grout.
- (3) Sump covers shall be either precast concrete or cast-in-place concrete with appropriate manhole access.

16.3. Bollards and Guard Posts

Bollards and guard posts provided to protect buildings and facilities from moving or parking vehicles shall be steel pipes at least 4 inches in diameter embedded in concrete-filled holes at least 30 inches deep and having a diameter at least three times the pipe diameter. See bollards and guard post detailed in Company Standard Drawing STD-CIDT-2724 in Appendix K of this standard.

17.0 CIVIL CONSTRUCTION

17.1. General

General earthwork design and construction procedures shall conform with the recommendations of the Project Civil/Structural Design Basis, Geotechnical Report, and to the requirements outlined herein. In cases in which the requirements of this document are in conflict with the recommendations of the Design Basis or Geotechnical Report, the latter shall govern.

17.2. Protection of Existing Services

- (1) Existing utility lines and underground facilities, where known, shall be indicated on the drawings. Once site work has started, such information including supporting documentation and/or sketches (if necessary) shall be communicated via the projects' established chain of command.

NOTE: Should the condition encountered be of such importance that project scheduling or permitting issues may be affected, The Company's Representative shall ensure that the information is communicated to appropriate project and/or facility management personnel as quickly as reasonably possible.
- (2) Care shall be exercised to prevent damage to utility lines and underground facilities going to or leaving the facility.
- (3) The work site and all portions thereof shall remain accessible to heavy vehicles and personnel throughout the duration of the project. .
- (4) Security at the site should be maintained throughout the duration of the project and without additional cost to the Company.

- (5) No excavation, grading, or other earthwork shall be performed in wet, cold, or other weather conditions that the Company's Representative considers unfavorable for securing satisfactory construction.

17.3. Clearing and Grubbing

The entire facility site shall be cleared of stumps, brush, logs, trees, and shrubs, except any trees or shrubs designated by Company for preservation. The site shall be grubbed of stumps, large roots, and other undesirable material, to a depth of at least 2 ft below the bottom of any excavation that will be performed in the area that is grubbed, or at least 2 ft below the ground surface if no excavation will take place. All holes remaining after clearing and grubbing shall be backfilled and compacted to a minimum density equivalent to the undisturbed soil density. Debris from clearing and grubbing operations shall be removed from the site. Method of disposal and location of disposal site shall be subject to Company approval.

17.4. Stripping and Proof Rolling

Topsoil shall be stripped from all areas within the boundaries of the site that will not be left in their natural state. Topsoil shall be stockpiled or disposed of as directed or approved by the Company representative. Following site stripping, all areas to receive fill shall be proof rolled with a rubber-tired roller or other heavy equipment to locate any soft or spongy zones. Any such zones found shall be excavated and replaced with suitable material and compacted.

17.5. Excavation and Trenching

- (1) Excavation and trenching shall be conducted carefully to prevent any damage to existing facilities.
- (2) Drawings shall contain directions to Construction Contractors to contact local utility companies and centralized utility line locating services (811 one-call agencies) at least 48 hours prior to excavation. Every effort shall be made to locate any underground utilities prior to excavating. Water utilities may not be a member of a one-call system. The Company representative shall be notified when any unexpected underground utilities are uncovered.
- (3) Any pipelines greater than 3 inches in diameter abandoned in place shall be filled with a non-compactable material such as sand/cement slurry per Company standard STD.8711. Company Safety Policies Manual Section 3.4 – *Excavation and Trenching* provides additional information.
- (4) Excavation consists of the removal of subsurface material below the "stripping" layer to the lines and elevations shown on the drawings and as required by this specification.
- (5) Excavation shall be classified as Category II material and shall be free of muck, debris, topsoil, and vegetation.
- (6) Excavation shall be performed in a manner that assures proper drainage during the course of the work. Flooded excavations shall be de-watered and all muck removed before proceeding with the work.

17.6. Fill Material Quality

- (1) Structural fill shall be free of organic matter, have a maximum particle size of 3 inches have a plasticity index less than 20, and have no more than 20 percent passing the #200 sieve. Suitability of imported structural fill shall be verified with an analysis and description from the Supplier. If on-site or native soil is used as fill, it shall be verified as suitable in the Design Basis or Geotechnical Report. Any material used for non-structural fill shall be approved by the Company representative.
- (2) Fill material that is to be used for containment dikes or berms shall be shown by testing to be non-dispersive.

- (3) Material from on-site excavation may be used for fill, if appropriate and approved by the Company.
- (4) Fill material areas corresponding to respective fill categories are as shown on the drawings. Un-designated areas may be composed of any of the fill categories or a combination thereof.
- (5) No fill shall be placed until authorized by the Company. Final approval of a fill will be made only after the fill has been placed, compacted and achieved the degree of compaction in conformance with the testing criteria.
- (6) The entire area on which fill is to be placed shall be uniformly proof-rolled with a heavy roller to at least 95 percent of standard Proctor maximum dry density (ASTM D698). Additional excavation shall be performed in all soft areas revealed by proof-rolling.
- (7) Areas to be filled shall be stripped and excavated to the desired depth using suitable equipment. A layer of fill material not exceeding 6 inches in loose depth shall be spread over the excavated surface and the whole area compacted as required by the specification. Additional layers shall be deposited and compacted as required to bring the area up to grade elevation.
- (8) Structural fill shall be placed in successive horizontal layers not exceeding 8 inches in loose depth, and each layer compacted to the percent of maximum dry density defined below:
 - (a) Category I, Category III, and Lime stabilized materials:
 - 95 percent maximum dry density in conformance with ASTM D 698.
 - Moisture content shall be within 1 percent dry to 3 percent wet of optimum.
 - (b) For other areas:
 - 90 percent maximum dry density in conformance with ASTM D 698.
 - Moisture content shall be within 1 percent dry to 3 percent wet of optimum.

17.7. Soil Compaction

- (1) Fill shall be compacted to the following percent of maximum dry density obtainable at optimum moisture content, as determined per ASTM D1557:
 - Areas that will support structures or equipment: 95 Percent
 - All other areas: 90 Percent
- (2) Compacted thickness of fill material shall not exceed 6 inches per lift.
- (3) Compaction shall be performed by equipment suitable for the soil and compaction specified. Any areas inaccessible to heavy equipment shall be compacted by mechanical tampers. Material shall be moistened or aerated, as necessary, to provide the moisture content that will facilitate obtaining the specified compaction.

17.8. In-place Density Testing Frequency

- (1) Category I, Category III, and Lime stabilized fill placed at areas designated on the drawings shall have one in-place density test performed for each lift covering an area not to exceed 5,000 sq ft. When used as back-fill, one in-place density test shall be performed for each 200 cu yd of back-fill.
- (2) Category II fill and un-designated areas of fill shall have one in-place density test performed for each lift covering an area not to exceed 10,000 sq ft.

17.9. Site Erosion Control

- (1) Appropriate erosion control measures shall be provided by the Grading Contractor, using both mechanical and vegetative means, as appropriate. Mechanical means include the installation of protective covers to prevent erosion. Vegetative means include the planting or preservation of grasses to curb erosion. Consideration shall be given to preserving as much natural vegetation as possible that does not interfere with construction or with future operations. Disturbed areas should be revegetated to reduce erosion, where possible, following construction. Erosion controls will be judged as effective, and thus appropriate if sediment is prevented from leaving the site boundary and, within an active plant, does not interfere with operations.
- (2) Erosion control measures are the responsibility of both the party possessing day to day control of construction operations and the site owner/developer. Where a Contractor is employed to perform civil construction, the burden of erosion control should be placed on that Contractor; however, the site owner/developer has a responsibility to ensure that effective erosion control measures are in place and are properly maintained so as to be effective.

17.10. Cut and Fill Slopes

- (1) No permanently exposed cut or fill slopes shall be steeper than 3:1 (horizontal:vertical), unless allowed in the Design Basis or Geotechnical Report.
- (2) Embankments made on existing sloping surfaces with slopes steeper than 5:1 shall have the existing surface benched. The bench should be at least 5 ft wide and less than 5 ft in height. A shear key at least 10 ft wide and 2 ft deep should be provided at the toe of the slope.
- (3) Sloped surfaces steeper than 4-to-1 shall be stripped and/or excavated in a stepped or benched manner. Fill and compaction shall be as described above.

17.11. Finished Grade Slopes

- (1) Nominal slope of finished grade across site shall not be less than 1 percent. Maximum slope shall not exceed 3 percent.
- (2) Surfaces shall slope away from all building and equipment foundations

17.12. Grading Tolerances

- (1) Grading shall be in accordance with the drawings, with surfaces sloping uniformly between given points. Tolerances shall be as follows:

	Vertical	Horizontal
Rough Grade	0.30 ft	1.0 ft
Finished Grade	0.10 ft	0.25 ft

- (2) In those areas where a base course or ballast is to be placed, the top of the sub-grade and base course shall be of such smoothness that, when tested with a 16 foot straight edge applied parallel and at right angles to the centerline of the roadway, it shall not show any deviation in excess of 1/2 inch, and shall not be more than 0.05 feet from true grade.
- (3) In areas other than those upon which a base course or ballast is to be placed, the surface shall not vary by more than 0.12 feet from true grade. Perimeter dikes shall be within a tolerance of +0.10 feet, -0.00 feet from true grade, after allowance for any settlement.

17.13. Quality Assurance

- (1) Grading work should be inspected by the Company's geotechnical consultant to determine compliance with the specified requirements. The consultant should evaluate and approve all stripping and foundation preparation measures in advance of placing compacted fill and will direct any necessary undercutting and special stabilization measures that may be required.

- (2) Tests by the Company should be performed on fill at a rate of two tests per lift or one test per each 500 cu yd of material placed, whichever creates the greatest number of tests. Lifts failing to comply with the specified requirements shall be scarified, adjusted in water content as required, re-compacted, and retested to establish compliance.

18.0 TOPSOIL AND SEEDING

18.1. General

- (1) Topsoil over those areas indicated on the drawings or as directed by the Company Project Manager or designee shall be uniformly deposited 4 inches thick in loose depth and rolled lightly.
- (2) Fertilize and seed those areas indicated on the drawings, or as directed by the Company.
- (3) Before fertilizing, the surface shall be trimmed and raked and be free from unsightly variations, humps, ridges, or depressions. The surface material shall be free from clumps of soil, matted roots, roots greater than $\frac{1}{2}$ inches in diameter, and any other objectionable material that might hinder subsequent grassing and mowing operations.

18.2. Fertilizer and Lime

Fertilizer, lime, rate of application, and equipment should be considered to uniformly blend these ingredients with the topsoil to encourage a deep root system for the new grass.

18.3. Seed

A perennial grass seed mixture that is compatible with the climate conditions of the area and consists of tried and proven species grown in the general location shall be used. The mixture shall be able to sustain normal abuse in an industrial plant environment with a minimum of maintenance. Seed shall have a minimum 85 percent germination.

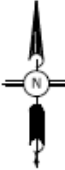
18.4. Application

- (1) Seed shall be applied to the topsoil bed by mechanical, hydroseeding, or any other method that will produce a uniform distribution, and then rolled lightly before applying mulch.
- (2) Within 24 hours after seeding, wood cellulose, straw, or hay mulched material shall be uniformly applied at a rate not less than 1 ton per acre. Mulch may be spread either by hand, mechanical spreader or by blowers. Newly spread mulch shall be held in place by asphalt binder conforming to ASTM D977 Type SS-1 or RS-1 as appropriate. Binder shall be uniformly applied at a rate of 6 to 10 gallons per 1,000 square feet.
- (3) During progress of the work, the Company reserves the right to reject any and all materials that in Project Manager or designee's opinion appears unsatisfactory for its intended use.
- (4) After the first cutting the area should be inspected to determine any barren or sparse locations where a good stand of grass has not developed. These areas shall then be reworked, adding fertilizer, lime, or seed mixture as necessary to the satisfaction of the Company.

19.0 FINAL CLEAN-UP


Before final acceptance of the project, all equipment, unused, and useless material, rubbish, and temporary buildings shall be removed and fences and other private or public property that may have been damaged on account of the work shall be repaired. Depressions and water pockets shall be repaired, all obstructions from waterways shall be removed, and all drains and ditches within and adjacent to the site shall be cleaned and cleared.

Appendix A Plant Design Coordinate System

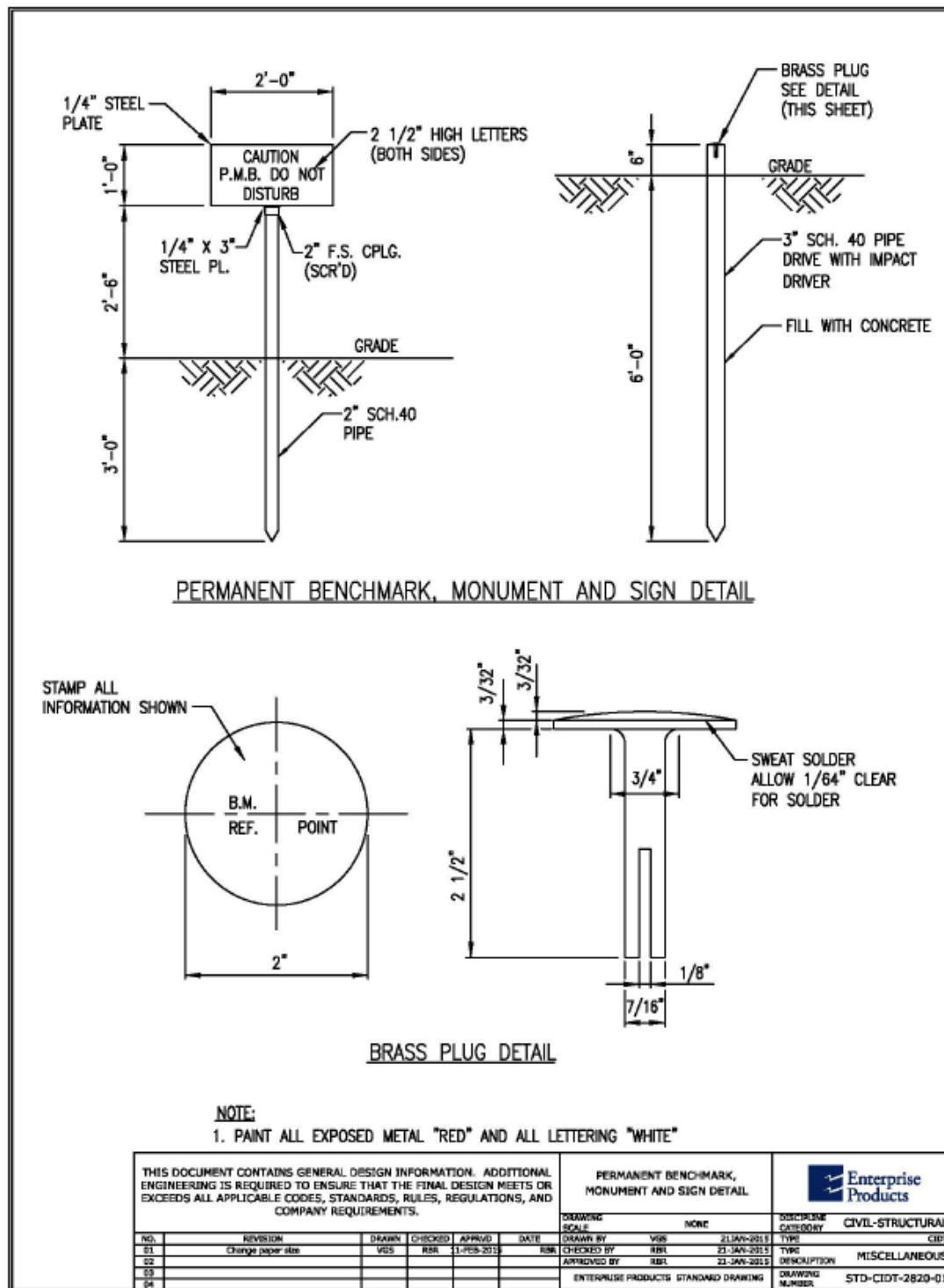
SURVEY NO.		COUNTY/PARISH, STATE	
N 1700 N 1600 N 1500 N 1400 N 1300 N 1200 N 1100 N 1000			
E 1000 E 1100 E 1200 E 1300 E 1400 E 1500 E 1600 E 1700			

NOTE:

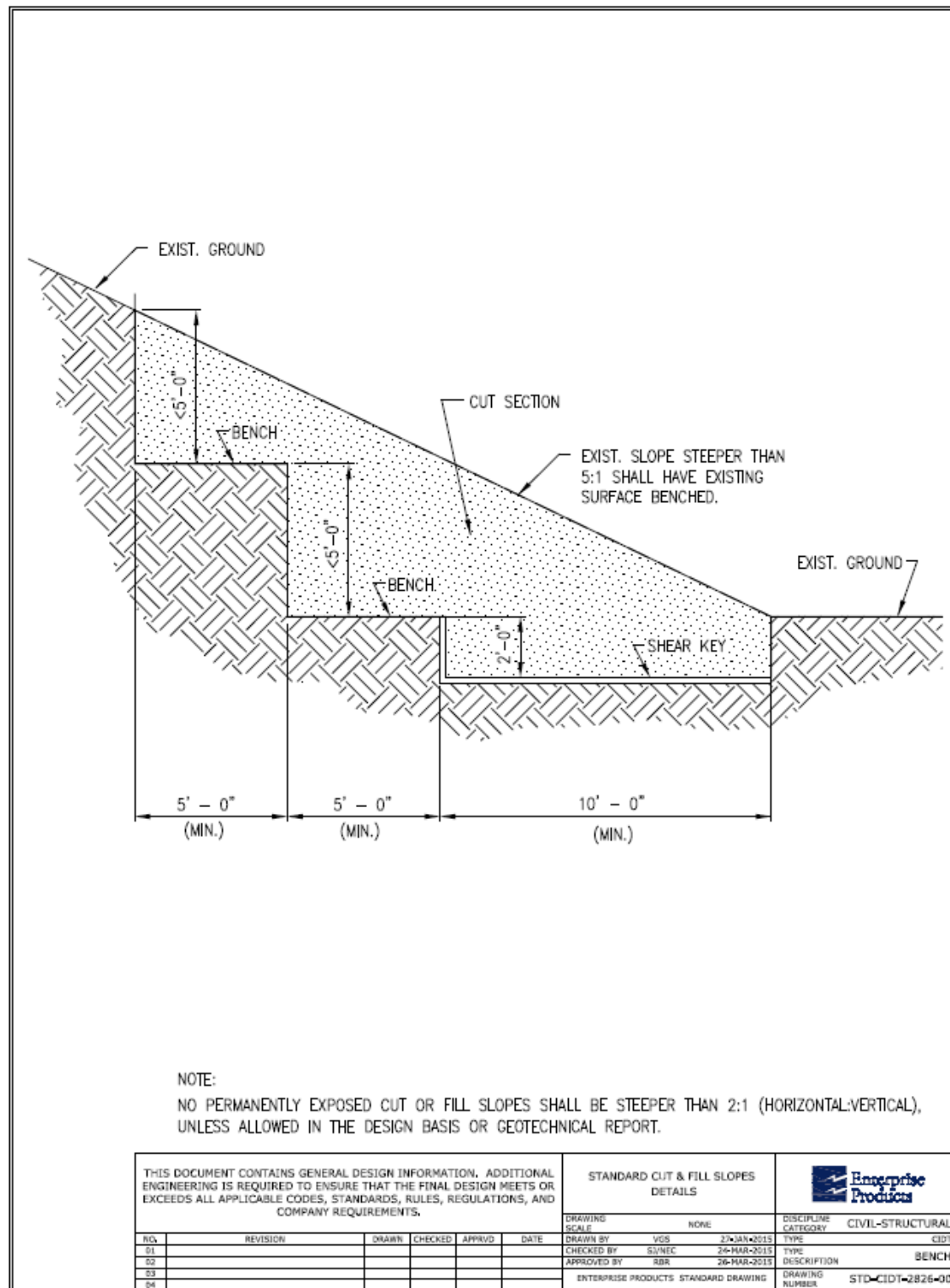
- ELEVATION 100.00 SHALL BE DEFINED AS THE COMPRESSOR BUILDING FINISHED FLOOR (OR, IN THE ABSENCE OF A COMPRESSOR BUILDING, THE TOP OF CONCRETE OF THE MOST SUBSTANTIAL FOUNDATION ON SITE).
- THE STANDARD COORDINATE SYSTEM SHALL BE ON A 100'-0" GRID. SMALLER SITE MAY UTILIZE A 50'-0" GRID IF CLARITY IS ENHANCED.
- THE LOCATION AND ELEVATION OF BENCHMARKS SHALL BE FIXED AND IDENTIFIED. ELEVATION SHALL BE RECORDED WITH RESPECT TO NAVD88 AND HORIZONTAL POSITION SHALL BE RECORDED WITH RESPECT TO THE NAD83 STATE PLANE.
- THE BENCHMARK SHOULD BE LOCATED ON A LINE PARALLEL TO THE MAIN COORDINATE SYSTEM, OUT OF THE WAY OF PLANNED CONSTRUCTION AND IN A READILY ACCESSIBLE BUT PROTECTED LOCATION.

THIS DOCUMENT CONTAINS GENERAL DESIGN INFORMATION. ADDITIONAL ENGINEERING IS REQUIRED TO ENSURE THAT THE FINAL DESIGN MEETS OR EXCEEDS ALL APPLICABLE CODES, STANDARDS, RULES, REGULATIONS, AND COMPANY REQUIREMENTS.					PLANT DESIGN COORDINATE SYSTEM			
NO.	REVISION	DRAWN	CHECKED	APPROVED	DATE	DRAWING SCALE	DISCIPLINE CATEGORY	
01						DRAWN BY: VES	CIVIL-STRUCTURAL	
02						CHECKED BY: SJWEC	CIDT	
03						APPROVED BY: SBR	PLANT COORDINATES	
04						ENTERPRISE PRODUCTS STANDARD DRAWING	DRAWING NUMBER	
							STD-CIDT-2828-00	

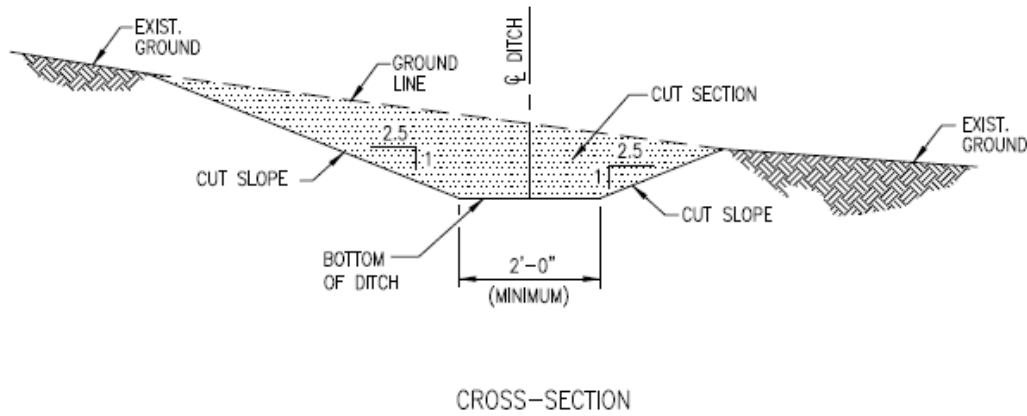
Appendix B Permanent Benchmark, Monument, and Sign Detail




Appendix C Standard Cut and Fill Slope Design



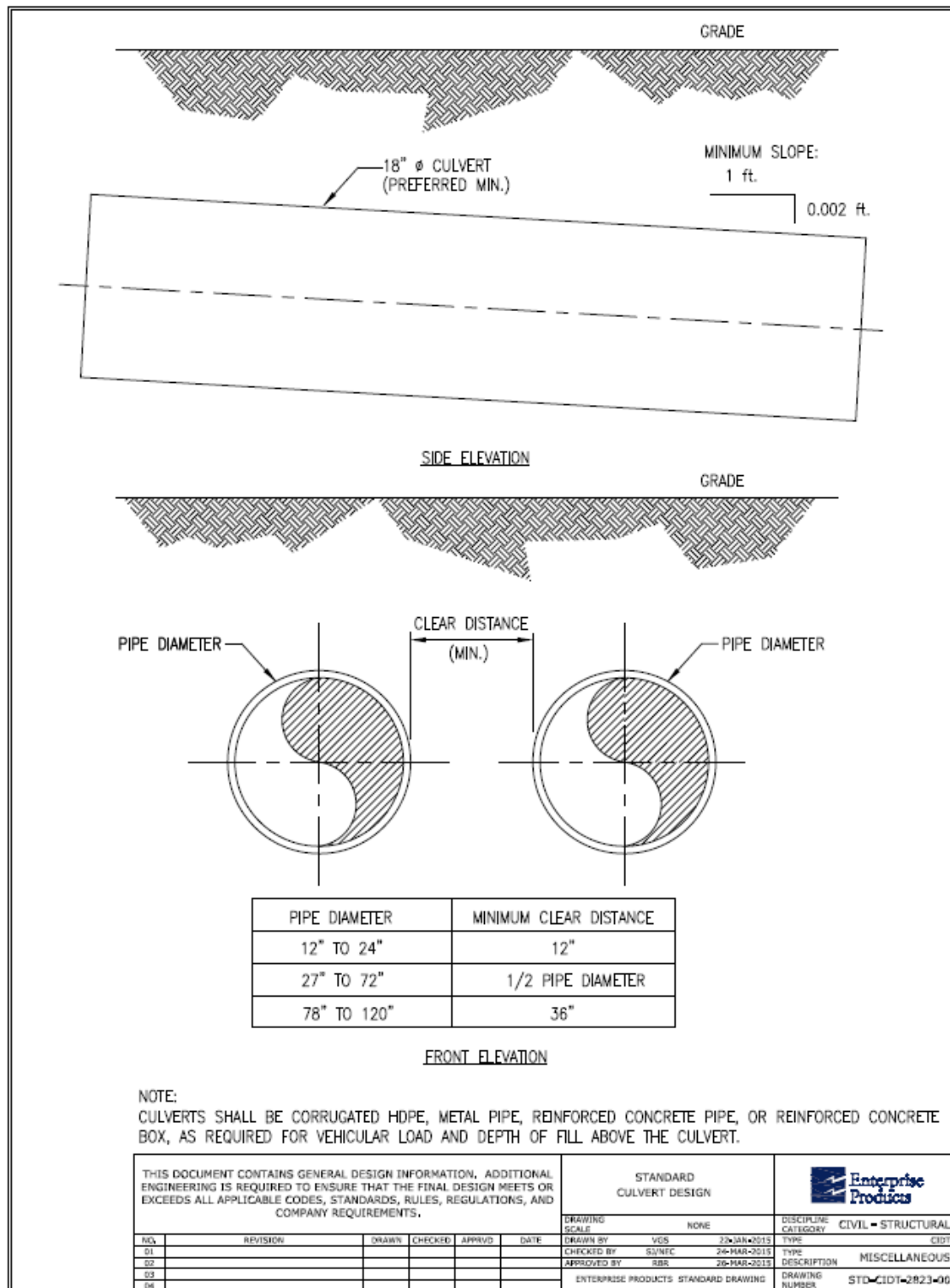
Appendix D Standard Ditch Design


NOTES:

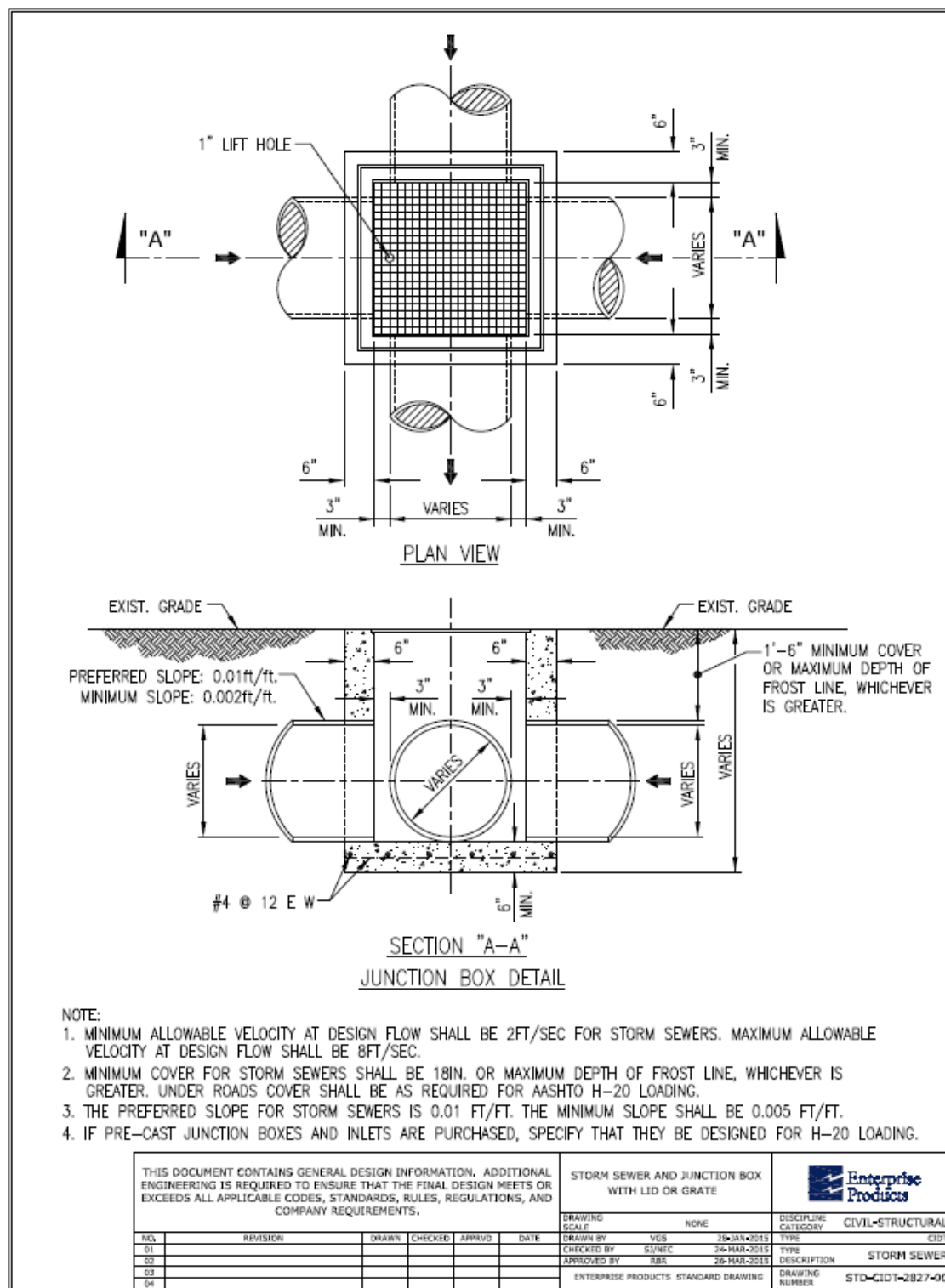
1. DITCH SHALL NORMALLY BE TRAPEZOIDAL WITH A MINIMUM BOTTOM WIDTH OF 2 FEET.
2. THE SIDE SLOPE SHALL NORMALLY BE 2.5:1 (HORIZONTAL:VERTICAL) BUT MAY BE AS STEEP AS 1.5:1, IF SPACE IS LIMITED AND SOIL CONDITIONS PERMIT.
3. VEE DITCHES MAY BE USED FOR SHORT LATERALS.
4. MINIMUM GRADIENT SHALL BE 0.005 FT/FT.
5. DITCHES WHICH ATTAIN A DEPTH GREATER THAN 1 FOOT SHOULD BE CONCRETE LINED.

THIS DOCUMENT CONTAINS GENERAL DESIGN INFORMATION. ADDITIONAL ENGINEERING IS REQUIRED TO ENSURE THAT THE FINAL DESIGN MEETS OR EXCEEDS ALL APPLICABLE CODES, STANDARDS, RULES, REGULATIONS, AND COMPANY REQUIREMENTS.						STANDARD DITCH DESIGN				
						DRAWING SCALE	NONE		DISCIPLINE CATEGORY	CIVIL-STRUCTURAL
NO.	REVISION	DRAWN	CHECKED	APPROVED	DATE	DRAWN BY	VOS	26-JAN-2015	TYPE	CIDT
01						CHECKED BY	SJW/EC	24-MAR-2015	TYPE	DITCH
02						APPROVED BY	SBB	24-MAR-2015	DESCRIPTION	
03						ENTERPRISE PRODUCTS STANDARD DRAWING			DRAWING NUMBER	STD-CIDT-2611-06
04										

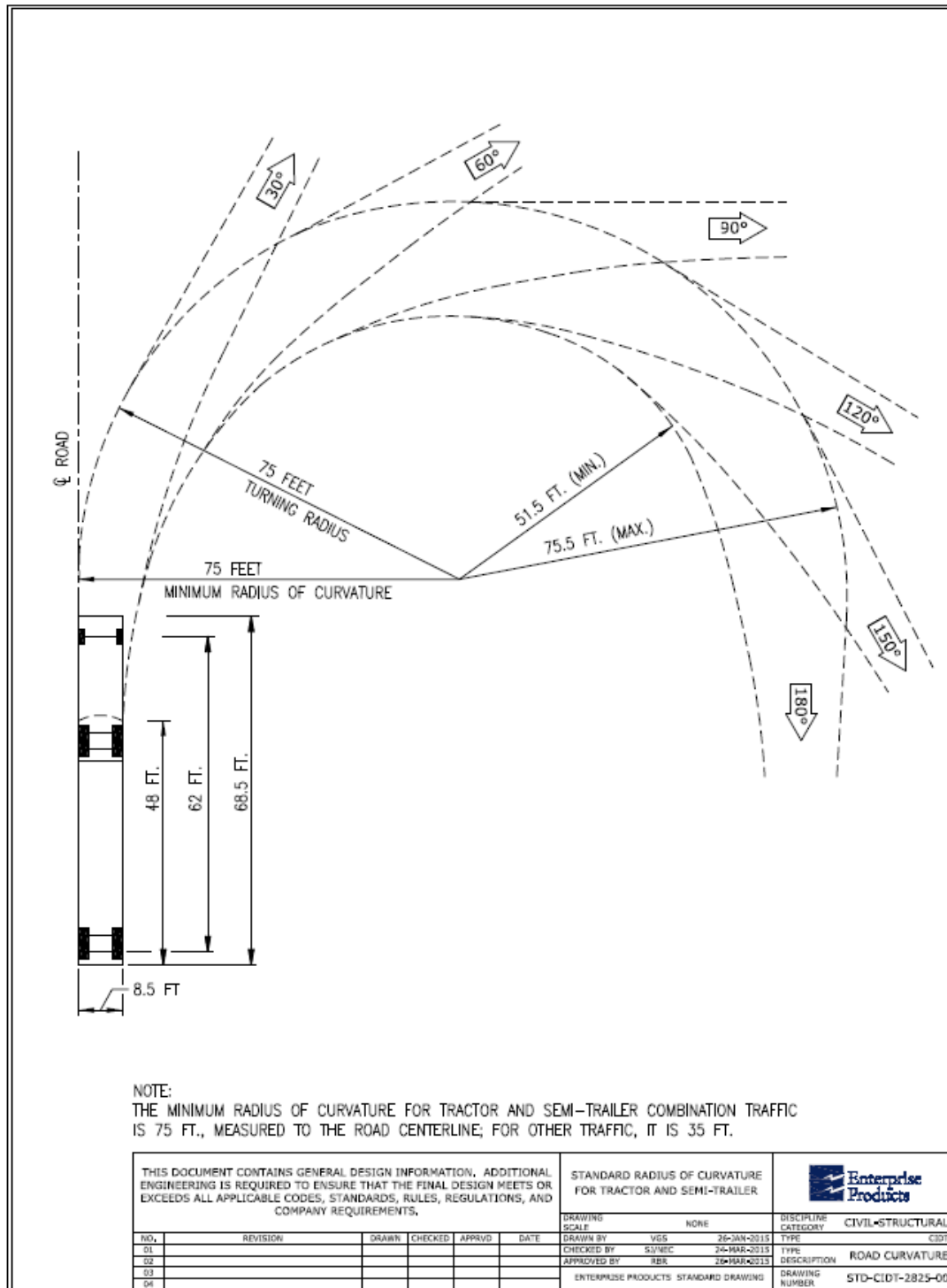
Appendix E Culvert Design Standard Detail



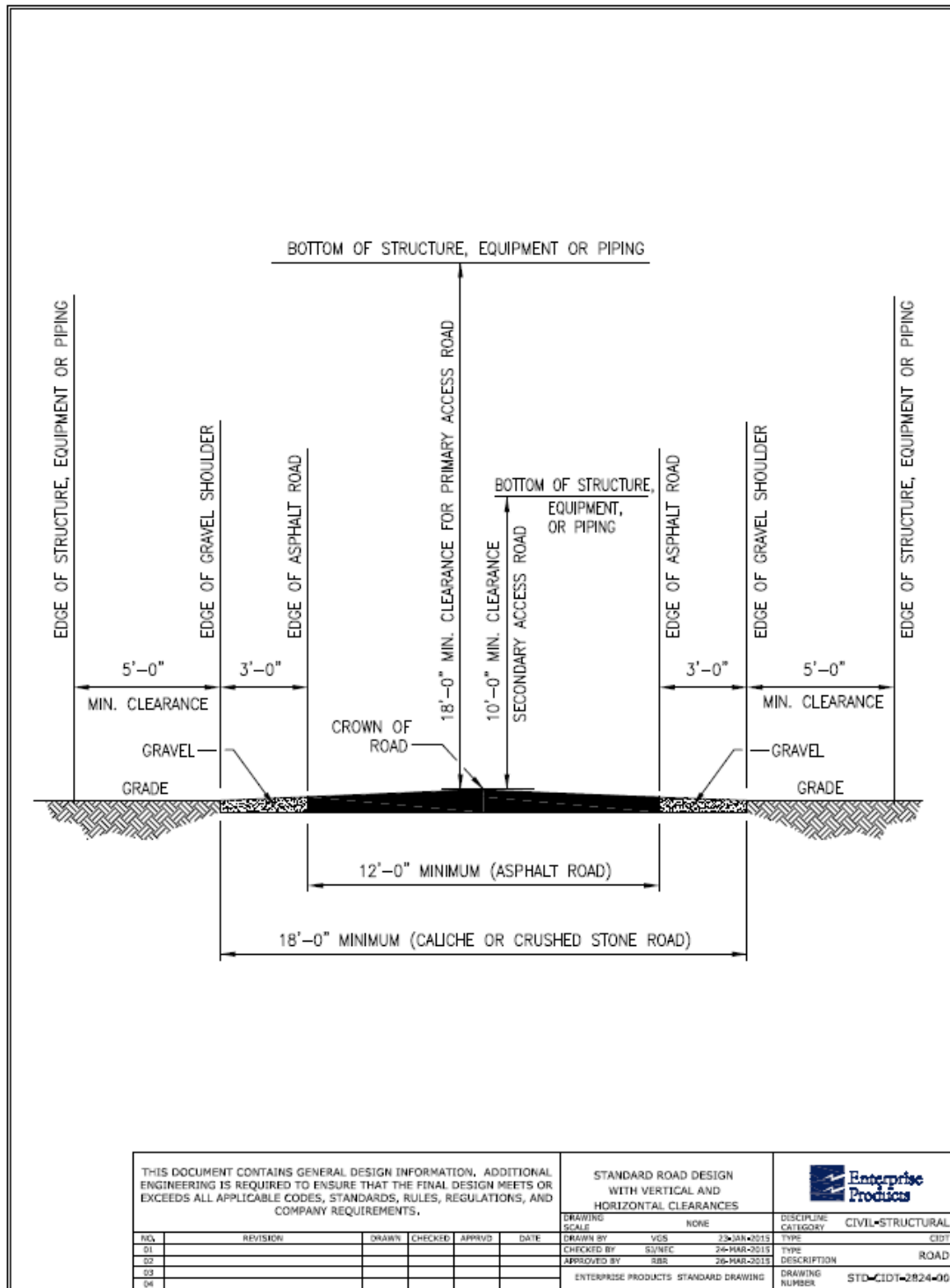
Appendix F Storm Sewer and Junction Box Design



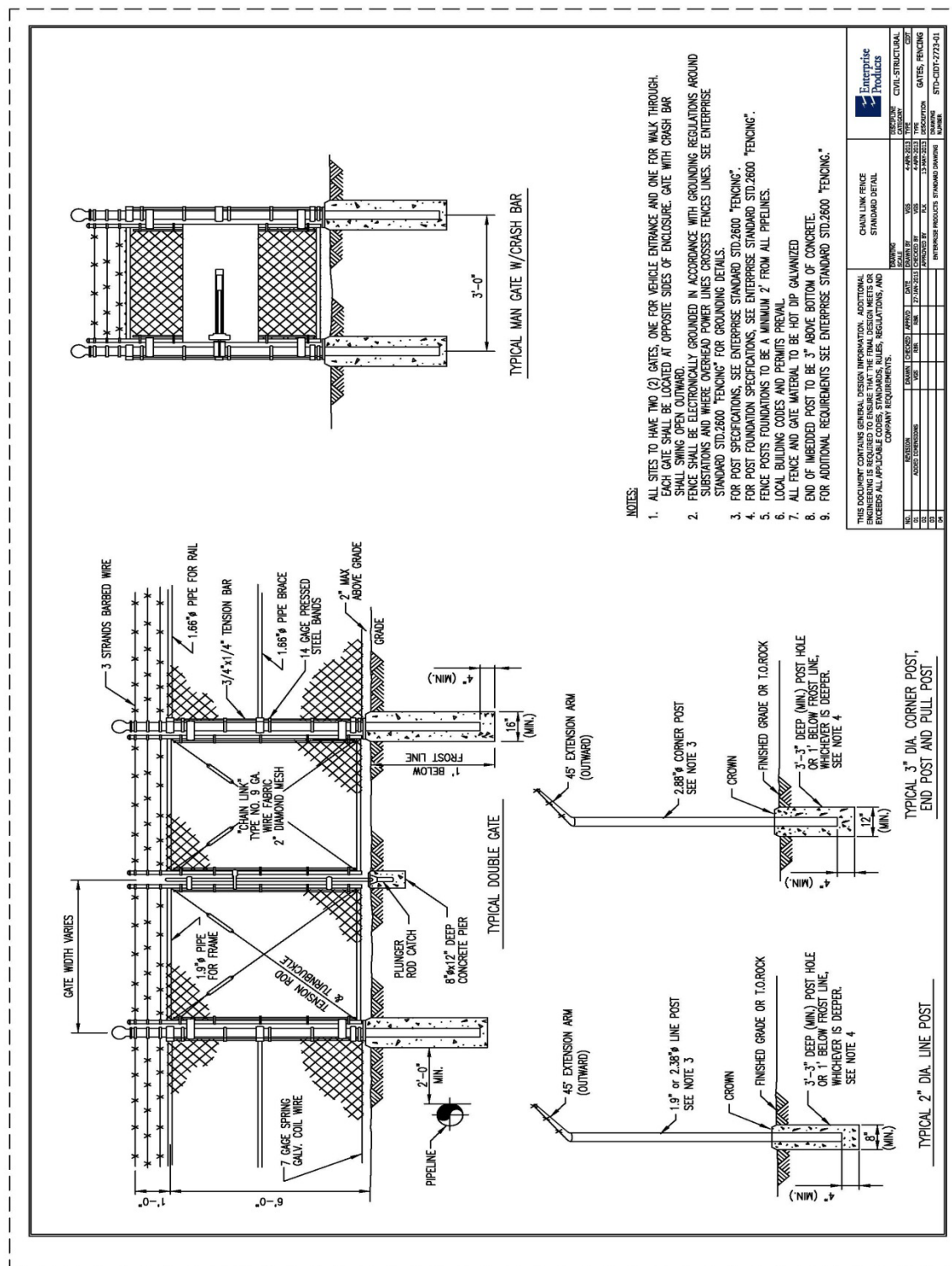
Appendix G Standard Radius of Curvature for Tractor and Semi-Trailer



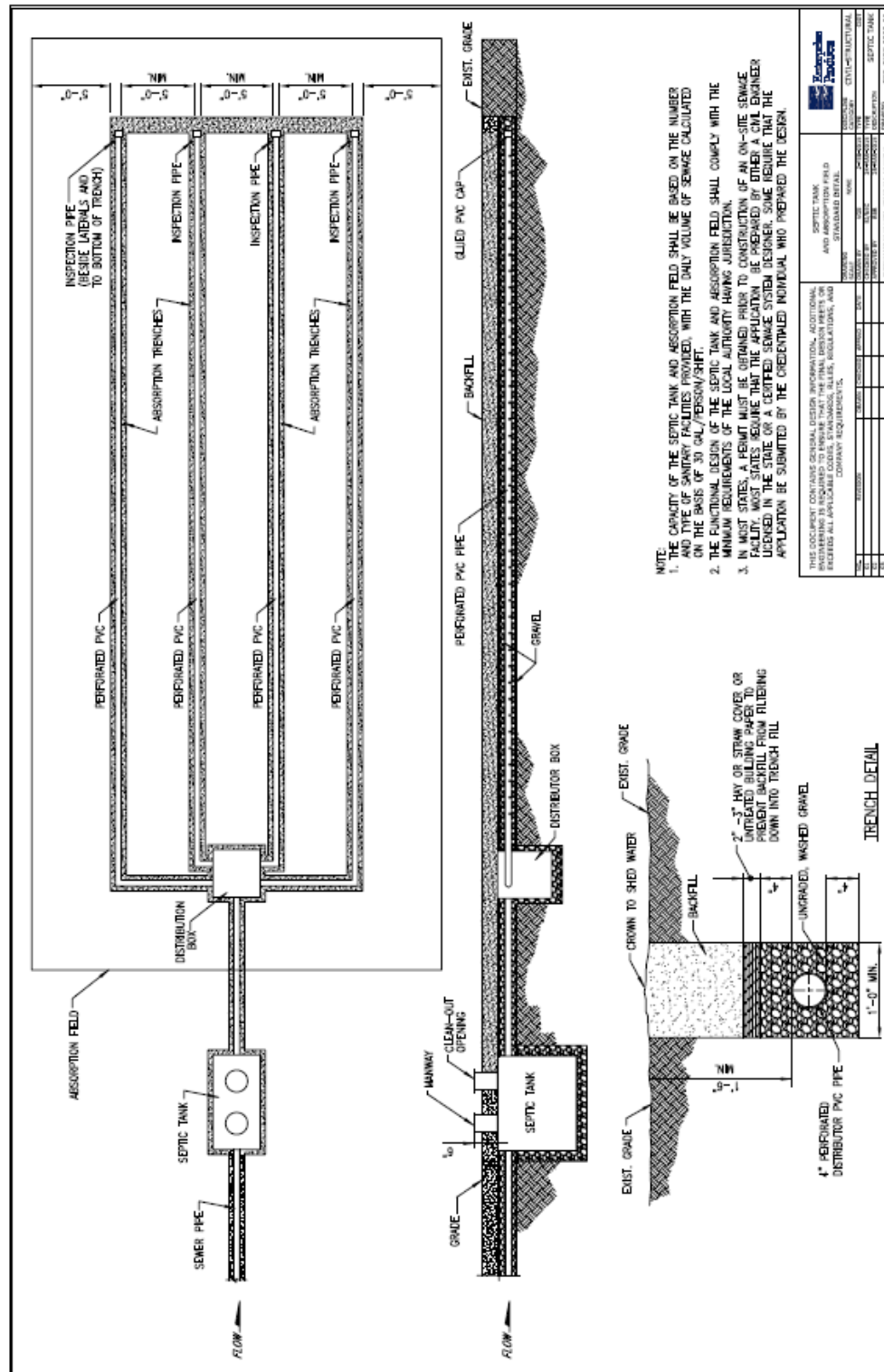
Appendix H Standard Road Design with Vertical and Horizontal Clearances



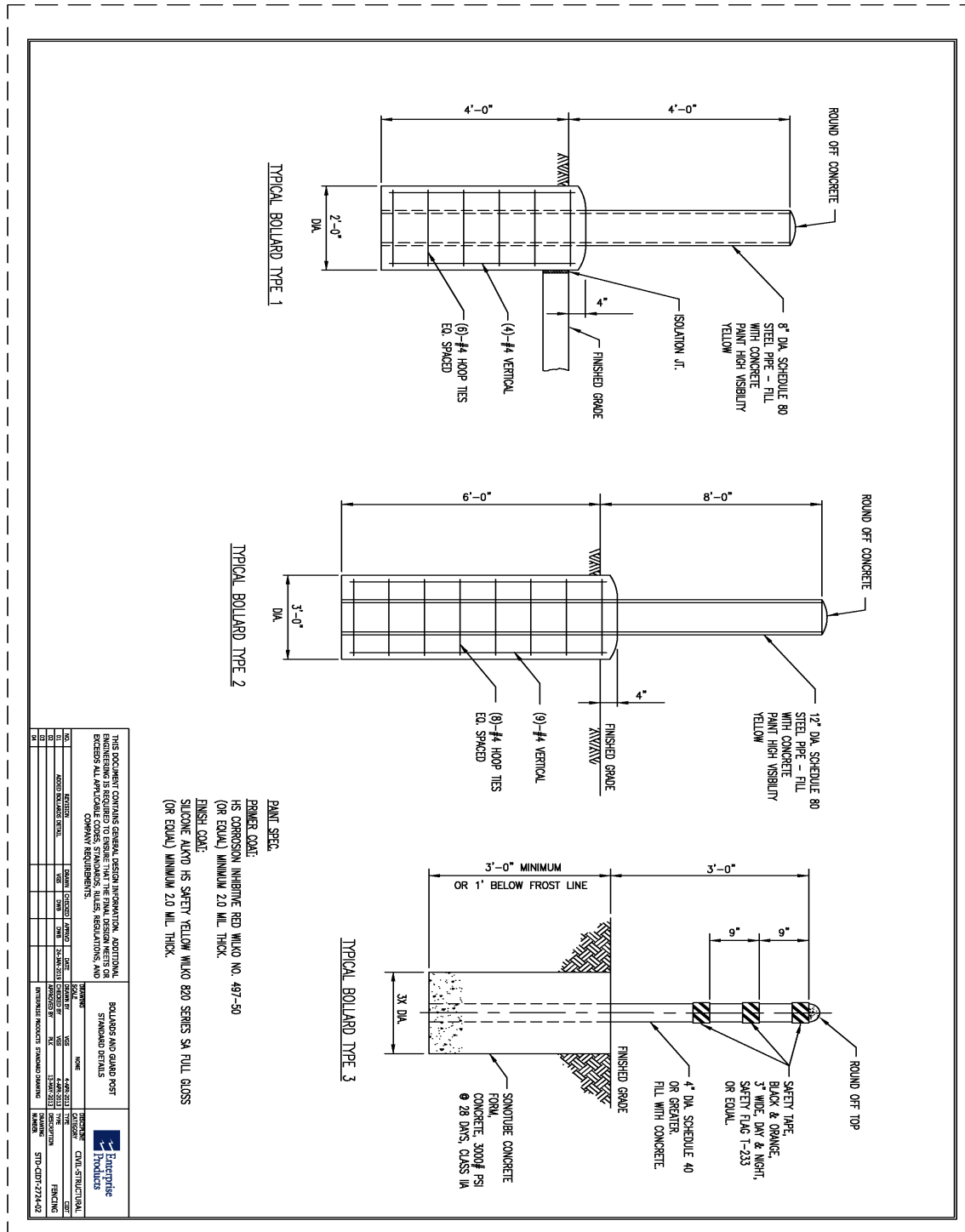
Appendix I Fence Detail



Appendix J Septic Tank and Absorption Field Detail



Appendix K Bollards and Guard Post Standard Details



Attachment Revision Log

Revision 0.0			Publish Date: 14 Mar 18
Location of Change	Type of Change	Reason for Change	
N/A	N/A		
Revision 0.1			Publish Date: 19 Nov 18
Location of Change	Type of Change	Reason for Change	
Section 8.2(7)	Correction	Section 7.1(1) was corrected to 8.1(1)	
Revision 0.2			Publish Date: 20 Feb 19
Location of Change	Type of Change	Reason for Change	
Appendix K	Revision	Revised STD-CIDT-2724 to add bollard standard details by transferring from STD-CIDT-2634-01	