


Earthwork Operations

Construction Academy

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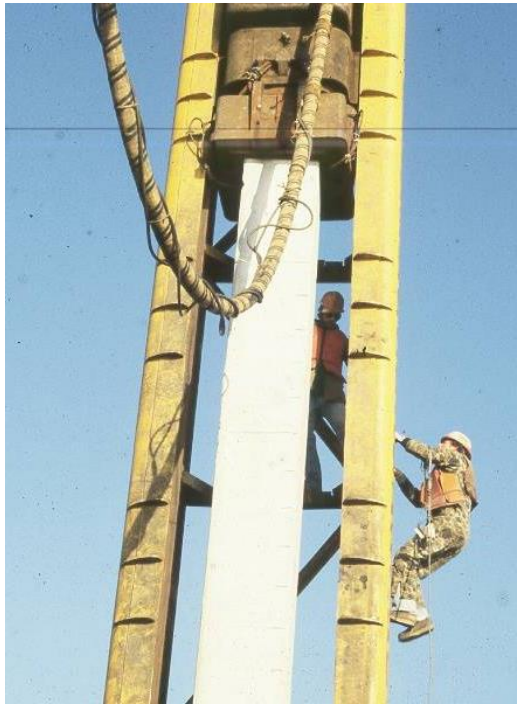
Geotechnical Engineering Unit

- **From beginning to end, Geotechnical Materials is involved with the life of a project:**
  - Planning, Development, and Engineering Phase (PD&E)
  - Design Phase
  - Construction Phase
  - Maintenance Phase



Geotechnical Sections at State Materials

- Aggregate
- Earthwork
- Field Operations
- Test Pit Program
- Laboratory (Soils, Foundation & Aggregate)

Objectives

- **Overview of Soils Mechanics**
- **Overview of Earthwork Lab/Field Testing**
- **Overview of Earthwork Standard Contract Documents**
- **Overview of Recording of Earthwork Construction Data**
  - Earthwork Records System (ERS)
    - MAC-ERS
    - Non-Electronic Logbook
  - Brief Introduction to Plots Coding

Soil Mechanics

- **Soil Mechanics is a discipline of Civil Engineering involving the study of the physical properties of soil.**
  - Some of these properties of soil are the grain-size distribution, permeability, compressibility, shear strength, and load bearing capacity.
- **Soils Engineering is the application of soil mechanics in real life scenarios**
- **Geotechnical Engineering is a subdiscipline of civil engineering that involves the application of soil mechanics and rock mechanics.**

Soil Identification

- Soil particle size vary over a wide range and generally referred to as gravel, sand, silt, or clay, depending on the predominant size of particles within the soil.
- Peat and muck (dirt) may have visual characteristics of soil but are organic matter that are accumulated from decayed animals/vegetations.
- Several organizations have developed a soil classification system to describe soils by their particle size, consistency, and behavior.
- Massachusetts Institute of Technology (MIT), U.S. Department of Agriculture (USDA), ASTM - Unified Soil Classification System (USCS), AASHTO, etc.

Soil Classification

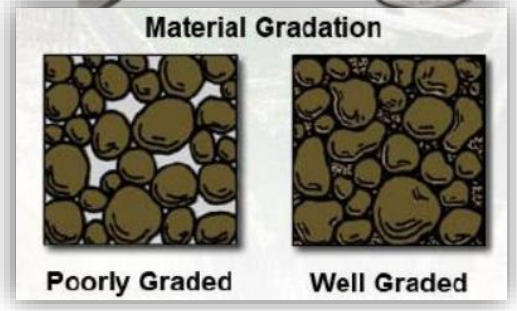
- In construction operation, the Department uses AASHTO Soil Classification System to classify soil

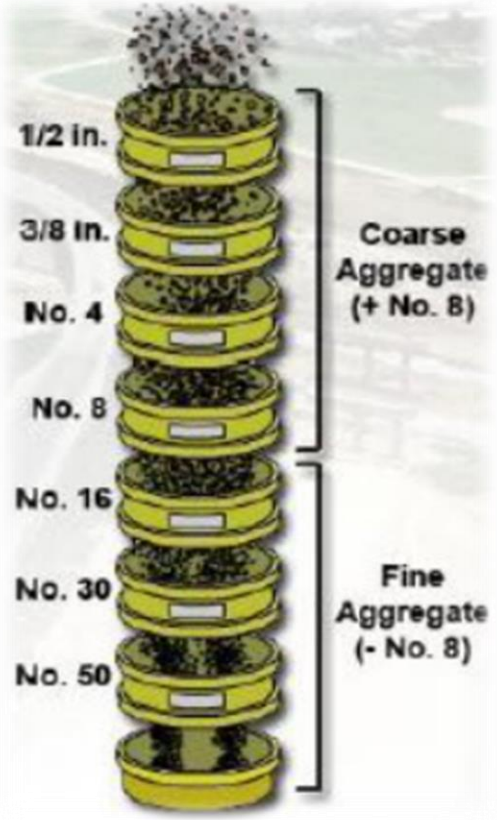
General Classification	Granular Materials (35 Percent or Less Passing 75 µm)							Silt-Clay Materials (More Than 35 Percent Passing 75 µm)			
	A-1			A-2							A-7
Group Classification	A-1-a	A-1-b	A-3	A-2-4	A-2-5	A-2-6	A-2-7	A-4	A-5	A-6	A-7-5, A-7-6
Sieve analysis, percent passing:											
2.00 mm (No. 10)	50 max	—	—	—	—	—	—	—	—	—	—
0.425 mm (No. 40)	30 max	50 max	51 min	—	—	—	—	—	—	—	—
75 µm (No. 200)	15 max	25 max	10 max	35 max	35 max	35 max	35 max	36 min	36 min	36 min	36 min
Characteristics of fraction passing 0.425 mm (No. 40):											
Liquid limit	—		—	40 max	41 min	40 max	41 min	40 max	41 min	40 max	41 min
Plasticity index	6 max		NP	10 max	10 max	11 min	11 min	10 max	10 max	11 min	11 min[a]
Usual types of significant constituent materials	Stone fragments, gravel and sand		Fine sand	Silty or clayey gravel and sand				Silty soils		Clayey soils	
General rating as subgrade	Excellent to Good							Fair to Poor			

[a] Plasticity index of A-7-5 subgroup is equal to or less than $LL - 30$. Plasticity index of A-7-6 subgroup is greater than $LL - 30$. (See Figure 2.)

AASHTO Soil Classification

- **The following two laboratory tests are performed in order to use the AASHTO soil classification system:**
  - Sieve Analysis (AASHTO T88)
    - AASHTO T27/FM 1-T11 for material used for retaining wall systems
  - Atterberg Limits (AASHTO T89 & T90)
- **In addition, AASHTO T 267 Organic Content**





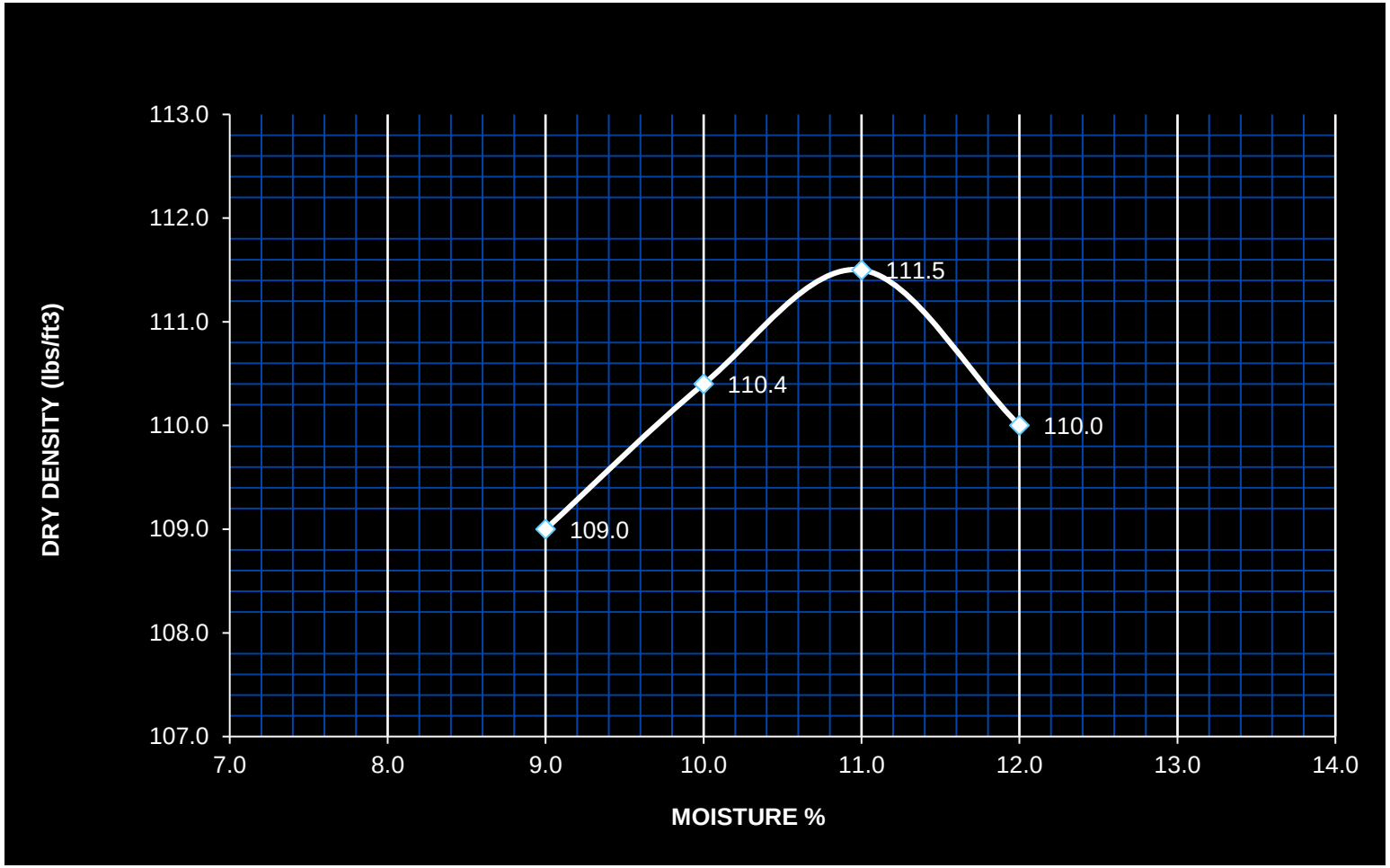
Moisture-Density Relationship of Soil

- The amount of water in soil affects its load-carrying capacity.
- Very dry soil becomes powdery, very wet soil becomes mud, but the proper amount of water can act as a lubricant to bond soil particles together.
- In optimum moisture condition, the soil particles will be densely packed resulting in increased density)

Proctor Theory

- The purpose of the Proctor test is to experimentally determine the optimal moisture content at which a given soil type will become most dense and achieve its maximum dry density.
- It establishes a density standard that a Contractor must achieve in the field represented as a compaction percentage for a given material.
- With a known volume (standard mold), the soil is compacted to the point where the air could be completely removed, simulating the effects of a in-situ (on site) conditions.
- From this, the dry density could be determined by measuring the weight of the soil after compaction, calculating the moisture content, and calculating the dry density.

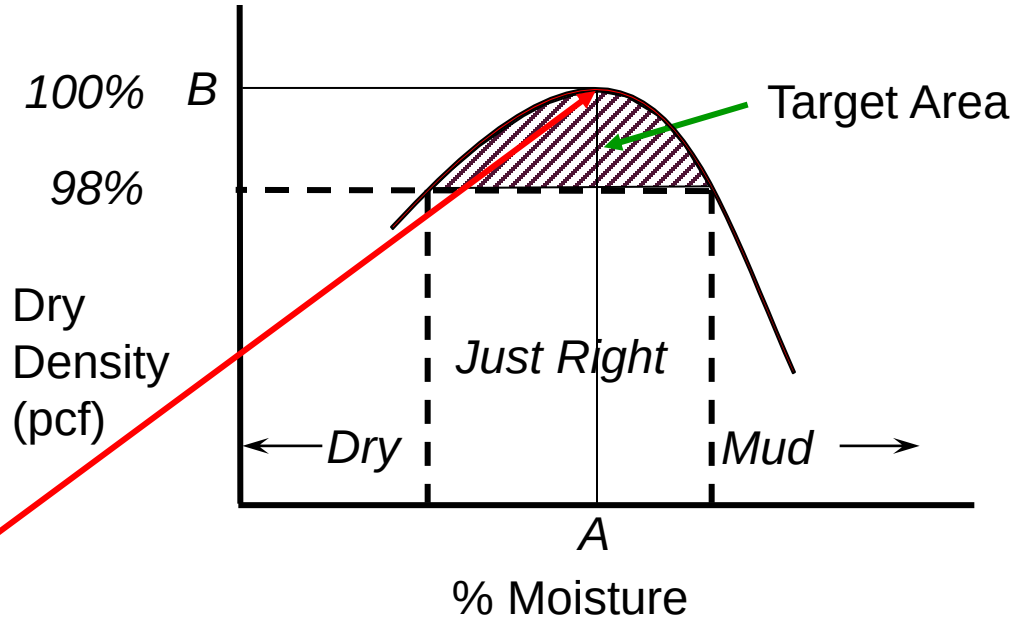
Proctor Curve



Proctor Data	
Dry Density (pcf)	**Moisture (%)**
109.0	9.0
110.4	10.0
111.5	11.0
110.0	12.0

Proctor Curve

MAXIMUM DENSITY (B)
at
OPTIMUM MOISTURE
CONTENT (A)



This is the maximum achievable density for the compactive effort.

Nuclear Density/SPEEDY Moisture

- To determine the in-place density and moisture of the soil for comparison to the maximum dry density determined by the Proctor test

Proctor Theory

- **Determine Dry Density**

$$Dry\ Density = \frac{Wet\ Density_{gauge}}{1 + \%\ Moisture}$$

- **Determine the Percent Maximum Density**

$$\%\ Max.Density = \frac{Dry\ Density \times 100}{Proctor\ Maximum\ Density}$$

Earthwork Laboratory Tests

- **AASHTO M145 – Soil Classification**
  - AASHTO T 88 – Gradation
  - AASHTO T 89 – Liquid Limit
  - AASHTO T 90 – Plastic Limit
- **FM1-T 267 Organic Content**
- **FM 1-T099/T180 Standard/Modified Proctor**
- **FM 5-515 – Limerock Bearing Ratio**
- **AASHTO T215 – Constant Head Permeability**
- **FM 5-550 – pH**
- **FM 5-551 – Resistivity**
- **FM 5-552 – Chlorides**
- **FM 5-553 – Sulfates**

Most Common

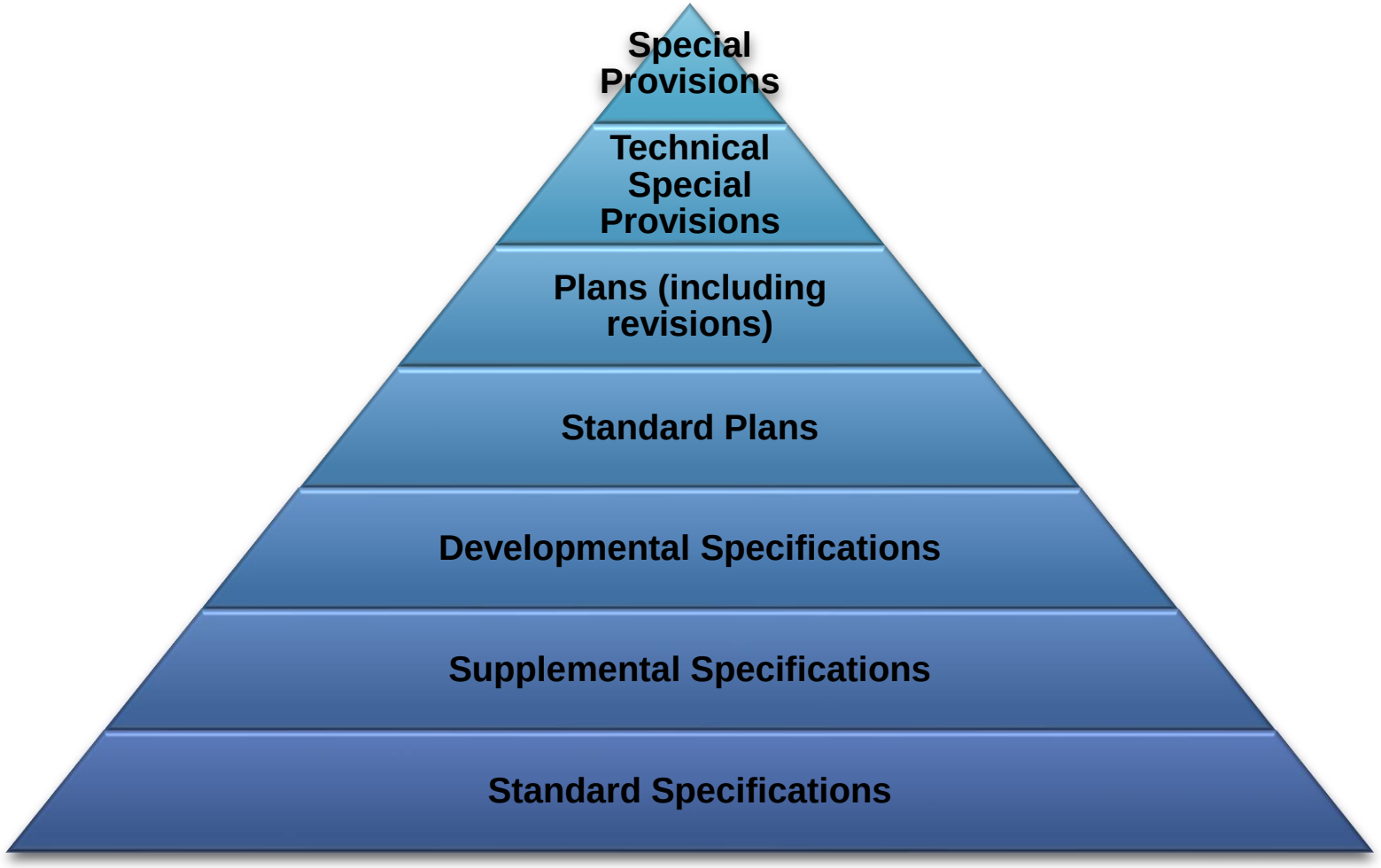
Earthwork Field Tests

- FM 1-T 310 – Nuclear Density
- FM 5-507 – Moisture using SPEEDY
- Stabilizing Mixing Depth
- FM 5-534 – Rock Base Thickness

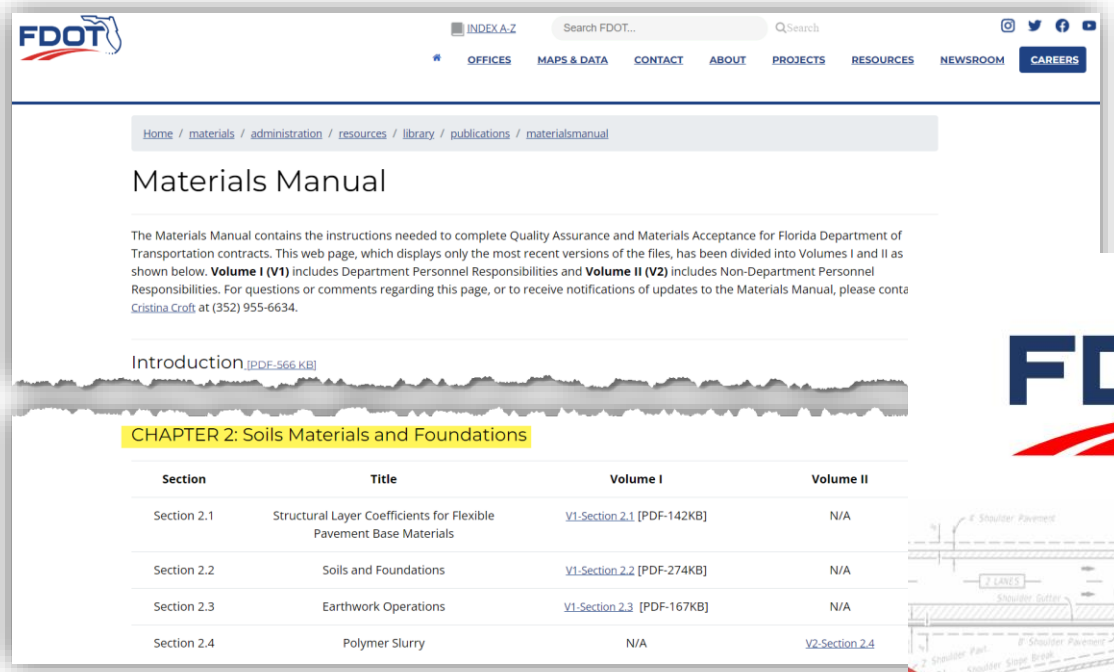
Objectives Check Point

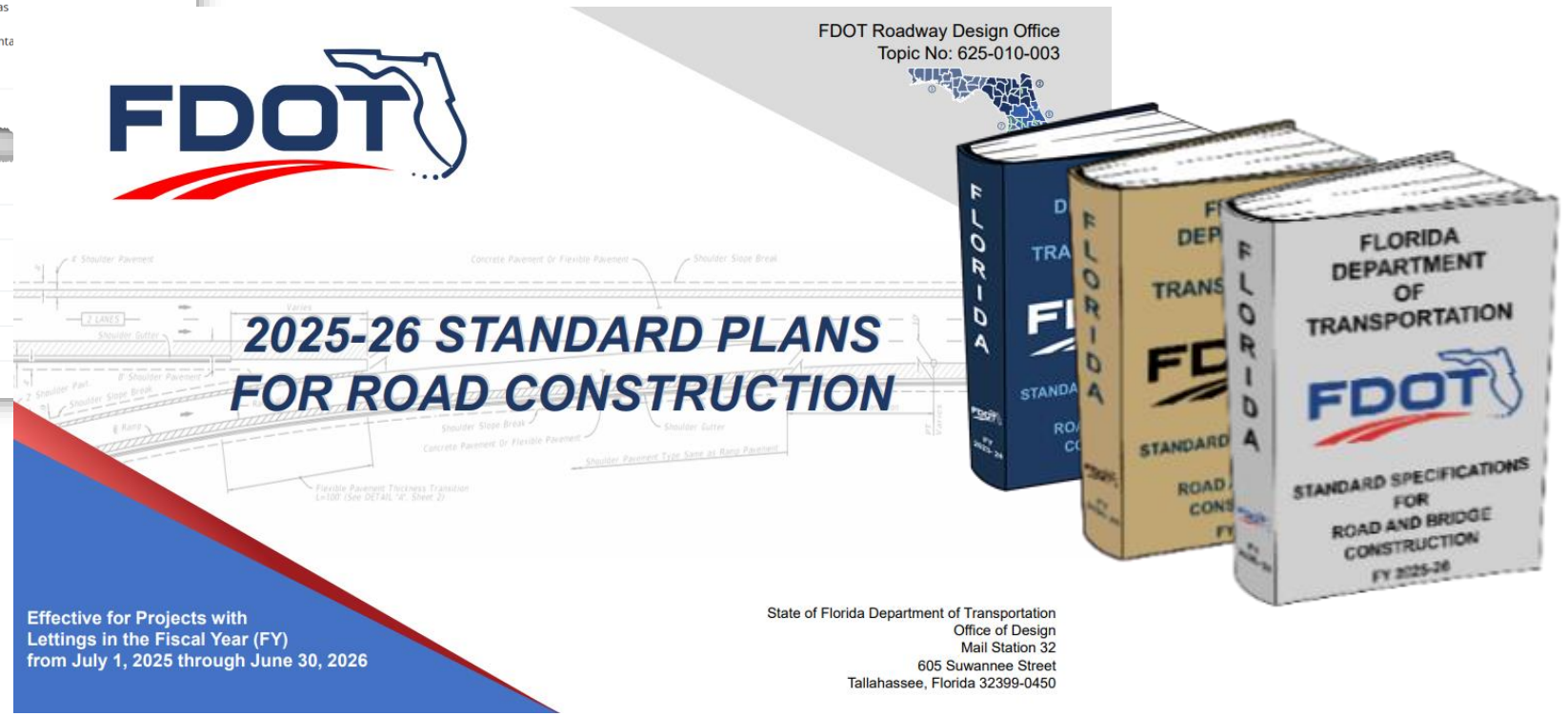
- Overview of Soils Mechanics ✓
- Overview of Earthwork Lab/Field Testing ✓
- Overview of Earthwork Standard Contract Documents

Governing Order of Contract Documents



Earthwork Operation Standard Contract Documents



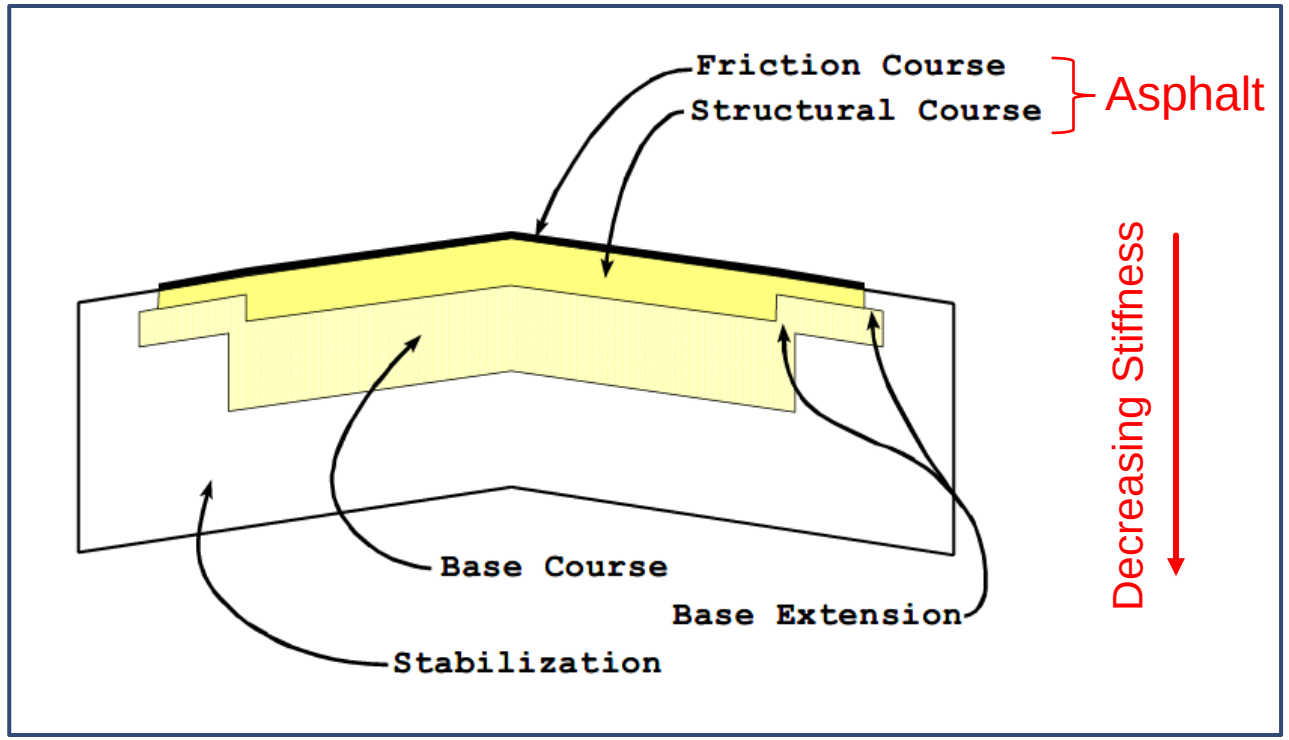


Earthwork Related Standard Specifications

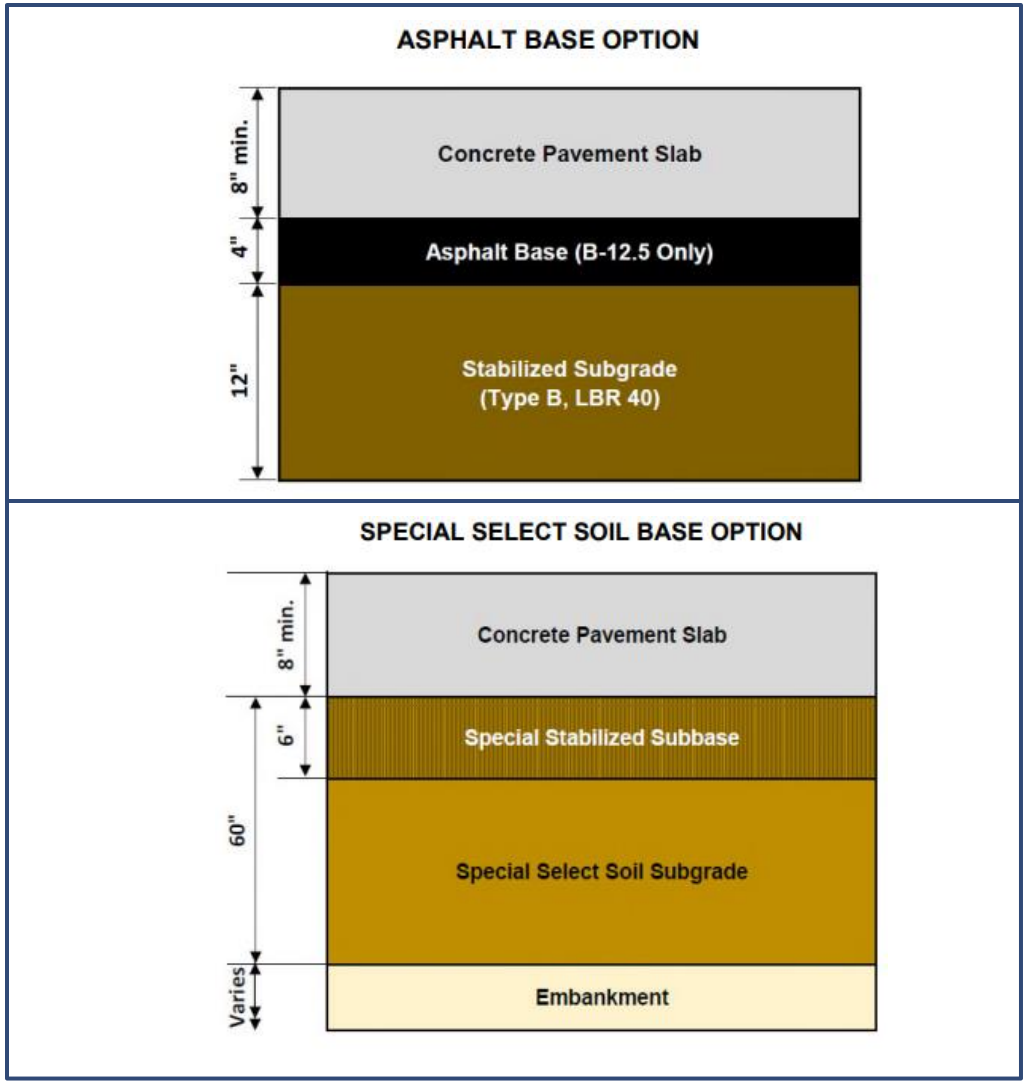
- **120** Embankment
- **125** Excavation for Structures and Pipes
- **145** Geosynthetic Reinforcement
- **160** Stabilizing
- **200** Rock Base
- **204** Graded Aggregate Base
- **285** Optional Base Course
- **290** Granular Subbase
- **455** Structures Foundations
- **514** Geosynthetic for Drainage Applications
- **522** Concrete Sidewalk and Driveways
- **548** Retaining Walls
- **914** Stabilization Materials
- **985** Geosynthetic Materials

www.fdot.gov/programmanagement/specs.shtm

Two Types of Pavement System



Flexible Pavement

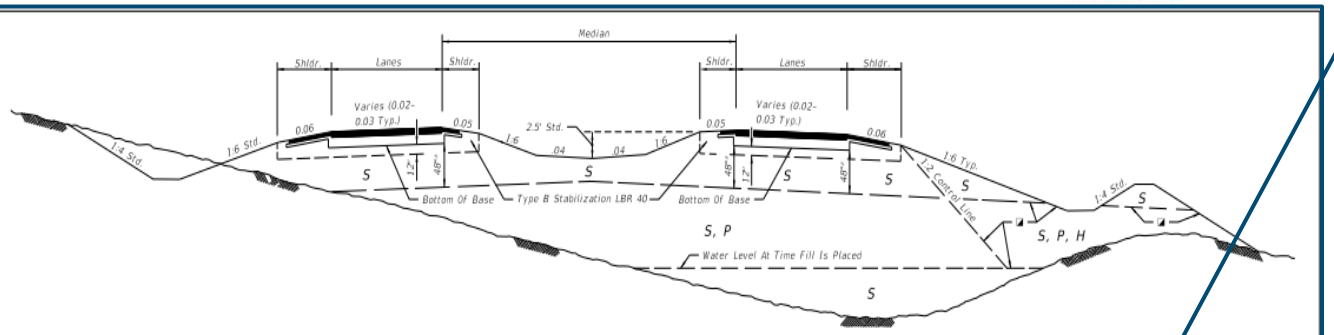


Rigid Pavement

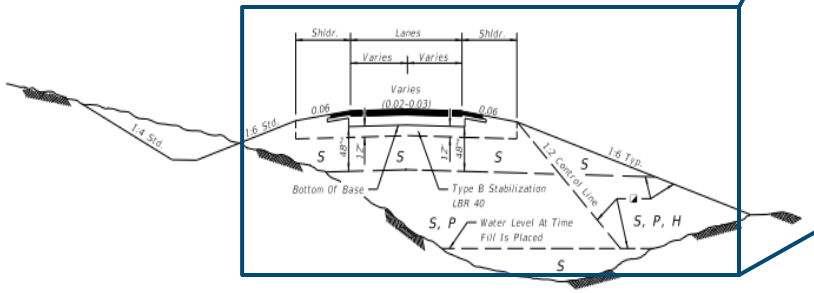
Two Types of Pavement System Details

- **Standard Plans, Index 120-001 – Embankment Utilization**
  - Sheet 1 – Flexible Pavement
  - Sheet 2 – Rigid Pavement, Asphalt Base Option
  - Sheet 3 – Rigid Pavement, Special Select Soil Option

www.fdot.gov/design/standardplans



DIVIDED ROADWAYS



UNDIVIDED ROADWAY

GENERAL NOTES:

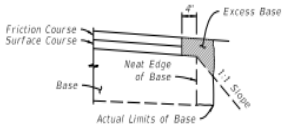
1. Roadway dimensions are representative. Subgrade dimensions and control lines are standard. The details shown on this Index do not supersede the details shown in the Plans or Indexes 120-002 and 160-001.

2. Plastic (P) soils may be placed above the existing water level (at the time of construction) to within 4 feet of the proposed base. It should be placed uniformly in the lower portion of the embankment for some distance along the project rather than full depth for short distances.

3. High Plastic (H) soils excavated within the project limits may be used in embankment construction as indicated on this Index. High Plastic soils are not to be used for embankment construction when obtained from outside the project limits.

4. Select (S) soils having an average organic content of more than two and one-half (2.5) percent, or having an individual test value which exceeds four (4) percent, are not permitted in the subgrade portion of the roadbed. Select (S), Plastic (P), or High Plastic (H) soils having an average organic content of more than five (5) percent, or an organic content individual test result which exceeds seven (7) percent, are not permitted in the portion of embankment inside the control line, unless written authorization is provided by the District Geotechnical Engineer; these soils may be used for embankment construction outside the control line, unless restricted by the Plans or otherwise specified in the Plans, provided they can be compacted sufficiently to sustain a drivable surface for operational vehicles as approved by the Engineer. Determine average organic content from the test results from a minimum of three randomly selected samples from each stratum or stockpile of a particular material. Perform tests in accordance with AASHTO T 267 on the portion of a sample passing the No. 4 sieve.

5. Highly organic soils, composed primarily of partially decayed organic matter, often dark brown or black in color with an odor of decay, and sometimes fibrous, are designated as muck. Further, any stratum or stockpile of soil which contains packets of highly organic material may be designated as Muck (M). Highly organic soils are not permitted within the subgrade or embankment portion of the roadbed.



NOTES:

1. All material in the shaded area is excess base to be removed.

2. There is no additional payment for removal of excess base material.

REMOVAL OF EXCESS BASE MATERIAL

SYMBOL	SOIL	CLASSIFICATION (AASHTO M 145)
S	Select	A-1, A-3, A-2-4 **
P	Plastic	A-2-5, A-2-6, A-2-7, A-4, A-5, A-6, A-7 (ALL WITH LL < 50)
H	High Plastic	A-2-5, A-2-7, A-5 Or A-7 (ALL WITH LL > 50)
M	Muck	A-8

Classification listed left to right in order of preference.

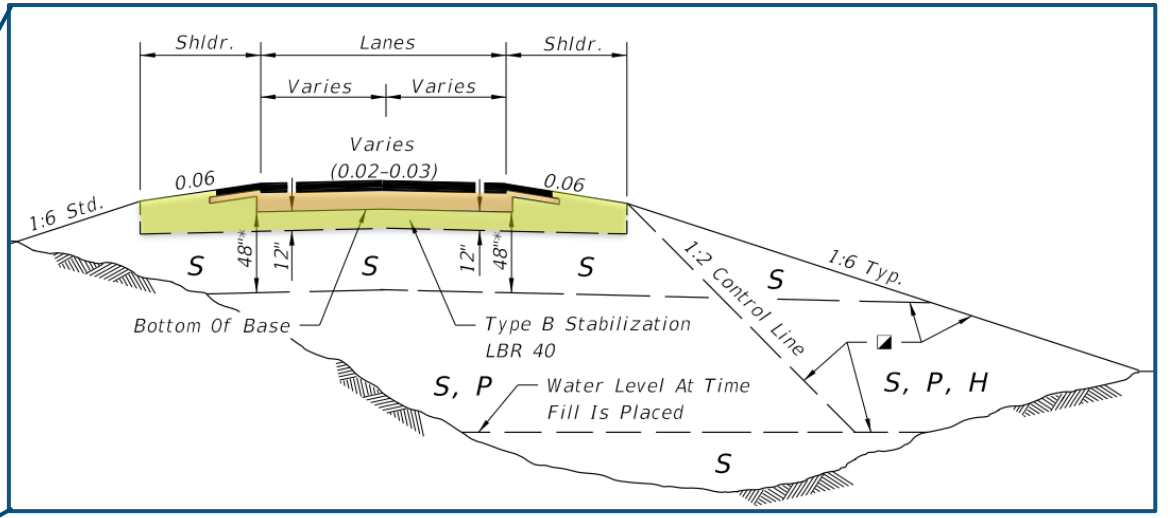
◪ See General Notes Nos. 4 & 5 for utilization of soils classified as organic material or muck.

** Certain types of A-2-4 material are likely to retain excess moisture and may be difficult to dry and compact. They should be used in the embankment above the water level existing at time of construction. They may be used in the subgrade portion of the roadbed when approved by the District Materials Engineer. A-2-4 material placed below the existing water level must be nonplastic and contain less than 15% passing the No. 200 U.S. Standard sieve.

* For cut sections this dimension may be reduced to 24"; see Index 120-002. For minor collectors and local facilities this dimension may be reduced to 18".

GENERAL NOTES AND FLEXIBLE PAVEMENT

LAST REVISION	DESCRIPTION:				
11/01/18		FY 2023-24 STANDARD PLANS	EMBANKMENT UTILIZATION	INDEX 120-001	SHEET 1 of 3



SYMBOL	SOIL	CLASSIFICATION (AASHTO M 145)
S	Select	A-1, A-3, A-2-4 **
P	Plastic	A-2-5, A-2-6, A-2-7, A-4, A-5, A-6, A-7 (ALL WITH LL < 50)
H	High Plastic	A-2-5, A-2-7, A-5 Or A-7 (ALL WITH LL > 50)
M	Muck	A-8

Classification listed left to right in order of preference.

◪ See General Notes Nos. 4 & 5 for utilization of soils classified as organic material or muck.

** Certain types of A-2-4 material are likely to retain excess moisture and may be difficult to dry and compact. They should be used in the embankment above the water level existing at time of construction. They may be used in the subgrade portion of the roadbed when approved by the District Materials Engineer. A-2-4 material placed below the existing water level must be nonplastic and contain less than 15% passing the No. 200 U.S. Standard sieve.

* For cut sections this dimension may be reduced to 24"; see Index 120-002. For minor collectors and local facilities this dimension may be reduced to 18".

Embankment Construction

- **120-8 Embankment Construction**
  - 120-8.1 General
  - 120-8.2 Dry Fill Method
  - 120-8.3 Hydraulic Method
  - 120-8.4 Reclaimed Asphalt Pavement (RAP) Method
- **120-10 Acceptance Program**

LOTs

- **120-8.1 – LOT definition and maximum length**
  - LOTs cover both vertical and horizontal

Mainline pavement lanes, turn lanes, ramps, parking lots, concrete box culverts and retaining wall systems → A LOT is defined as a single lift of finished embankment not to exceed **500 feet**.

Shoulder-only areas, shared use paths, and sidewalk areas → A LOT is defined as a single lift of finished embankment not to exceed **2000 feet**.

Maximum Compacted Lift Thickness

- **120-8.2 Dry Fill Method**
  - 120-8.2.2 – Lists maximum lift thickness based on group number

120-8.2.2 Maximum Compacted Lift Thickness Requirements: Construct the embankment in successive layers with lifts up to a maximum listed in Table 120-1 below based on the embankment material classification group.

Table 120-1

Group	AASHTO Soil Class	Maximum Lift Thickness	Thick Lift Control Test Section Requirements
1	A-3	12 inches	Not Needed
	A-2-4 (No. 200 Sieve ≤ 15%)		
2	A-1	6 inches without Control Test Section	Maximum of 12 inches per 120-8.2.3
	A-2-4 (No. 200 Sieve > 15%)		
	A-2-5, A-2-6, A-2-7, A-4, A-5, A-6		
	A-7 (Liquid Limit < 50)		

Thicklift Test Section

- 120-8.2.3
- Notify the Engineer prior to beginning construction of a test section
- Construct a test section of the length of one full LOT
- Perform five QC tests at random locations within the test section
- All five QC tests and a Department Verification test must meet the density requirement
- Identify the test section with the compaction effort and soil classification in the Earthwork Records System (Density Logbook).

Dewatering Methods & Hydraulic Method

- **120-8.2.4 – Dewatering Equipment and Methods**
  - Must perform dewatering when encountering water table in backfill areas.
  - Normal dewatering methods include, but not limited to, constructing shallow surface drainage trenches/ditches, using sand blankets, sumps and siphons.
  - When normal dewatering methods results does not adequately remove the water, the Engineer may require the embankment material to be placed in the water in lifts specified in ***120-8.2.5 Placing in Unstable Areas***.
- **120-8.3 Hydraulic Method**
  - Rarely done by choice but mostly used when mother nature provides rain

Reclaimed Asphalt Pavement (RAP) in Embankment Layer

- **Two methods for RAP usage in embankment**
  - Soil and RAP Mixture (120-8.4.2)
    - 4” of RAP with 8”-10” of Embankment Soil
  - Alternate Soil and RAP Layer Construction (120-8.4.3)
    - 6” - 12” of Embankment & 6” RAP alternate
    - Soil layer must have an LBR of 40 to prevent failure during compaction of the overlying RAP layer.
- **The Contractor must demonstrate feasibility with 500’ test section**

Reclaimed Asphalt Pavement (RAP) in Embankment Layer

- **Where is RAP prohibited?**
  - Construction areas that are below the seasonal high groundwater table elevation
  - Behind and below MSE Wall backfill
  - The upper 6 inches of the Embankment layer

Embankment Construction

- **120-10 Acceptance Program**
  - 120-10.1 General
    - 120-10.1.1 Equipment Comparison
    - 120-10.1.2 Density over 105%
  - 120-10.2 Quality Control Tests
  - 120-10.3 Department Verification
  - 120-10.4 Reduced Testing Frequency
  - 120-10.6 Verification Comparison Criteria and Resolution Procedures

Initial Equipment Comparison

- **120-10.1.1**
  - Before first density can be taken on the job, perform three-way comparison between IA to QC, IA to Verification, and QC to Verification.
  - Once gauge has been verified in a three-way comparison, then those verified gauges can be used to verify additional gauges on the project by performing a two-way comparison (QC to VT).
  - Ensure that the difference between any two computed ***wet*** densities does not exceed the limits in Table 120-2.

Table 120-2

Condition	Comparison Type	Manufacturer	Tolerance
Condition 1: When both gauges in the comparison are Nuclear Density Gauges (NDG)	NDG to NDG	Same Manufacturer	2 lb/ft^3
	NDG to NDG	Different Manufacturer	3 lb/ft^3
Condition 2: When one of the gauges in the comparison is a Low-Activity Nuclear Density Gauge (L-NDG)	L-NDG to L-NDG	Same Manufacturer	2 lb/ft^3
	L-NDG to L-NDG	Different Manufacturer	3 lb/ft^3
	NDG to L-NDG	Same/Different Manufacturer	

Low-Activity Nuclear Density Gauge (L-NDG)

- Commonly called EGauge
- Reference: FM 1-T310 – Florida Method of Test for In-Place Density of Soils and Soil Aggregates by Nuclear Methods
- Density gauge that uses lower levels of gamma radiation to determine the density of soil and soil aggregates (FM 1-T310, Section 5.1).
- It is “low activity” because the levels of radiation are lower than regular Nuclear Density Gauges (NDGs)
- Does not contain neutron source, therefore, no moisture measurements
- Moisture needs to be measured using another approved source for all materials (FM 1-T 310, Section 12.4.1)

Quality Control Tests

- **120-10.2 Quality Control Tests**
  - FM 1-T099 Standard Proctor
  - AASHTO M145 Soil Classification
    - AASHTO T88 (gradation), AASHTO T89 (LL), AASHTO T90 (PL), and FM 1-T267 Organic Content
  - FM 1-T310 In-place wet density by Nuclear Density Testing
    - 100% of the Standard Proctor, FM 5-507 SPEEDY
  - Frequency

Table 120-3

Test Name	Quality Control	Verification	Verification of Shoulder-Only Areas, Shared Use Paths, and Sidewalks
Standard Proctor Maximum Density	One per soil type	One per soil type	One per soil type
Density	One per LOT	One per four LOTS and for wet conditions, the first lift not affected by water	One per two LOTs
Soil Classification and Organic Content	One per Standard Proctor Maximum Density	One per Standard Proctor Maximum Density	One per Standard Proctor Maximum Density

Department Verification & Reduced Testing

- **120-10.3 Department Verification**
  - Lab tests one to one testing frequency (one per soil type)
    - Every test that QC runs, VT tests to verify test results
  - Field Density test is reduced frequency for VT
- **120-10.4 Reduced Testing Frequency**
  - Obtain Engineers written approval for the option to reduce QC density testing frequency to 1 per 2 LOTs
  - Must have data for 12 consecutive verified LOTs where resolution testing performed was not required
    - If resolution testing was required, but the QC test data was upheld.
  - Reduced testing frequency must not be used in construction of shoulder-only areas, shared use paths, sidewalks, and first and last lift.

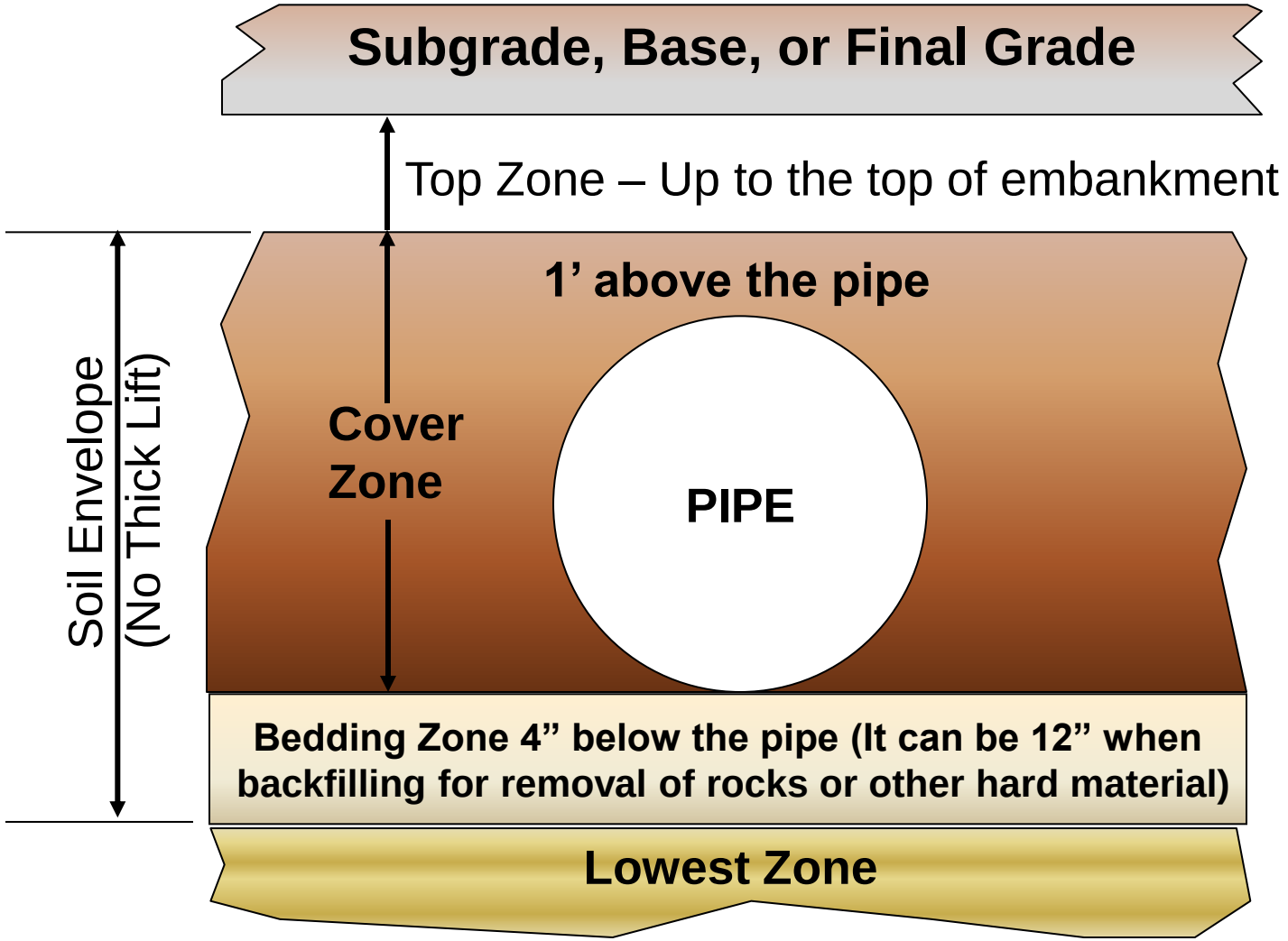
120-10.6 Verification Criteria and Resolution Procedure

- **FM 1-T 099 Proctor**
  - Use QC's Proctor if QC and VT are within 4.5 pcf
  - If not, perform resolution test (RT).
  - Use QC's Proctor if QC and RT are within 4.5 pcf
  - If not, use VT's Proctor
- **M145 Soil Classification, T88 gradation, T89 LL, T90 PL, and 1-T267 Organic Content must pass for both QC and VT**
  - If QC's test result fail any of the tests, reject the material for use as embankment
  - If all test for QC passes and one or more fails on VT's test panel, then perform RT
  - If RT passes all tests, then QC results upheld, and the Contractor may use the material for embankment portion.
- **T310 Field Density Testing**
  - QC must pass every LOT and VT verifies 4 LOTs by taking one random density test
  - If VT passes, 4 LOTs verified and accepted.
  - If not, QC performs a QR test within 5-foot radius of the failing VT test.
    - If QR passes, accept 4 LOTs
    - If QR fails, perform gauge comparison. If gauge comparison is in good status, then reprocess the entire 4 LOTs and retest using the same procedure above.

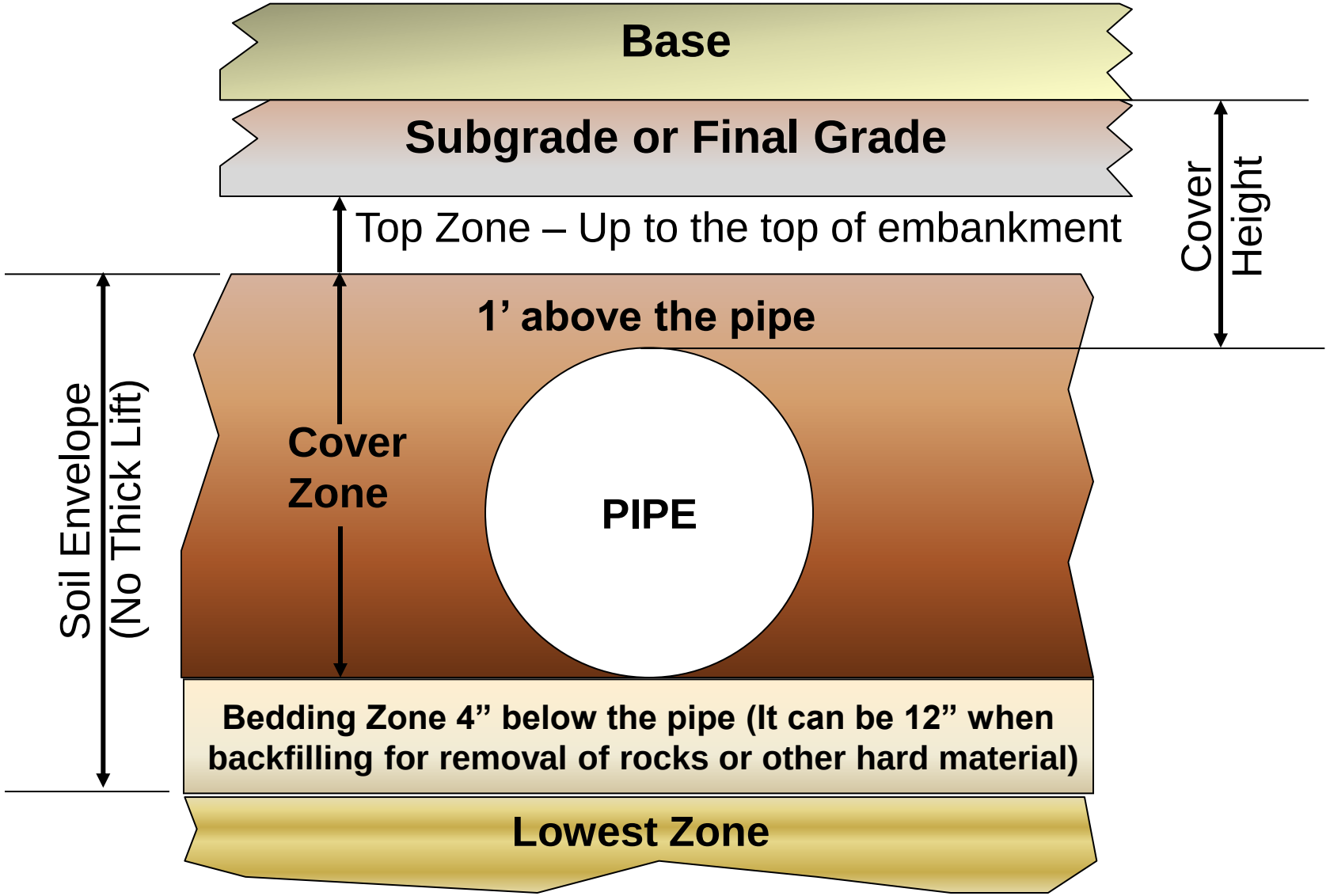
Excavation and Embankment for Structures and Pipe

- **125-8 Backfilling**
  - 125-8.3 Pipe Zones for Pipe ≥ 12” I.D.
  - 125-8.1 Lift Thickness
- **125-9 Acceptance Program**
  - 125-9.2 Density Testing Requirements

Pipe Zones 125-8.3

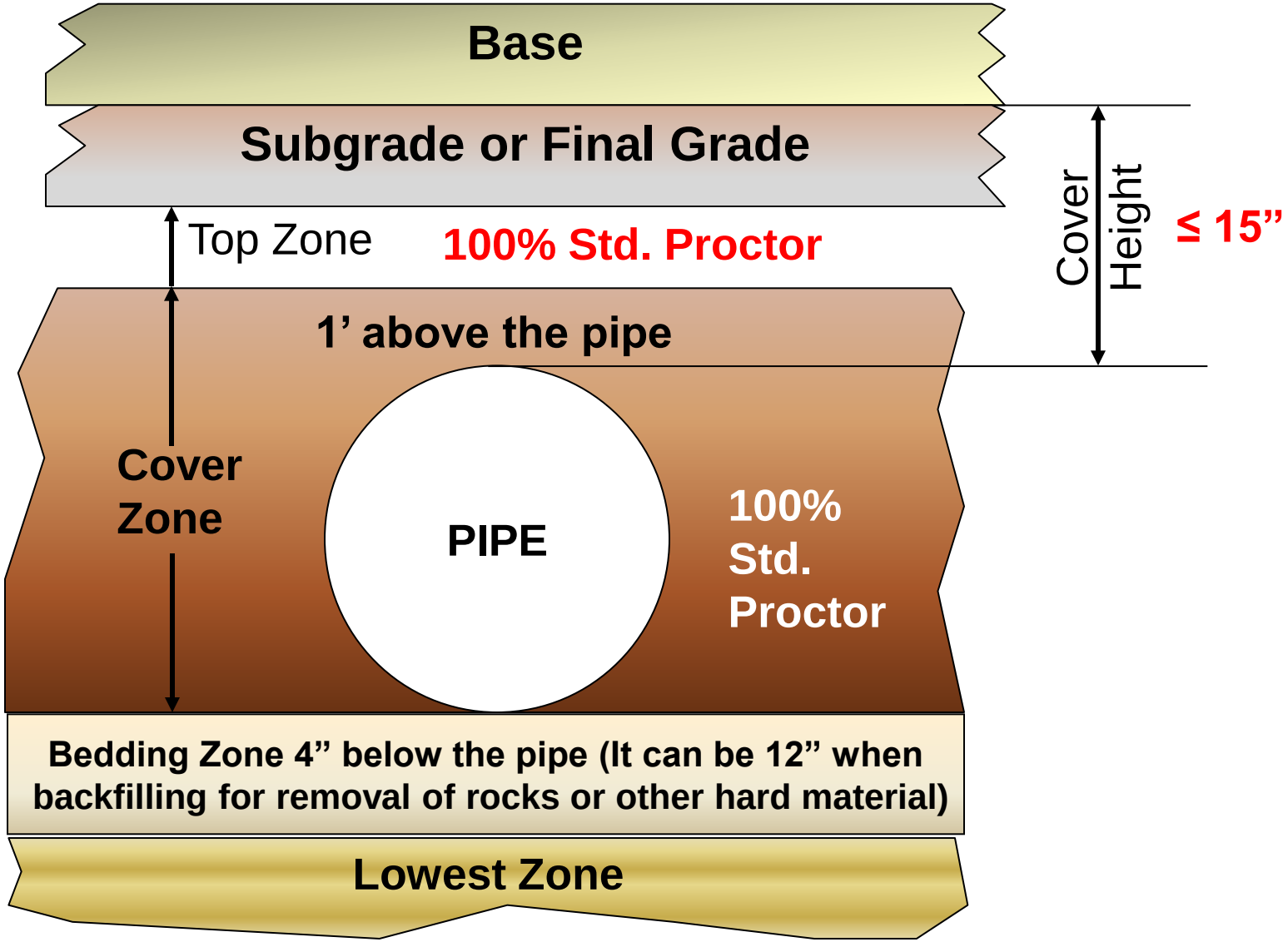


Cover Height



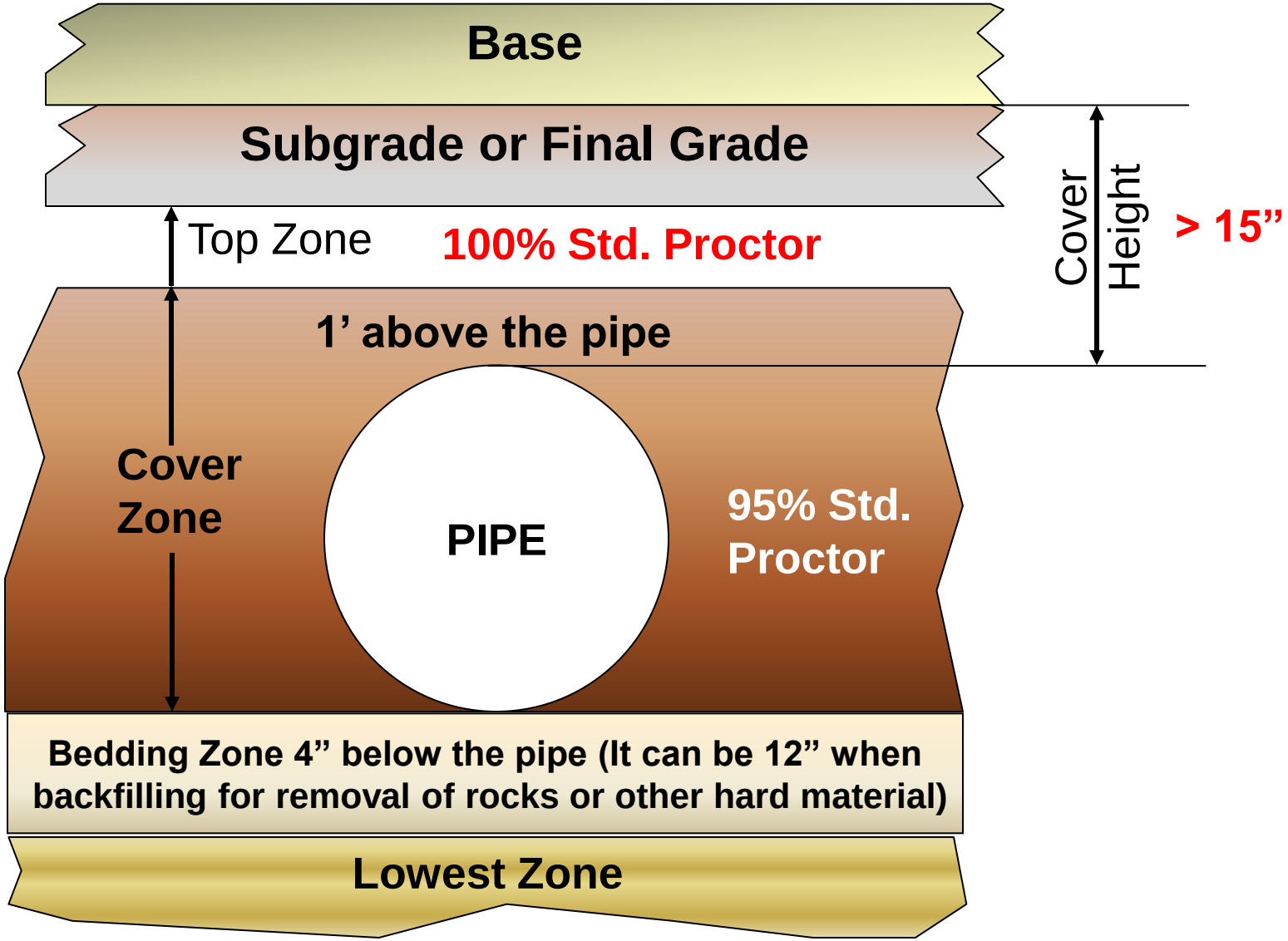
Density Requirements

- **Cover Zone Density**
  - Cover Height ≤ 15”
  - 100% of Standard Proctor
- **Top Zone Density**
  - Follow 120 Specification Criteria
  - 100% of Standard Proctor



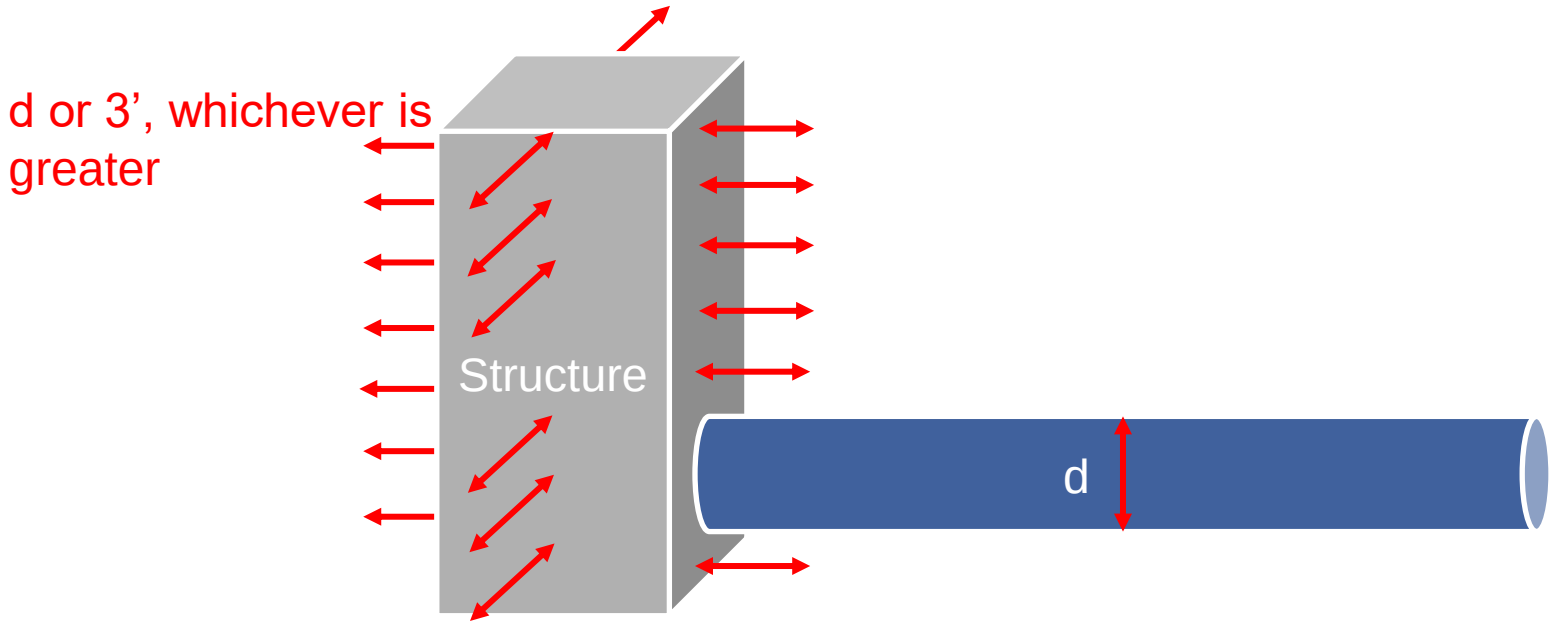
Density Requirements

- **Cover Zone Density**
  - Cover Height > 15”
  - 95% of Standard Proctor
- **Top Zone Density**
  - Follow 120 Specification Criteria
  - 100% of Standard Proctor



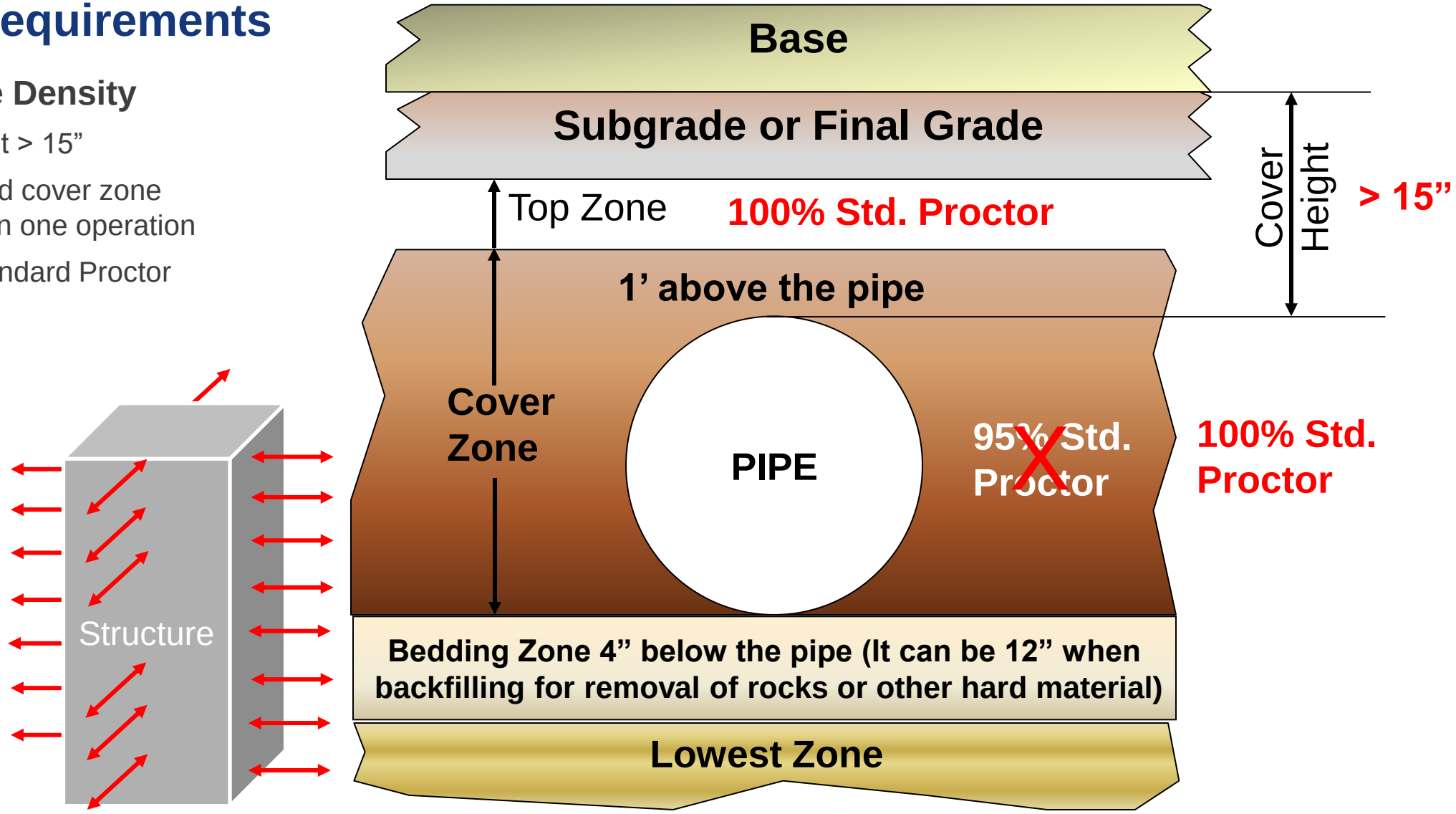
Density Requirements

- **Density around Structures**
  - 100% of standard Proctor regardless of the depth
  - For a distance of one pipe diameter but not less than 3’ from the outside face of the structure



Density Requirements

- **Cover Zone Density**
  - Cover Height > 15”
  - Structure and cover zone compacted in one operation
  - 100% of Standard Proctor



Pipe Backfill Density

- **Compaction requirements are the same for all pipe types**
- **If the cover height ≤ 15 inches below base**
  - 100% standard Proctor within cover zone
- **If cover height is greater than 15 inches below base**
  - 95% standard Proctor within cover zone
- **Structure backfill requires 100% of standard Proctor regardless of the depth**
  - For a distance of one pipe diameter but not less than 3 feet from the outside face of the structure

Pipe and Structure Compacted in One Operation

- **125-8.1.1 states "Backfill for structures and pipe compacted in one operation will be considered as one LOT within the cover zone"**
- **Since drainage structures require 100% density regardless of the depth, this requirement supersedes**
- **If pipe and structure are compacted in one operation, one density test that meets 100% density may represent both pipe and structure.**
  - Density tests must be taken at random locations along structure and pipe

125-8 Backfilling.

125-8.1 General Requirements for Structures and Pipe:

125-8.1.1 General: Backfill in the dry whenever normal dewatering equipment and methods can accomplish the needed dewatering. A LOT is defined as one lift of backfill material placement, not to exceed 500 feet in length or a single run of pipe connecting two successive structures, whichever is less. Backfill for structures and pipe compacted in one operation will be considered as one LOT within the cover zone. Backfill around structures compacted separately from the pipe will be considered as separate LOTs. Backfill on each side of the pipe for the first lift will be considered a separate LOT. Backfill on opposite sides of the pipe for the remaining lifts will be considered separate LOTs, unless the same compactive effort is applied. Same compactive effort is defined as the same type of equipment (make and model) making the same number of passes on both sides of the pipe. For multiple phases of backfill, a LOT shall not extend beyond the limits of the phase.

Maximum Lift Thickness

- 125-8.1.6 – In the soil envelope, maximum allowed thickness of backfill is 6 inches
- 125-8.1.6.1 – Maximum allowable thick lift compaction requirements based on AASHTO Soil Class

Table 125-1

Group	AASHTO Soil Class	Maximum Lift Thickness		Thick Lift Control Test Section Requirements	
		Within Cover Zone	Above Soil Envelope	Within Cover Zone	Above Soil Envelope
1	A-3	6 inches	12 inches	N/A	Not Needed
	A-2-4 (No. 200 Sieve ≤ 15%)				
2	A-1	6 inches without control test section		N/A	Maximum of 12 inches per 120-8.2.3
	A-2-4 (No. 200 Sieve > 15%)				
	A-2-5, A-2-6, A-2-7, A-4, A-5, A-6				
	A-7 (Liquid Limit < 50)				

- Same test section (test strip) requirements specified in 120

Reduced Frequency Testing

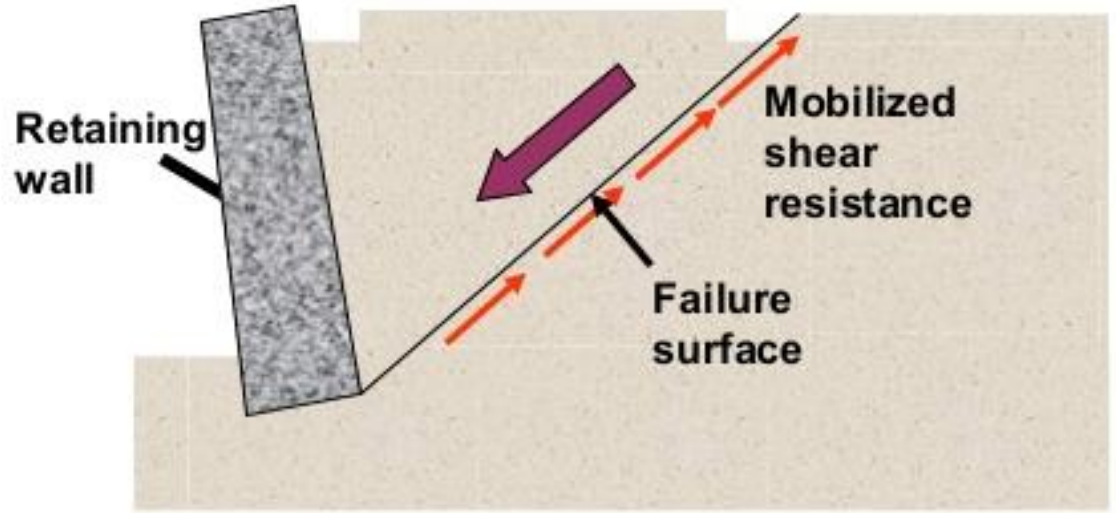
- **Number of passing density tests required before reduced frequency density testing is allowed;**
  - Embankment: After 12 passing tests → 1 per 2 LOTs per 120-10.4
  - Pipe Backfill: After 6 passing tests → 1 per 2 LOTs per 125-9.1.1
    - Reduced frequency for pipe backfill in the trench box is reduced to one test per four LOTs
    - *Do not apply reduced testing frequency for the first and last lift of pipe*
  - LOTs are to be selected randomly when reduced frequency testing is performed

Geosynthetic Reinforcement

- 145-1 Description
- 145-3 Material Requirements
- 145-4 Construction Requirements
- 145-5 Certification

Geosynthetic Reinforcement

Soils generally fail in shear

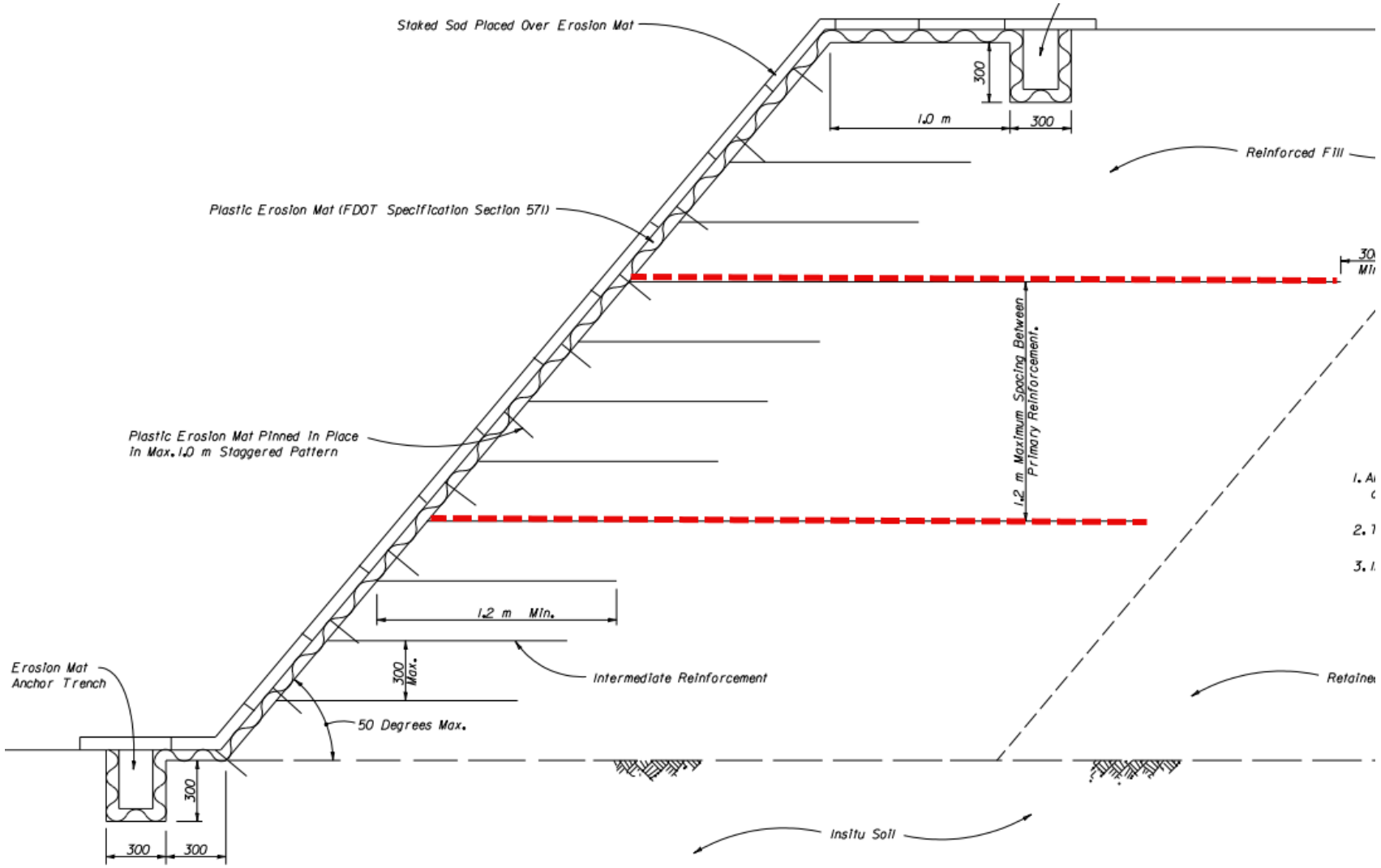



KOBELCO
KOBELCO
SK350

Geosynthetic Reinforcement

- **145-1 Applications**
  - Geosynthetic reinforced soil slopes
  - Geosynthetic reinforced foundations over soft soils
  - Geosynthetic reinforced embankment

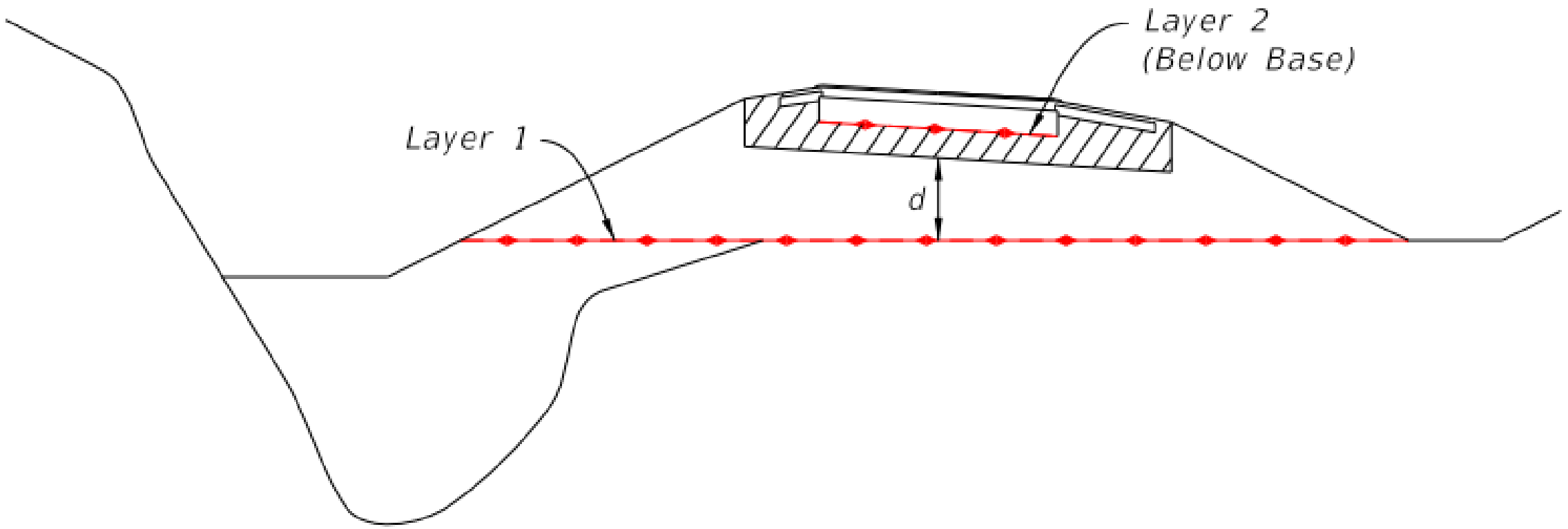
Reinforced Soil Slopes



Reinforced Foundations over Soft Soils

GEOSYNTHETIC REINFORCED FOUNDATIONS CONSTRUCTED ON SOFT SOILS

Reinforced Embankment



145-3 Material Requirements

- **Backfill Materials**
  - Geosynthetic Reinforced Soil Slopes
    - Free draining material
    - Organic Content
      - Individual ≤ 3.0% & Average ≤ 2.0%
    - Liquid Limit ≤ 15, PI ≤ 6.0
    - pH between 5 & 10. If polyester based geosynthetic, then pH between 5 and 9.
  - Reinforced Foundations over Soft soils
    - Meet requirements 120
    - Same pH requirements as reinforced soil slopes
  - Reinforced Embankment
    - Meet appropriate roadbed specifications (120, 160, 200, 204)
    - Same pH requirements as reinforced soil slopes

Table 145-1	
Sieve Size	Percent Passing
3-1/2 inches	100
3/4 inch	70 to 100
No. 4	30 to 100
No. 40	15 to 100
No. 100	5 to 65
No. 200	0 to 15

145-3 Material Requirements

- **Geosynthetic**
  - Can only use products that are listed on the APL
    - FDOT PATH website https://path.fdot.gov/Specifications
    - Go to 985 for list of APL products

985-5 Structural.

985-5.1 Applications: Materials for reinforcement, separation and stabilization applications must be tested in accordance with and meet the physical requirements below. The ultimate tensile strength of all R-1 materials must be at least 4800 pounds per foot in both the machine and cross machine directions.

Table 985-7
Reinforcement, Separation and Stabilization Applications

Type	Description
R-1	Geosynthetic Reinforced Soil (GRS-IBS)
R-2	Reinforcement of Foundations over Soft Soils
R-3	Reinforced Soil Slopes
R-4	Reinforced Embankment
R-5	Construction Expedient

145-4 & 145-5 Construction Requirements / Certification

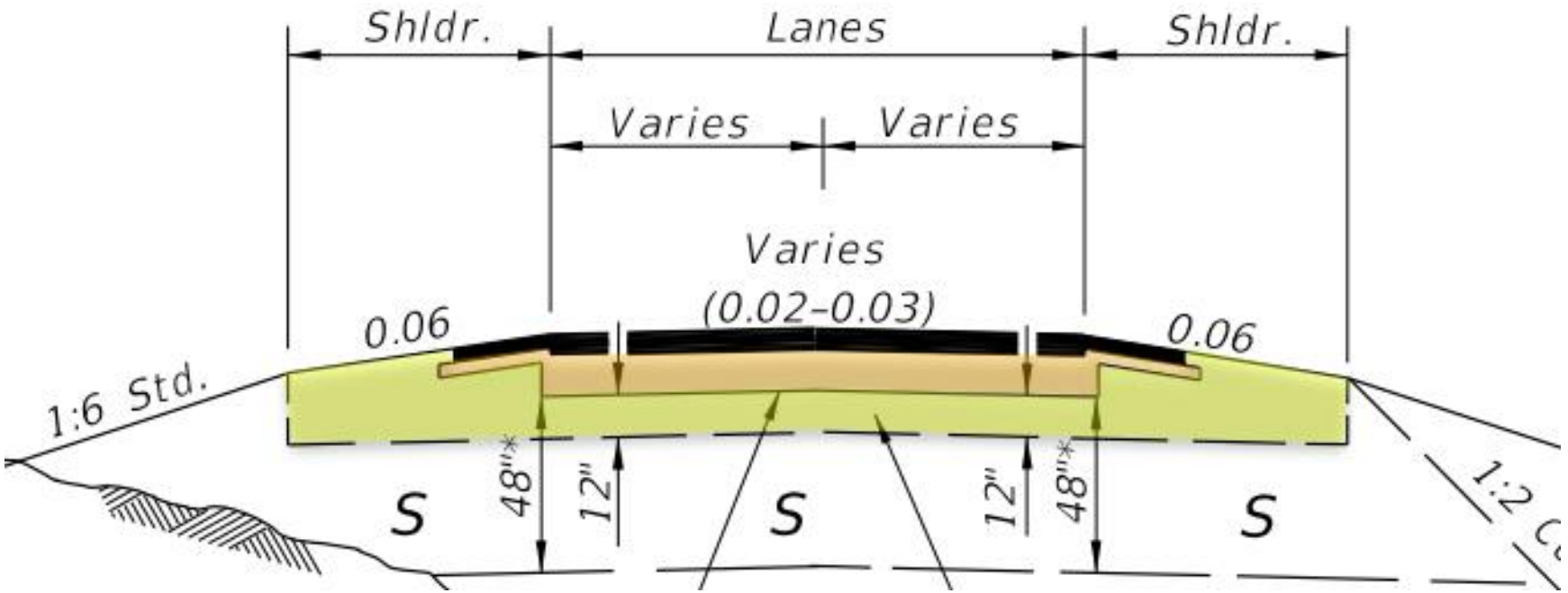
- **Ensure Contractor installs in accordance with Manufacturer's instructions**
- **At least *fourteen days prior to placement:***
  - Contractor to submit to the Engineer a certification
  - Two 8-inch by 10-inch samples of geosynthetic materials for product identification to the Engineer
- **VT to send both certification and physical samples to SMO for approval**
- **For backfill materials: Submit to the Engineer a signed and sealed certification by a Professional Engineer registered in the State of Florida, that the pH meets the requirements of 145-3**

160 Stabilizing

- 160-1 Description
- 160-2 Materials
- 160-3 Construction Methods
- 160-4 Acceptance Program

Stabilizing Material vs. Stabilized Subgrade

- **160-1 Description**
  - Stabilize roadbed to provide a firm and unyielding subgrade
  - Stabilizer in the industry maybe called “sweetener”



160-2 Stabilizing Materials

- Commercial Material
- Local Materials
- RAP or RAP Blended Material
- Existing Base

Commercial Material

- If Commercial material is used as a stabilizer, then the material must be obtained from an approved production facility and the product must be "Certified for FDOT" as specified in 914-2.1 and Aggregate Rule 1-103, FAC.
- The delivery tickets must be collected and kept with the CEI's office for records.

Local Materials

- **Local material must be tested at the source (440A) before spreading on the roadway**
  - Atterberg Limits
    - Liquid Limit ≤ 40
    - Plastic Index ≤ 10
  - AASHTO T267 Organic Content
    - 3 Individual Organic Content ≤ 4%
    - Average of 3 individual samples ≤ 2.5%

RAP or RAP Blended Material

- **When RAP is milled and windrowed back on the same project (Engineer Witness), no further testing is needed.**
- **If no Engineer witness, then it is RAP or RAP Blended Material**
  - Engineer will visually inspect the stockpile to ensure the source contains RAP
  - Source (440A) testing must be performed at the source to prove that the organic content is high due to asphalt content
- **After Engineer's approval in writing, the Contractor may spread and mix the material**
- ***After mixing*, FM 5-563 (Asphalt Content) test must be performed to ensure that the AC limit doesn't exceed 4.0%**
- **Failure may indicate too much Asphalt or the presence of a material that is truly high organic**

Existing Base

- Inform the Engineer of the location of existing base that will be excavated and stockpiled to be used as stabilizer
- Obtain the Engineer's approval in writing before using Existing Base

Granular Subbase

- **The Engineer may allow, at no additional cost to the Department, the substitution of 6 inches of Granular Subbase**
  - Must meet the requirements of 290-2 & 290-3
  - The 6” substitution is only when 12" of Type B Stabilization requiring a Limerock Bearing Ratio (LBR) value of 40 is specified
  - The correlation between design structural number and subbase substitution is **not** linear

Acceptance Program for Mixed Materials

- **Uses modified Proctor instead of standard Proctor**
- **LBR testing required**
- **Organic Content (Ind. ≤ 4.0%, Avg. ≤ 2.5%)**
  - When RAP is used as the stabilizer, Asphalt Content ≤ 4.0%
- **Mixing depth**
  - Report and record depth be to the nearest 0.25 inches
  - The difference between the individual measured depth thickness on the roadway and the Plan target thickness must not exceed 2 inches
  - The difference between the LOT average (average of the three individual measured depth thickness) and the plan target thickness must not exceed 1 inch.
  - No under-tolerance of mixing depth is allowed
- **Density Requirements**
  - Minimum density at any location of 98% of the modified Proctor

200 Rock Base

- 200-1 Description
- 200-2 Materials
- 200-6 Compacting and Finishing Base
- 200-7 Acceptance Program
- 200-8 Priming

200-1 & 200-2

- **Optional Base Group (OBG)**
  - 15 Groups for Non-Limited Use
  - 8 Groups for Limited Use (Not used on FDOT)
- **The Contractor may use more than one source of base rock on a single Contract provided that a single source is used throughout the entire width and depth of a section of base.**
- **Obtain approval from the Engineer before placing material from more than one source.**
- **Intermittent placement or "blending" of sources is not permitted.**

Table 285-1
Optional Base Groups 1 through 7

Base Materials	Base Group (Base Group Pay Item)						
	1 (701)	2 (702)	3 (703)	4 (704)	5 (705)	6 (706)	7 (707)
Limerock, LBR 100	4"	5"	5-1/2"	6"	7"	8"	8-1/2"
Cemented Coquina, LBR 100	4"	5"	5-1/2"	6"	7"	8"	8-1/2"
Shell Rock, LBR 100	4"	5"	5-1/2"	6"	7"	8"	8-1/2"
Bank Run Shell, LBR 100	4"	5"	5-1/2"	6"	7"	8"	8-1/2"
Calcarenite, LBR 100	4"	5"	5-1/2"	6"	7"	8"	8-1/2"
Recycled Concrete Aggregate, LBR 150(1)	4"	5"	5-1/2"	6"	7"	8"	8-1/2"
Graded Aggregate Base, LBR 100	4-1/2"	5-1/2"	6-1/2"	7-1/2"	8-1/2"	9"	10"
Type B-12.5	4"(3)	4"(3)	4"(3)	4"(3)	4-1/2"	5"	5-1/2"
B-12.5 and 4" Granular Subbase, LBR 100 (2)	-	-	-	-	-	-	-
RAP Base	5"	-	-	-	-	-	-

(1) Do not use on interstate roadways.
(2) The construction of both the subbase and Type B-12.5 will be bid and used as Optional Base. Granular subbases include limerock, cemented coquina, shell rock, bank run shell, recycled concrete aggregate and graded aggregate base. All subbase thicknesses are 4" minimum prior to adding the required prime coat.
(3) Based on minimum practical thickness.
(4) To be used for widening, three feet or less.

200-2 Materials

- **OBG**
- **Existing Rock**
  - Meeting the requirement of 200- 2.2.
  - The existing rock must be material that was previously “Certified for FDOT”
  - Notify the Engineer in writing
  - Submit process control plan
  - Stockpile and test for LBR at the source (stockpile) at a frequency specified in the Specs
  - Tested again at the roadway after spreading for Proctor

200-6 Compacting and Finishing Base

- **Construct the base in multiple courses of equal thickness**
  - Individual courses shall not be greater than 6 inches or less than 3 inches
- **Thicklift allowed if approved by test section**
  - Construct in accordance with 200-5 Spreading Rock
  - 8-inch maximum lift thickness using thicklift
  - Five QC nuclear density tests at random locations within the test section
    - At each test location, test the bottom 6 inches in addition to the entire course thickness
    - One VT test at random location
    - All 5 QC tests and the VT test must meet minimum percent compaction (98% of Modified Proctor)
  - The minimum density required on the thicker lift will be the average of the five QC test results obtained on the thicklift
  - If source changes construct new thicklift test section

200-7 Acceptance Program

- **Test and Testing Frequency**

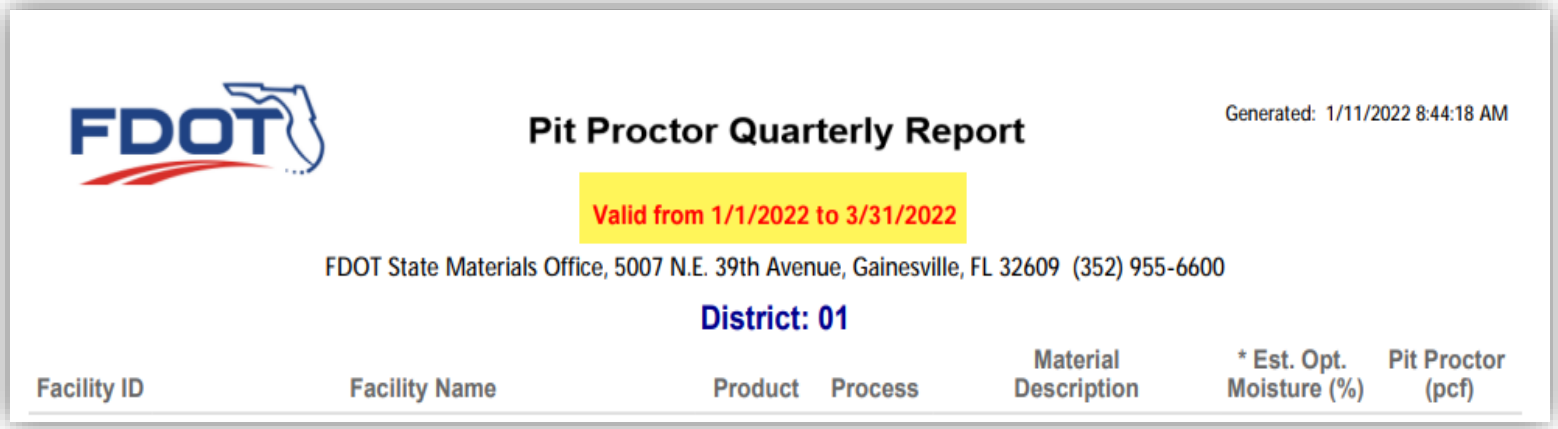
Table 200-1 Mainline Pavement Lanes, Turn Lanes, Ramps, Parking Lots, Concrete Box Culverts and Retaining Wall Systems		
Test Name	Quality Control	Verification
Modified Proctor Maximum Density	One per eight consecutive LOTs	One per 16 consecutive LOTs
Density	One per LOT	One per four LOTs
Roadway Surface and Cross Slope	One per LOT	One per two LOTs
Roadway Thickness	Three per LOT	Witness

200-7.2.3 Pit Proctor

- **Use the “Pit Proctor” value in lieu of the traditional modified Proctor testing**
- **Effective 2015, Pit Proctor program was introduced**
  - Optional for Contractor
  - Contractor notifies the Engineer in writing of the option to use the Pit Proctor process
- **Pit Proctor values are supplied by the Department and come from testing done at the mines**
- **The Pit Proctor values are updated by SMO the first day of each calendar quarter based on previous quarter test results**
  - Posted on the following website: https://www.fdot.gov/materials/laboratory/geotechnical/aggregates/pitproctor/index.shtm

Pit Proctor

- Pit Proctor is a quarterly process which is documented at the top of the report. The information on the report is only valid for the time frame noted “Valid from…”



FDOT

Pit Proctor Quarterly Report

Generated: 1/11/2022 8:44:18 AM

Valid from 1/1/2022 to 3/31/2022

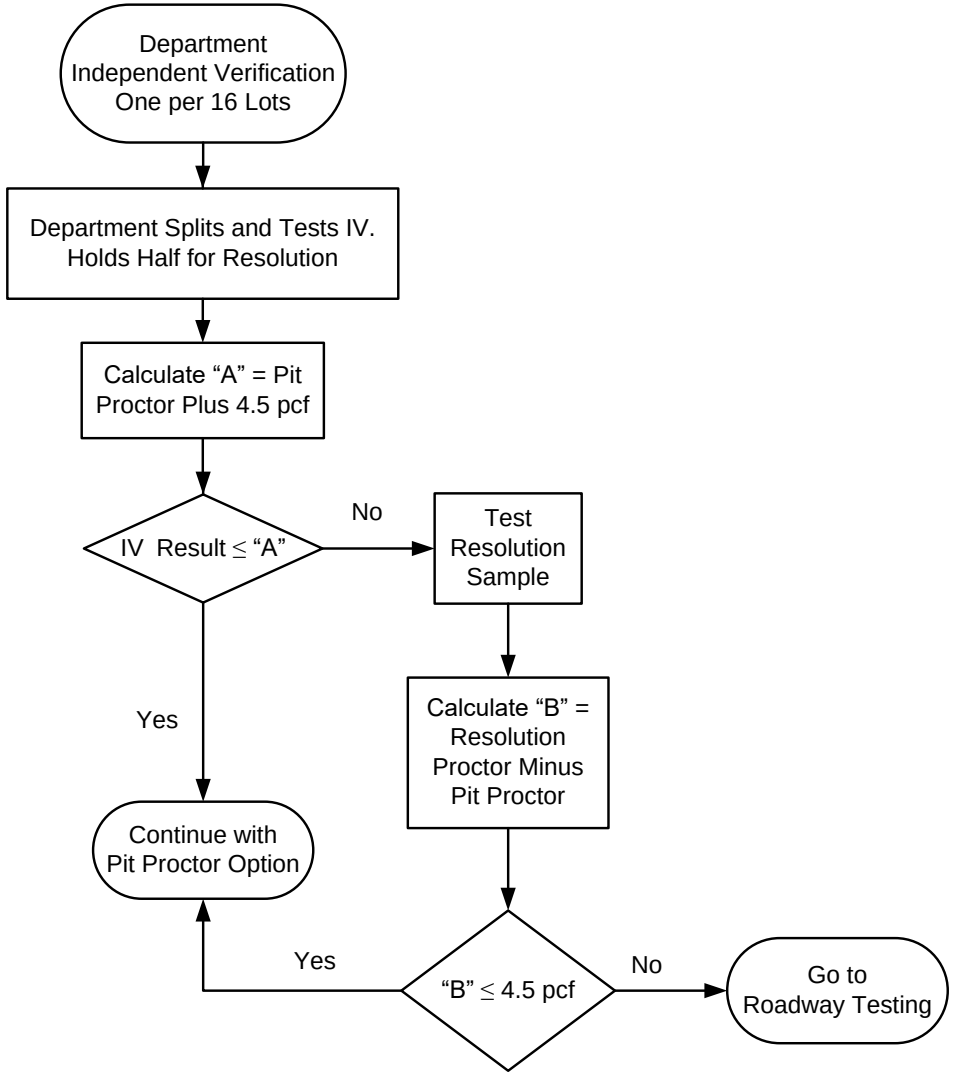
FDOT State Materials Office, 5007 N.E. 39th Avenue, Gainesville, FL 32609 (352) 955-6600

District: 01

Facility ID	Facility Name	Product	Process	Material Description	* Est. Opt. Moisture (%)	Pit Proctor (pcf)

- Density tests must use current quarter Pit Proctor value to calculate percent density compaction regardless of when the Contractor brought the material to the job
- QC reports the Pit Proctor value into MAC and IV tests every 16 LOTs to verify the accuracy of the Pit Proctor
  - IV Proctor can’t be higher than 4.5 pcf of Pit Proctor

Pit Proctor Flow Chart



Quality Control and Verification Testing

- **Thickness and Surface Testing**
  - Considered deficient if the measured depth is over 1/2 inch less than the specified thickness
- **Density Requirements**
  - Minimum density in any LOT of 98% of modified Proctor maximum density

514 Geosynthetic for Drainage Application

- 514-1 Description
- 514-2 Material
- 514-4 Acceptance Criteria

Drainage Applications

- **514-1 Description / 514-2 Material**
  - Geosynthetics used in drainage, slope protection, and material separation applications
  - Can only use products that are listed on the APL
    - FDOT PATH website https://path.fdot.gov/Specifications
    - Go to 985 for list of APL products

Table 985-1
Drainage Applications

Geotextile Type	Description	Standard Plans Index
D-1	Revetment (Special)	
	Rock, Rubble without bedding stone	
	Ditch Pavement (Rubble Riprap) without bedding stone	524-001
D-2	Revetment (Standard)	
	Articulating Block	
	Gabions	524-001
	Rock, Rubble, and Broken Concrete with bedding stone	
	Ditch Pavement (Rubble Riprap) with bedding stone	524-001
	Joint Cover for Mechanically Stabilized Retaining Wall with Coarse Aggregate Backfill	
	Joint Cover for Mechanically Stabilized Retaining Wall Supporting Spread Footing Foundations	
D-3	Underdrain: Types II, III, and V	440-001
	French Drain	443-001
	Sheet Piling Filter	
	Filter Fabric Jacket (Culvert)	430-001
	Box Culvert Joints	400-289 and 400-291
	Concrete Pavement Subdrainage	446-001
	Joint Cover for Mechanically Stabilized Retaining Wall with Sand or Limerock Backfill	
D-4	Slope Pavement	
	Ditch Pavement (Sand-Cement Riprap or Concrete)	524-001
	Coarse Aggregate Wrap	
D-5	Separation Geotextile	
	Cast-In-Place Retaining Wall	

Drainage Applications

- **Determine class type for the in-place soil type being used with the geosynthetic (Table 985-2) for drainage applications D-1, D-2, & D-3**
- **APL has the detailed information for the approved class types**

Table 985-2
Geotextile Selection

In-situ Soil Type or Drainage Application	Class for Type D1, D2, D3 Materials
< 15% passing a No. 200 Sieve*	a
15% to 50% passing a No. 200 Sieve*	b
> 50% passing a No. 200 Sieve*	c
> 50% passing a No. 200 Sieve* with Plastic Index >7	d
MSE Joint Cover for Sand or Limerock Backfill	e
MSE Joint Cover for Coarse Aggregate Backfill	f

*as per AASHTO T88.

Mirafi FW300 (APL Product)

Supplier: TenCate Geosynthetics

- **Model Number:**
- **APL Number:** 985-007-035
- **Specification:** Geosynthetic Materials
- **Product Type:** Drainage Geotextiles, D-2
- **BABA Eligible:** Eligible
- **Comment:** Approved for D-2(f).
- **Fabrication:** Buy America Category: Construction Ma

Mirafi 160N (APL Product)

Supplier: TenCate Geosynthetics

- **Model Number:**
- **APL Number:** 985-008-003
- **Specification:** Geosynthetic Materials
- **Product Type:** Drainage Geotextiles, D-3
- **BABA Eligible:** Eligible
- **Comment:** Approved for D-3 (a, b, c, d, e) for all contracts. || NTPEP GTX-2018-01-062
- **Fabrication:** Buy America Category: Construction Material - Plastic or Polymer Based

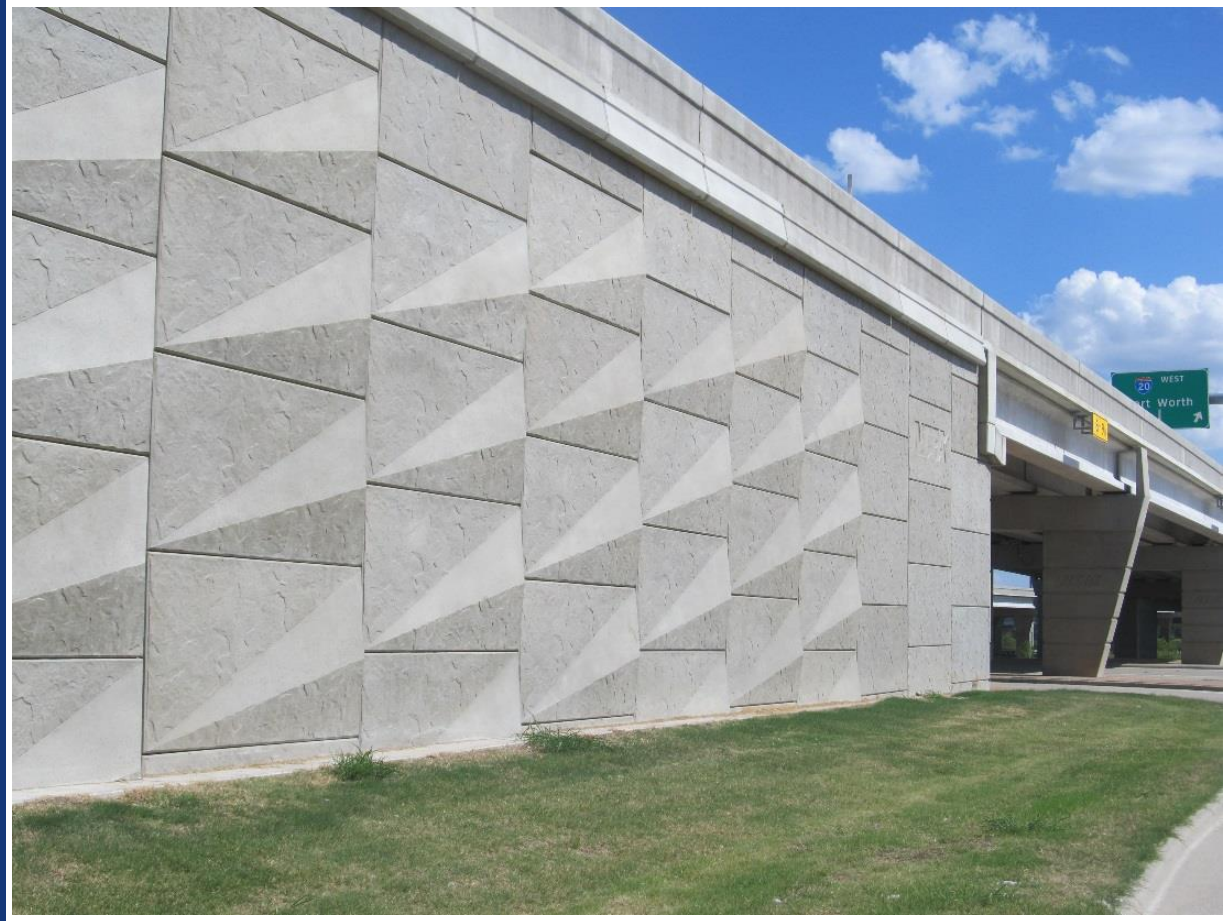
514-4 Acceptance Criteria

- **Ensure Contractor installs in accordance with Manufacturer's instructions**
- **At least *fourteen days prior to placement:***
  - Contractor to submit to the Engineer a certification
  - Two 8-inch by 10-inch samples of geosynthetic materials for product identification to the Engineer
- **VT to send both certification and physical samples to SMO for approval**
- **This applies to ALL drainage materials used on the job**

548 Retaining Wall Systems

- 548-1 Description
- 548-2 Materials
- 548-3 APL
- 548-8 Construction Requirement
- 548-9 Acceptance Program
- 548-10 Certification

Mechanically Stabilized Earth (MSE) Walls



Retaining Wall Systems

- **548-1 Description**
  - Permanent and temporary retaining wall systems
  - Sheet pile wall and C-I-P walls are not part of this Section
- **548-2 Materials**
  - 548-2.6 Backfill Material
    - Coarse Aggregate at least one foot above the DHW shown in the Plans
      - Size No 57 through Size No 89 (unless restricted in the Plans)
    - Flowable fill can only be used when shown in the Plans
      - Metallic wall components must be completely encapsulated by the flowable fill
    - Select backfill must meet 105 and 120.
      - Gradation must be using FM 1-T27/ FM 1-T011, in lieu of AASHTO T88.
      - LL ≤15, PI = NP, & Organic Content (Individual ≤ 3.0% & Average ≤ 2.0%)
    - Electro-chemical testing required

548-2 Backfill Material Requirement

- **T27/T11 Gradation**

Table 548-2 Gradation Limits	
Sieve Size	Percent Passing
3-1/2 inches	100
3/4 inch	70-100
No. 4	30-100
No. 40	15-100
No. 100	0-65
No. 200	0-12

- **Electro-chemical testing**

Metallic Reinforcement

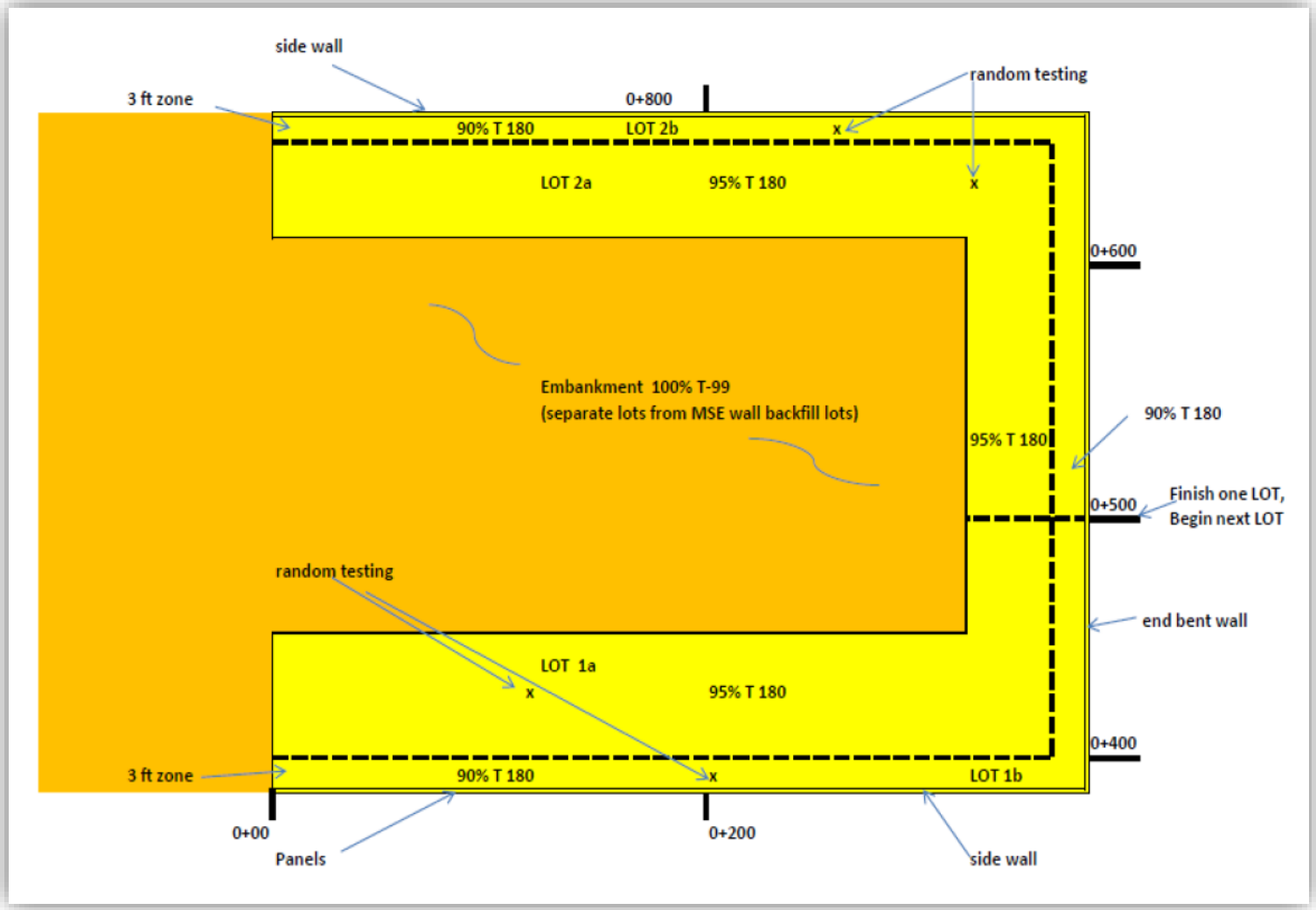
Test	Criteria
pH	5.0 – 10.0
Resistivity	> 3,000 ohm-cm
Soluble chloride content	< 100 PPM
Soluble sulfate content	< 200 PPM

Geosynthetic Reinforcement

Test	Geosynthetic Type	Criteria
pH	Polyester	5.0 – 9.0
	Non-Polyester	5.0 – 10.0

Retaining Wall Systems

- **548-3 APL**
  - Entire system must be on the APL under 548
- **548-8 Backfill Placement**
  - A LOT is defined as a single lift of finished embankment not to exceed 500 feet in length or cumulative length of continuous, interconnected walls
  - Backfill within 3 feet from the panels and backfill beyond 3 feet from the panels are separate LOTs



Additional LOT Details

- Strips up to 8 feet wide between two retaining wall volumes constructed with the same material in one operation may be considered as one LOT with the retaining wall volumes.
- Overlapping retaining wall volumes may be considered one LOT, excluding the 3 feet width behind the panels.

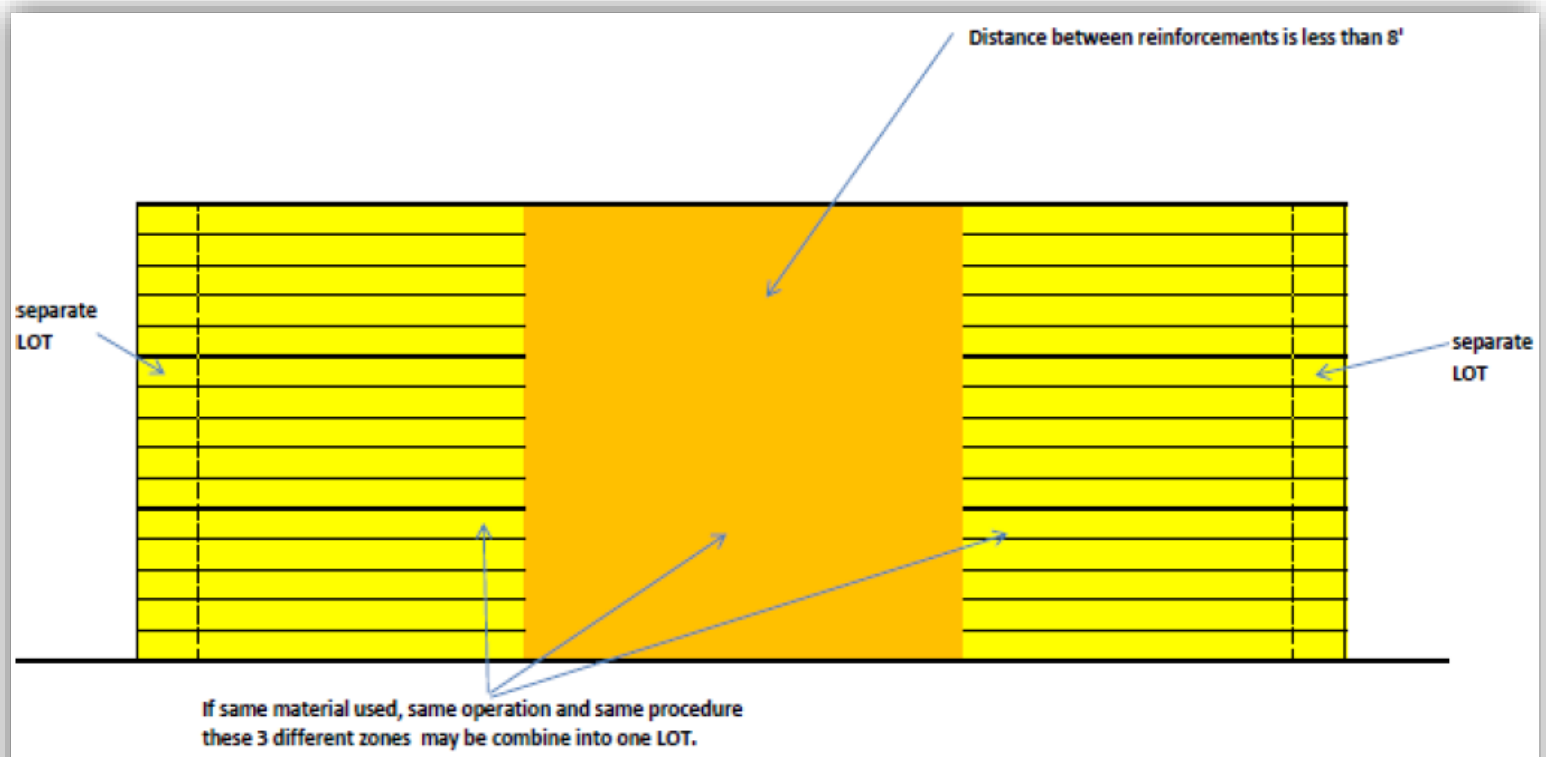


Figure 58 . Paralell walls, with a narrow gap between reinforcements

Rolling Pattern

- **Within 3’ of all MSE Wall Backfill Types**
  - Achieve compaction of all backfill types within three feet of the back of the wall face using a power operated roller or plate weighing less than 1,000 pounds
- **Coarse Aggregate Backfill**

Equipment Weight Limit	Min # of Passes
Between 600 and 1000 pounds	3 passes
Greater than 1000 pounds	2 Passes

Acceptance of Compaction for Backfill

- **548-9.4 Acceptance Criteria**
  - Within 3 feet of the wall face – minimum 90% of the modified Proctor maximum dry density
  - Beyond 3 feet of the wall face – minimum 95% of the modified Proctor maximum dry density
- **548-9.4.1 Optional Acceptance Criteria for A-3 and A-2-4 Materials**
  - Within 3 feet of the wall face – minimum 95% of the *standard* Proctor maximum dry density
  - Beyond 3 feet of the wall face – minimum 100% of the *standard* Proctor maximum dry density

Retaining Wall Systems

- **548-10 Certification**
  - For backfill materials: Submit to the Engineer a signed and sealed certification by a Professional Engineer registered in the State of Florida, that the electro-chemical properties meet the requirements of 548-2.6.2
  - Submit all test reports to the Engineer necessary to document compliance with the Specifications, at least ten days prior to wall construction.
  - Submit a certificate of compliance certifying that the retaining wall materials, backfill and construction practices comply with this Section.
  - For SBW systems, the Engineer will randomly select samples of each type of block used in the segmental block retaining wall system and review a copy of the certified test report corresponding the sample at a frequency of one sample per type of block for each wall.
  - Acceptance of furnished material will be based on the certificate

Earthwork Records System

(ERS)

Earthwork Records System

- **ERS, also known as density logbook, is a group of logbooks with pertinent field data put together for earthwork construction**
- **The electronic logbook (MAC-ERS), provide as-built records of the pavement substructure**
  - Graphical representation of the materials used to build the earthwork layers
  - Densities achieved for each construction type (i.e., roadway, MSE walls, pipe backfill, etc.)
- **ERS is used as the acceptance method for material certification**
- **District Materials Office initially provides the MAC-ERS training**
- **The training is provided for project personnel that will have an upcoming project in MAC-ERS**
- **Training videos and instructions manual are available from the following website:**
  - https://www.fdot.gov/materials/mac

Responsibilities

Quality Control

- Plot roadway and drainage sheets
  - Data entry to generate plots in MAC
- Maintain the QC ERS throughout the project.
- Take QC densities
- Sample, split and test for Proctors
- Retain resolution and verification samples
- Sample for all QC lab tests
- QC takes resolution density tests
- Meet the requirements of the contract.

Verification

- Verify Contractor's test results
- Review ERS for completeness and accuracy.
- Provide the reference gauge for comparisons on new gauges brought to the project
- Sample for LBR
- Verification density testing
- Witness mixing depth checks for stabilized subgrade
- Witness surface and depth checks for base

District Materials IA

- Assist & train project personnel in interpreting the Earthwork Contract Documents
- Provide the reference nuclear density gauge for initial comparison
- Perform Independent Assurance (IA) on ERS to ensure all deficiencies are resolved before final acceptance
- Verify personnel working in Earthwork are CTQP qualified and perform IA technicians.
- Perform random field inspection on ongoing construction projects

Don’t forget…

- **Contact the Earthwork Team at the District Materials Office if any support is needed**
- **Check with the Materials Office about:**
  - Paper Logbooks (when and if needed)
  - Coding elevations from Plans
  - Using DLB Plot Program (when and if needed)
  - MAC plotting questions

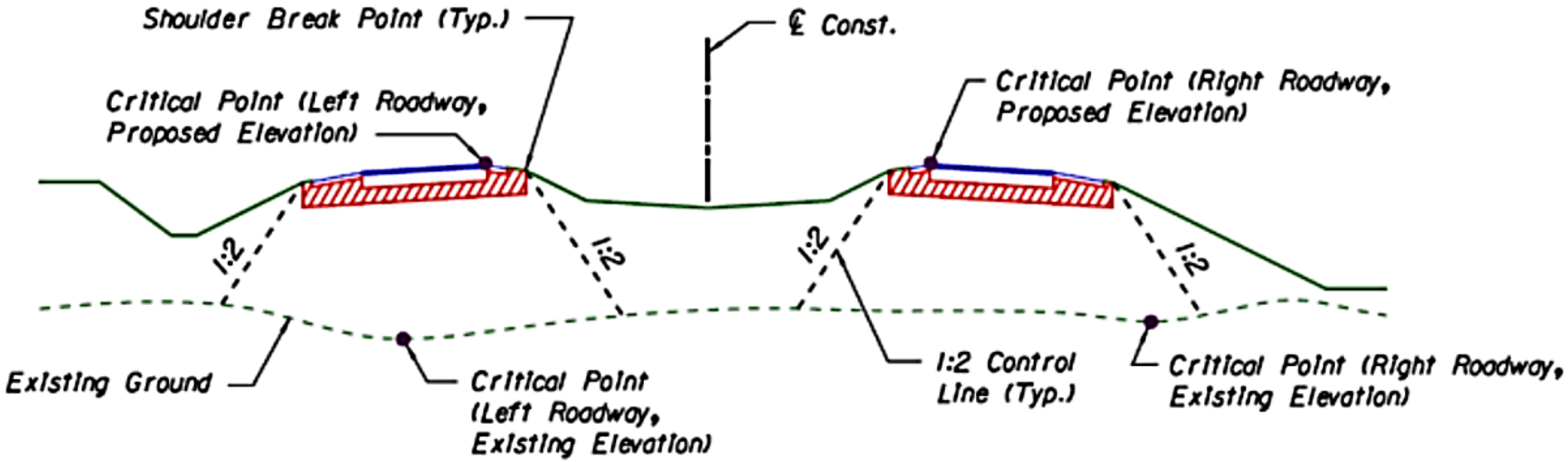
Plot Coding

Roadway and Drainage Plots

Required for Coding Roadway

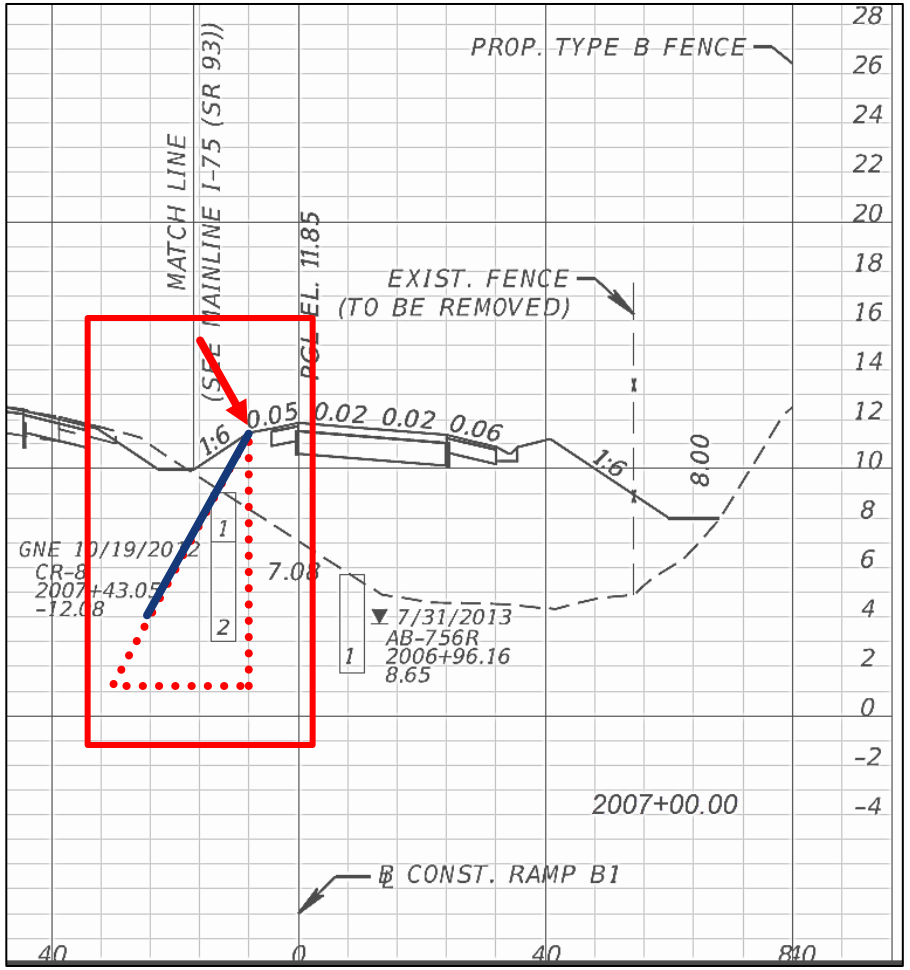
- Highest proposed pavement elevation
- Lowest existing ground elevation
- Code for unsuitable material
- Locate shoulder break points and draw the 1V:2H control line
- Code thickness of Asphalt, Base, & Subgrade
- Code Shoulder Base, Shoulder Subgrade, Sidewalk, etc.

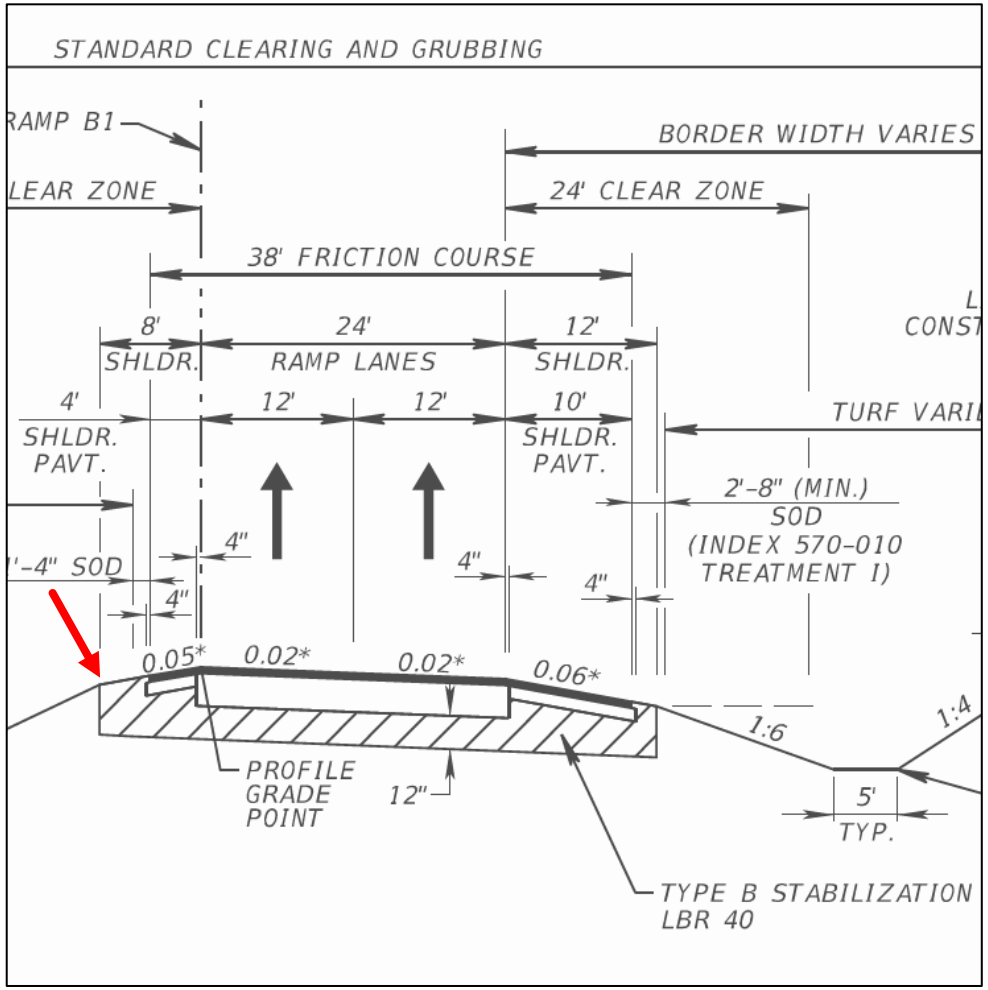
Required for Coding Roadway



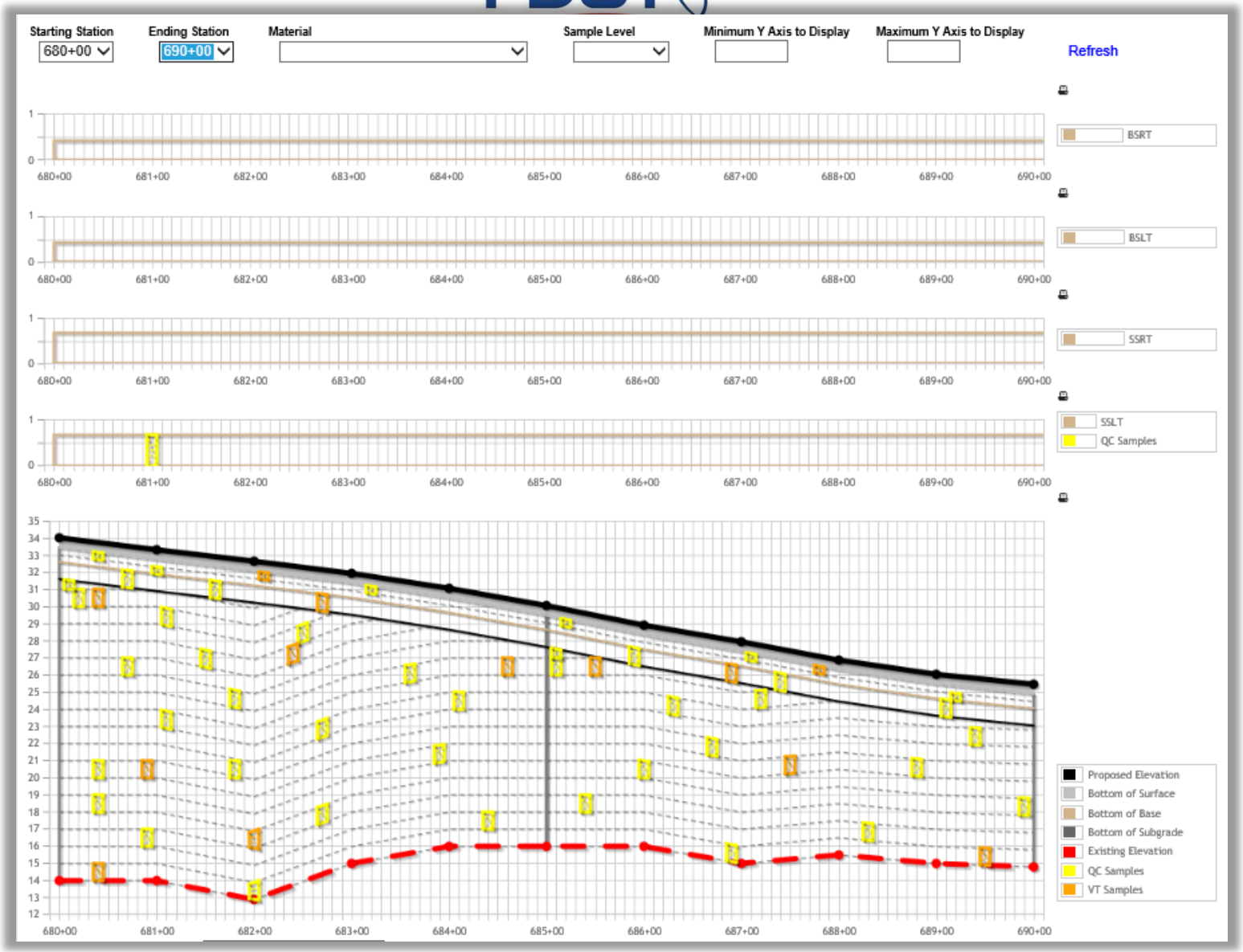
Code Critical points for both Left and Right Roadways from each Cross Section

Determining the 2:1 Slope





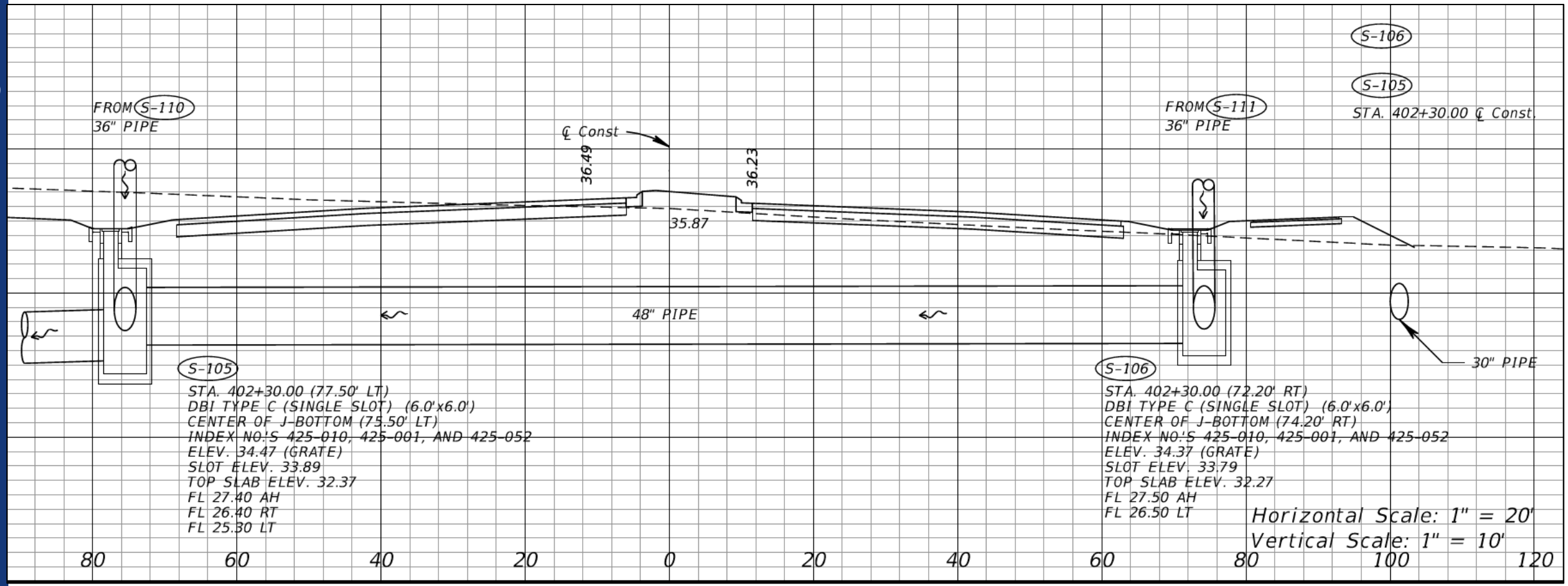
Plot Coding


Starting Station
680+00
Ending Station
690+00
Material
Sample Level
Minimum Y Axis to Display
Maximum Y Axis to Display
Refresh
BSRT
BSLT
SSRT
SSLT
QC Samples
Proposed Elevation
Bottom of Surface
Bottom of Base
Bottom of Subgrade
Existing Elevation
QC Samples
VT Samples

Required for Coding Drainage

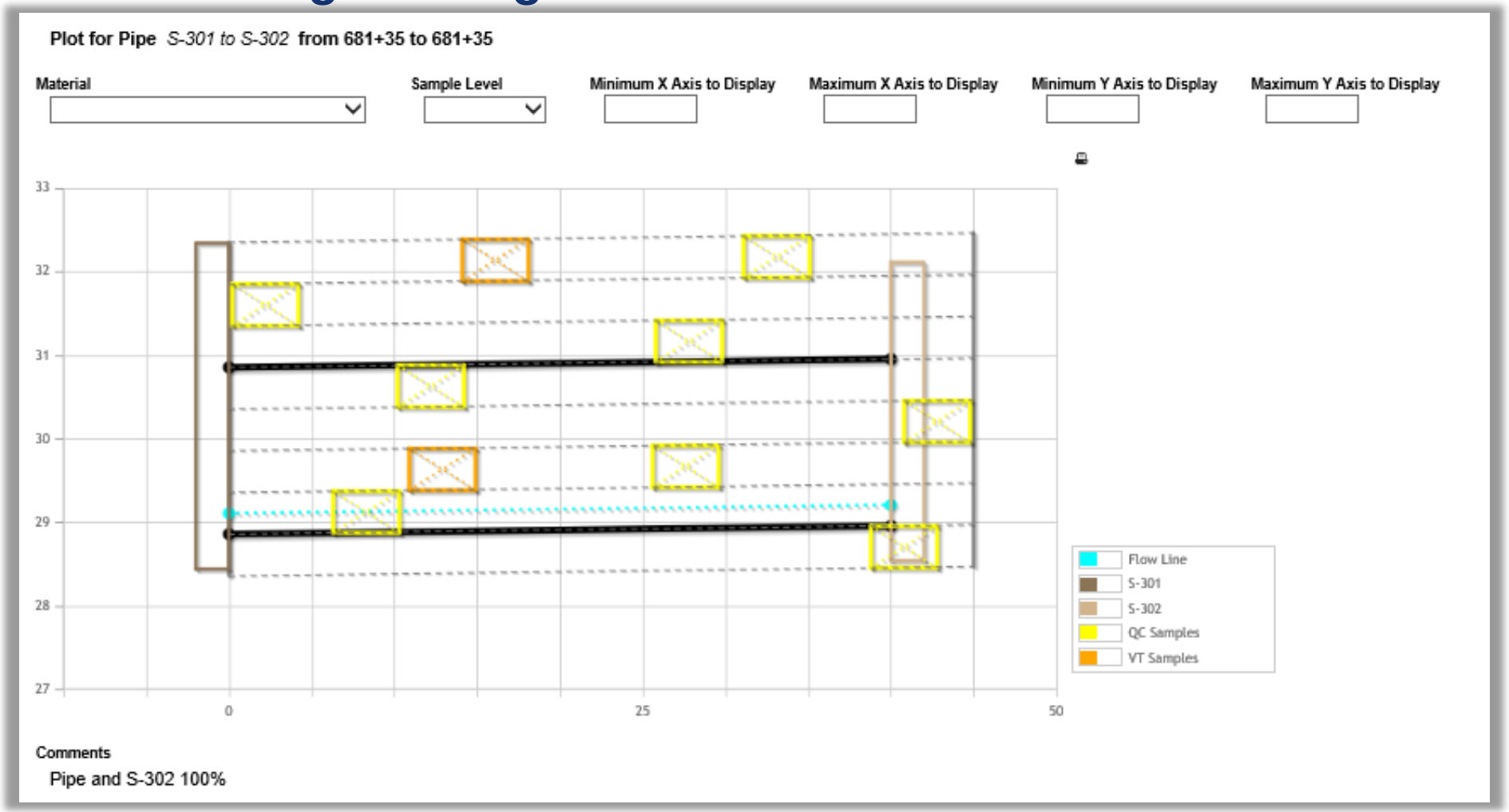
- **Flow line**
- **Top & invert structure elevation**
- **Length & size of pipe**
- **These values are manually read from the Plans; this information is rarely given in one place.**
  - May require cross referencing with plan/profile view or summary of drainage structures.

Required for Coding Drainage



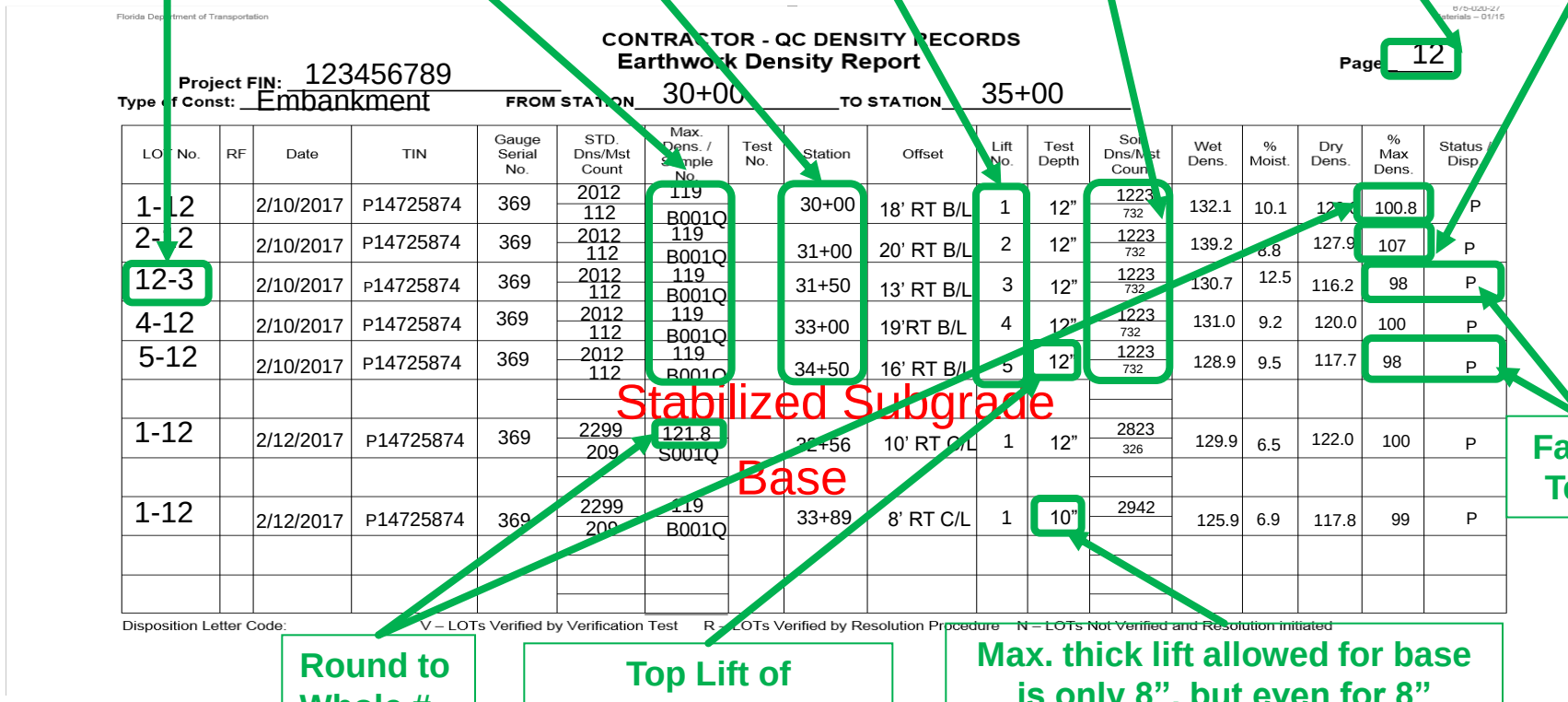
Some structure tops & bottoms must be scaled from cross sections. We need to find the lengths of pipe.

Required for Coding Drainage



Exercise

Find the Errors on the Density Report



LOT No.	RF	Date	TIN	Gauge Serial No.	STD. Dns/Mst Count	Max. Dens. / Sample No.	Test No.	Station	Offset	Lift No.	Test Depth	Soil Dns/Mst Count	Wet Dens.	% Moist.	Dry Dens.	% Max Dens.	Status / Disp.
1-12		2/10/2017	P14725874	369	2012 112	119 B001Q		30+00	18' RT B/L	1	12"	1223 732	132.1	10.1	120.0	100.8	P
2-12		2/10/2017	P14725874	369	2012 112	119 B001Q		31+00	20' RT B/L	2	12"	1223 732	139.2	8.8	127.9	107	P
12-3		2/10/2017	P14725874	369	2012 112	119 B001Q		31+50	13' RT B/L	3	12"	1223 732	130.7	12.5	116.2	98	P
4-12		2/10/2017	P14725874	369	2012 112	119 B001Q		33+00	19'RT B/L	4	12"	1223 732	131.0	9.2	120.0	100	P
5-12		2/10/2017	P14725874	369	2012 112	119 B001Q		34+50	16' RT B/L	5	12'	1223 732	128.9	9.5	117.7	98	P
1-12		2/12/2017	P14725874	369	2299 209	121.8 S001Q		32+56	10' RT C/L	1	12"	2823 326	129.9	6.5	122.0	100	P
1-12		2/12/2017	P14725874	369	2299 209	119 B001Q		33+89	8' RT C/L	1	10"	2942	125.9	6.9	117.8	99	P

Round to Whole #

Top Lift of Embankment is 6"

Max. thick lift allowed for base is only 8", but even for 8" test strip is required.

Failing Tests

Max Density over 105%

Page # & Letter (12A)

Incorrect Soil Density & Moisture Counts

Missing Total # of Lifts

Appears Random # Generator wasn't used

Incorrect Proctor

LOT# – PAGE #

*From district 3 Density Workshop

Exercise

Earthwork Density Report

FDOT State Materials | 5007 NE 39th Ave. | Gainesville, FL 32609 | (352) 955-6600

Generated: 11/7/2023 1:55:24 PM

Contract ID: [redacted] Let Date: 6/15/2022

Yellow highlight indicates: sample pending finalization, gauge company does not match technician company, small density/moisture count, lift thickness ≠ test depth, QC/QR sample with >105% max. density, target compaction override, or comparison package comparing samples on same lift with different Proctors.

Red font indicates: unqualified tech, density/moisture count error, failing test result, or a gauge with one of the following issues: (1) incorrect units, (2) missing calibration parameter document, (3) missing OR zero-valued parameter values for corresponding test depth, (4) unrealistic parameter values, or (5) duplicate gauge calibration. (For more details on gauge errors, run the 'ERS - Gauge Error' report)

Red highlight indicates a resolution sample used as a Proctor, non-Proctor sample used as a Proctor, or a failing comparison package. Green highlight indicates an upheld resolution.

#	MAC Sample ID / FDOT Sample #	Test Date / TAT	Sample Level	Initiated User / Tested By (TIN)	Gauge SN / $\gamma_{std.}$ Count / $\omega_{std.}$ Count	γ_{max} (pcf) / Proct. Sample #	ω_{opt} (%)	Elev. (ft)	Station / Pipe Dist. (ft)	Offset	Lift #	Lift Thick. (in)[1]	Test Depth (in)	γ_{soil} Count / ω_{soil} Count	γ_{wet} (pcf) / ω (%)	γ_{dry} (pcf)	γ_{max} (%) / % Trgt Cmpct.	Comparison Package
ERS Project: [redacted]-52-01 — Ardaman & Associates, Inc. [QC], Greenman-Pedersen, Inc. (GPI) [QC], RS&H, Inc. [VT], District 3 Materials Office [IA]																		
Drainage																		
S-534 to S-515 *(11+35 to 482+75)*																		
Spec ID: 120																		
Embankment																		
1	1163514	6/16/2023	QC	V. Scott	76794	107.3	12.4	44.1	182.50	2' L of C/L of Pipe	2	6	6	2731	116.3	108.1	101	166218
	PH001-T001	4		H40049897	2678 634	E0006Q (1035166)								113	7.6		100	
2	1163516	6/16/2023	QC	V. Scott	76794	107.3	12.4	45.2	125.20	2' R of C/L of Pipe	2	6	6	2719	116.5	106.9	100	166218
	PH001-T002	4		H40049897	2678 634	E0006Q (1035166)								131	9.0		100	
3	1163518	6/16/2023	QC	V. Scott	76794	107.3	12.4	45.1	154.60	2' R of C/L of Pipe	3	6	6	2604	118.5	109.3	102	166218
	PH001-T003	4		H40049897	2678 634	E0006Q (1035166)								125	8.4		100	
4	1163520	6/16/2023	QC	V. Scott	76794	107.3	12.4	45.9	135.30	2' R of C/L of Pipe	4	6	6	2678	118.2	109.4	102	166218
	PH001-T004	4		H40049897	2678 634	E0006Q (1035166)								634	8.0		100	
5	1182630	6/16/2023	VT	J. Toure	20484	107.3	12.4	45.9	143.20	3' L of C/L of Pipe	4	6	6	1593	115.4	106.8	100	166218
	PH001-T004	24		P65010491	1577 689	E0006Q (1035166)								129	8.1		100	
6	1163524	6/16/2023	QC	V. Scott	76794	107.3	12.4	45.8	170.70	2' L of C/L of Pipe	5	6	6	2584	118.9	109.8	102	166219
	PH001-T005	4		H40049897	2678 634	E0006Q (1035166)								124	8.3		100	
7	1163527	6/16/2023	QC	V. Scott	76794	107.3	12.4	46.7	145.90	2' R of C/L of Pipe	6	6	6	2542	119.7	110.6	103	166219
	PH001-T006	4		H40049897	2678 634	E0006Q (1035166)								123	8.2		100	
8	1163531	6/22/2023	QC	V. Scott	76794	107.3	12.4	47.0	162.60	2' L of C/L of Pipe	7	6	6	2857	114.3	107.1	100	166219
	PH001-T007	0		H40049897	2678 634	E0006Q (1035166)								102	6.7		100	
	1182633	6/16/2023		J. Toure	20484	107.3	12.4			3' R				1623	115.0		100	

Exercise

S-205 to S-206 *(363+17 to 363+17)*

Spec ID: 120

Embankment

1	1068557	2/1/2023	VT	R. Kincaid	14149		106.0	12.8	60.2	27.20	3' L of C/L of Pipe	1	6	6	2399	110.1	104.9	99	165550
	PH001-T001	4		K52372178	1952	515	E0004Q (1035156)								64	5.0		95	
2	1068353	1/31/2023	QC	J. Hill	75683		106.0	12.8	60.2	4.10	2' L of C/L of Pipe	1	6	6	3105	1092.0	1033.1	975	165550
	PH001-T001	5		H40049897	2596	680	E0004Q (1035156)								95	5.7		100	
3	1068358	1/31/2023	QC	J. Hill	75683		106.0	12.8	60.0	13.60	2' R of C/L of Pipe	1	6	6	3114	109.0	102.3	97	165550
	PH001-T002	5		H40049897	2596	680	E0004Q (1035156)								105	6.5		95	
12	1060081	11/22/2022	VT	L. Brueckhei..	14149		105.4	12.2	58.3	189.80	4' L of C/L of Pipe	9	6	6	1883	108.4	105.7	100	145354
	T0010	45		G62077361	1943	525	E0001Q (1009961)								54	2.6		95	
13	1032427	11/22/2022	QC	J. Hill	76794		105.4	12.2	59.0	345.80	3' L of C/L of Pipe	9	6	6	3174	108.9	103.8	98	145354
	T0010	5		H40049897	2646	651	E0001Q (1009961)								82	4.9		95	
14	1094259	11/22/2022	QC	J. Hill	75683		105.4	12.2	58.5	70.80	3' L of C/L of Pipe	10	12	12	85	111.9	106.6	101	164047
	PH001-T0011	82		H40049897	2646	651	E0001Q (1009961)								737	5.0		100	
15	1094265	11/22/2022	QC	J. Hill	75683		105.4	12.2	59.9	149.90	4' L of C/L of Pipe	11	12	12	711	112.9	107.7	102	164047
	PH001-T0012	82		H40049897	2646	651	E0001Q (1009961)								83	4.8		100	
18	1249615	10/18/2023	VT	J. Roberts	14149		105.4	12.2	60.3	-3.10	4' L of C/L of Pipe	7		6	2185	113.2	106.0	101	177942
	PH002-T007	1		R16343690	1918	525	E0001Q (1009961)								177	6.8		100	
19	1039564	12/5/2022	QC	J. Hill	76794		105.4	12.2	61.0	72.50	3' L of C/L of Pipe	7	12	6	696	113.9	108.8	103	177939
	T008	5		H40049897	2694	662	E0001Q (1009961)								83	4.7		95	
20	1092655	12/5/2022	QC	J. Hill	75683		105.4	12.2	61.0	-4.20	4' R of C/L of Pipe	8		6	2838	115.2	109.5	104	177942
	PH002-T008	71		H40049897	2694	662	E0001Q (1009961)								90	5.2		100	
21	1039569	12/5/2022	QC	J. Hill	76794		105.4	12.2	62.2	37.50	3' L of C/L of Pipe	8	12	6	82	113.9	108.9	103	177940
	T009	5		H40049897	2694	662	E0001Q (1009961)								694	4.6		95	
22	1092632	12/5/2022	QC	J. Hill	75683		105.4	12.2	62.9	22.10	3' R of C/L of Pipe	9	12	12	685	114.4	109.8	104	177940
	PH001-T0010	71		H40049897	2694	662	E0001Q (1009961)								77	4.2		100	

Questions?