APPENDIX G

ANSWERS TO STUDY QUESTIONS

CHAPTER 1 – ANSWERS TO STUDY QUESTIONS

1) True or False. The voids in a saturated soil are partly filled with water and partly filled with air.
False – They are completely filled with water.

2) VDOT uses AASHTO and Unified Soil Classification Systems to classify soils.

3) Consistency refers to the texture and firmness of a soil.

4) Silt and clay are made up of particles that are smaller than the No. 200 (75 µm) sieve.

5) The gradation is the distribution of various particle sizes within the material.

6) Dense graded means that the particles in a mixture are sized so that they fill most of the voids; there is very little space in between soil or stone particles.

7) The moisture content at which a soil begins to behave like a liquid is called the liquid limit.

8) The behavior of a material where the material deforms under load and does not go back to its original shape is called plasticity.

9) The moisture content at which a soil can be compacted to its maximum dry density with the least amount of compactive effort is called the optimum moisture content.

10) True or False. A soil that contains a high percentage of fines is more affected by water than one with a low percentage of fines. True

11) True of False. Open graded aggregates are used in a pavement to give the structure more strength. False – Dense graded aggregates are used in a pavement to give the structure more strength.

CHAPTER 2 – ANSWERS TO STUDY QUESTIONS

1) True or False. Clearing and Grubbing is required in fill sections less than 5 feet in depth, in borrow areas before excavation can begin, and in all cut sections. True.

2) In fill sections where stumps may be left in place, they must be no more than 6 inches high.

3) Grading to drain means to crown surface of embankment, roll surface of embankment smooth, direct water to appropriate erosion and siltation controls.

4) The first lift of embankment material placed in swampy areas is called a work platform.

5) How should layers of embankment material be placed? Layers of embankment material should be placed with uniform thickness and parallel to finished grade.

6) Please answer the following questions:

    a. For a fill with a height of 8 feet, a length of 1500 feet, and a volume of 61,200 cubic yards what is the minimum number of density tests required? 45 tests – 1 per 2,500 cubic yard increment = 25; 2 per 6 inch layer within the top 5 feet of fill = 20.

    b. For a fill with a height of 8 feet, a length of 400 feet, and a volume of 61,200 cubic yards what is the minimum number of density tests required? 33 tests – 1 per 2,500 cubic yard increment = 25; plus 1 for every other layer from bottom of fill to top of fill, starting with the second lift = 8.

    c. For a fill with a height of 10 feet, a length of 2200 feet, and a volume of 80,000 cubic yards what is the minimum number of density tests required? Volumetric requirement is 80,000 cubic feet ÷ 2500 = 32 tests. Greater than 2,000 feet split into two equal parts. For first 1100 feet, 2 tests per 6 inch layer within the top 5 feet of fill = 20 tests; and for last 1100 feet, 2 tests per 6 inch layer within the top 5 feet of fill = 20 tests. Total number of tests = 32 + 20 + 20 = 72 tests.

7) Material is being placed 15 feet below the proposed subgrade in a rock fill. The maximum nominal size of the rocks is 3 feet. The maximum lift thickness in this case is 3 feet.

8) True or False. In building an embankment on a hillside, benching provides a place to test. False – In building an embankment on a hillside, benching provides a foundation for the new embankment and a bond to the existing slope.

9) Is frozen embankment material acceptable to use in embankments? No.

10) Is 108 % compaction acceptable for embankment? No.

11) True or False. For subgrade and embankment, the specifications require that each lift be compacted at optimum moisture content with a tolerance of ±40%. False - ± 20%.

12) True or False. Embankment is a structure of soil, soil aggregate, soil-like materials, or broken rock between the existing ground and the subgrade. True.

13) Six (6) feet is the minimum bench width for a slope steeper than 4:1 and less steep than 1½:1?

14) What is the density testing rate for fill areas less than 500 feet long? One test per 2,500 cubic yards, plus one test for every other 6 inch layer in the embankment from the bottom of the fill to the top of the fill, starting with the second lift.

15) What is the density testing rate for fill areas between 500 feet and 2000 feet? One test per 2,500 cubic yards, plus two tests for every 6 inch layer within the top 5 feet of fill.

16) What is the maximum distance from the heel of an abutment/gravity or cantilever retaining wall that is to be tested by the specified rates for walls if the structure is 12 feet high? The height of the structure plus 10 feet (12 + 10 = 22).

17) Material having a moisture content of more than 30% above optimum cannot be placed on a previously placed layer for drying, unless it is shown that it will not detrimentally affect the previously placed layer due to downward migration of water.

18) The typical lift thickness for soil is 8 inches loose, 6 inches compacted.

19) The maximum diameter of the material placed in the top 12 inches of an embankment is 3 inches.

20) The maximum diameter of material that can be placed 9 feet under the embankment surface is 2 feet.

CHAPTER 3 – ANSWERS TO STUDY QUESTIONS

1) Subgrade is the top surface of the embankment and the foundation for the pavement structure.

2) Subgrade must be scarified for a distance of 2 feet beyond the proposed edges of pavement to a depth of 6 inches and recompacted to the original requirements.

3) Seven (7) days after placement of the Cement Stabilized Subgrade the next course of pavement or approved cover material must be applied.

4) True or False. Cement is used with soil or aggregate to make the soil or aggregate more workable. False – Cement is used to add strength the mixture.

5) Why is lime used with soil? Lime is used with soil to add strength to the mixture, to raise the pH of the mixture, to assist in drying out soils, and to reduce soil plasticity.

6) The tolerance on the optimum moisture content at which aggregate must be compacted is ± 2 percentage points.

7) The tolerance on the optimum moisture content for cement treated subgrade is optimum moisture to 20% above optimum moisture.

8) The most common type of geosynthetic used is a geotextile.

9) True or False. Sewing of embankment stabilization fabric seams is not required. False – Sewing of the seams is required in all cases.

10) What is the minimum number of tests required for finished subgrade from Station 453+60 to Station 553+60? 5 tests are required; one test for each 2000 feet of subgrade full width. Calculation: 553+60 – 453+60 = 100+00 or 10,000 feet.

11) Cement Stabilized Subgrade has been placed 48 feet in width from Station 392+20 to Station 550+60, with a paver application width of 12 feet. Determine the number of tests required and the density and moisture requirements. Minimum number of tests required is 24, density must be 100%, and optimum moisture must be between optimum moisture to 20% above optimum moisture.

    Calculation:
    1) 550+60 – 392+20 = 158+40 or 15,840 feet
    2) 15,840 ÷ 5280 (feet in a mile) = 3 miles
    3) 48 feet ÷ 12 feet paver width = 4 pulls
    4) One test per ½ mile per paver width = 3 miles x 4 pulls = 12 x 2 = 24 tests

CHAPTER 3 – ANSWERS TO STUDY QUESTIONS (CONT.)

Chapter 3 - Practice Problem Number 1
Cement Application Rate (Volume Method)

The plans call for 12% cement by volume, 6" depth. Width of treatment is 26 feet. The net weight of the cement in the tanker is 23.09 tons. How many feet of roadway should this load of cement treat?

1) Application Rate = $[(W_t \times D_t)] \times [(D_c \times 94)]$

$= [(26 \times 0.5) \times [(0.12 \times 94)]$

$= 13 \times 11.28$

Application Rate = 146.64 lb/ft^3

2) Application Length = $\dfrac{(\text{Cement Weight} \times 2000)}{\text{Application Rate}}$

$= \dfrac{(23.09 \times 2000)}{146.64}$

$= \dfrac{(46180)}{146.64}$

Application Length = 315 Feet

Chapter 3 - Practice Problem Number 2
Cement Application Rate (Volume Method)

The plans call for 6.5% cement by volume, 6" depth. Width of treatment is 24 feet. The net weight of the cement in the tanker is 22 tons. How many feet of roadway should this load of cement treat?

1) Application Rate = $[(W_t \times D_t)] \times [(D_c \times 94)]$

$= [(24 \times 0.5) \times [(0.065 \times 94)]$

$= 12 \times 6.11$

Application Rate = 73.32 lb/ft^3

2) Application Length = $\dfrac{(\text{Cement Weight} \times 2000)}{\text{Application Rate}}$

$= \dfrac{(22 \times 2000)}{73.32}$

$= \dfrac{(44000)}{73.32}$

Application Length = 600 Feet

CHAPTER 4 – ANSWERS TO STUDY QUESTIONS

1) What should be located before starting to dig? Utilities.

2) True or False. When moving concrete pipe you should pick it up by one end. False – You should use leather or nylon slings or a pipe fork.

3) What are the testing requirements for backfilling around pipe? When backfilling around pipe, you should test every other lift on alternating sides beginning after the first 4 inch compacted layer above the structure's bedding and continue until backfill is 1 foot above the pipe for a maximum of 300 feet of pipe length.

4) What is the maximum size a rock to be placed within 12 inches of a pipe? 2 inches.

5) True or False. You do not have to place pipe bedding material down first when installing a UD-4. True.

6) Where can the typical underdrain drawings be found? VDOT Road and Bridge Standards.

7) What is the maximum height of cover for a 48 inch pipe diameter Class IV concrete pipe culvert? 21 feet.

8) A 36 inch diameter pipe, 290 feet long, is placed on a project as a drainage culvert. What is the minimum number of density tests that should be run on the backfill material? 11 tests; $[(36 \div 4) + (12 \div 4)] - 1 = 11$.

9) When can No. 57 stone be used? No. 57 stone can be used with sub-bedding when standing water is encountered.

10) What is the maximum backfill lift thickness? 6 inches loose compacted to 4 inches.

11) Pipe openings in precast drainage structures shall not exceed the outside cross sectional dimensions of the pipe by more than how much? 8 inches.

12) How long after installation is complete can the video inspection can be done? 30 days.

13) What is the maximum allowed crack size of a rigid pipe? 0.1 inches.

14) What is the maximum deflection allowed for flexible pipe? 7.5%.

15) What end of the pipe system do you start installation? Upstream or down- stream? Downstream.

16) What is the level of compaction required for pipe backfill? 95%.

CHAPTER 5 – ANSWERS TO STUDY QUESTIONS

1) What are the three differences between AASHTO T-99 and AASHTO T-180? The three differences between AASHTO-T99 and AASHTO T-180 are 1) the weight of the hammer; 2) height of drop of the hammer; and 3) the number of layers of soil compacted in the mold.

2) Three (3) layers of soil are required to make a standard proctor mold and each layer must be compacted 25 blows with a 5.5 lb. hammer dropped 12 inches.

3) The moisture content corresponding to the peak of the curve will be termed the optimum moisture content and the density corresponding to the peak of the curve will be termed the maximum dry density.

4) Three (3) scoops of reagent are placed in the body of the "speedy" moisture tester.

5) According to AASHTO, the base on which the proctor test molds are made must weigh at least 200 lbs.

6) If the dial on the Speedy exceeds 20, a half-size sample must be used and the dial reading must be multiplied by 2.

7) The proctor is run on soil which passes the No. 4 sieve.

8) Rotate the Speedy for 10 seconds, rest for 20 seconds for a period of 3 minutes.

9) Calculate the moisture content using the following information:

$W_{wet} = 10.85$

$W_{dry} = 10.05$

$W_{con} = 1.69$

$$W\% = \frac{(10.85 - 10.05)}{(10.05 - 1.69)} \times 100$$

$$= \frac{0.80}{8.36} \times 100$$

W% = 9.569 or 9.6%

CHAPTER 5 – ANSWERS TO STUDY QUESTIONS (CONT.)

Chapter 5 – Practice Problem Number 1
Establishing Target Densities (One-Point Proctor)

A. Complete the one-point proctor form (Form TL-125A) on soil using the information provided.

Date: Today's Date
Compacted Depth of Lift: 6"

Weight of Mold + Weight of Soil = 8.45 lbs.
Weight of Mold = 4.41 lbs.
Speedy Dial Reading = 13.2

B. Answer the following questions.

a) What is the maximum dry density? 107.1 lb/ft^3

b) What is the optimum moisture and optimum moisture range? 17.6% (Range = 14.1% to 21.1%)

17.6 x 0.20 = 3.52
17.6 – 3.52 = 14.1
17.6 + 3.52 = 21.1

c) A nuclear density test determines the dry density to be 102 lb/ft^3 with a moisture content of 18.2%. Does this test pass? Yes, it meets density and moisture requirements.

1) (102 ÷ 107.1) x 100 = 95.2% (which is greater than the minimum required density of 95.0%)
2) Moisture content of 18.2% falls within the optimum moisture range of 14.1% to 21.1%

Form TL-125A (Rev. 07/15)

CHAPTER 5 – ANSWERS TO STUDY QUESTIONS (CONT.)
PRACTICE PROBLEM #1

Route No. 635 **County** Amherst

Project No. 0635-005-187, C501 **Inspector**

FHWA No. FH-151(102)

Field Test No.		1	2	3
Date of Test				
Location of Test	Station Number – ft. (m)	77+50		
	Reference to Center Line – ft. (m)	7' Lt. C/L		
Reference Elevation	Original Ground – ft. (m)	+10 ft.		
	Finished Grade – ft. (m)	-23 ft.		
Type of Roller		Sheepsfoot		
A. Weight (mass) of mold and wet soil – lb. (kg)		8.45		
B. Weight (mass) of mold – lb. (kg)		4.41		
C. Weight (mass) of wet soil (A - B) – lb. (kg)		4.04		
D. Wet density of soil (Line C x 30 lb/ft^3) or (Line C x 1060 kg/m^3)		121.2		
E. "Speedy" Dial Reading		13.2		
F. Moisture Content (%) from Speedy Chart		15.3		
G. Maximum Dry Density – lb/ft^3 (kg/m^3)		107.1		
H. Optimum Moisture (%)		17.6		
I. Field Density – lb/ft^3 (kg/m^3) from TL-125				
J. No. 4 (+4.75 mm) material from field density hole				
K. Corrected Maximum Density – lb/ft^3 (kg/m^3)				
L. Compaction (%)				

Comments:

BY: _____

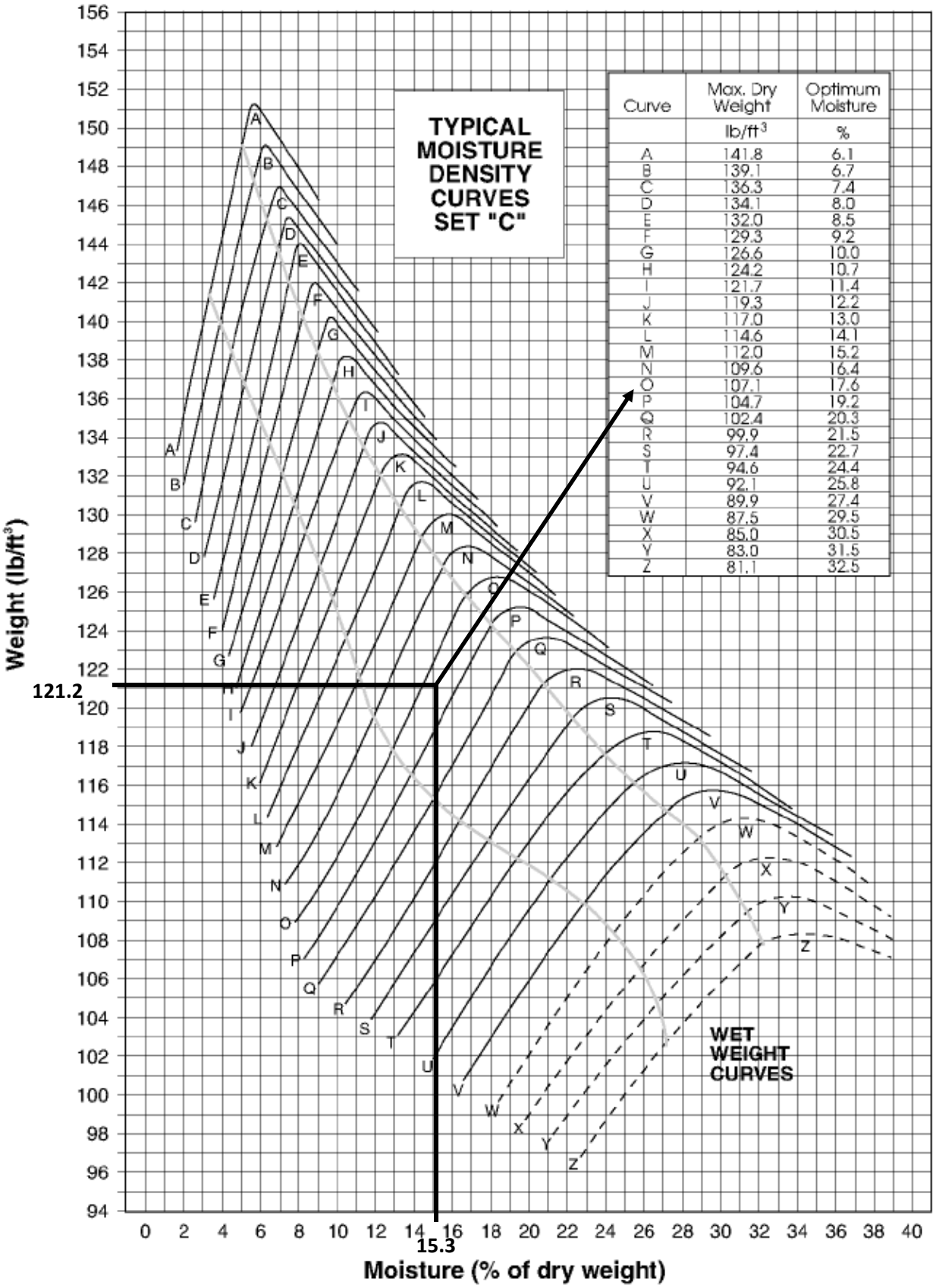
TITLE: _____

SPEEDY MOISTURE CHART

SPEEDY MOIST.		SPEEDY MOIST.		SPEEDY MOIST.		SPEEDY MOIST.		SPEEDY MOIST.		SPEEDY MOIST.		SPEEDY MOIST.	
READ.	CONT.	READ.	CONT.	READ.	CONT.	READ.	CONT.	READ.	CONT.	READ.	CONT.	READ.	CONT.
1.0	1.0	8.2	9.0	15.4	18.3	22.6	29.2	29.8	42.5	37.0	58.8	44.2	79.2
1.2	1.3	8.4	9.2	15.6	18.5	22.8	29.6	30.0	42.9	37.2	59.3	44.4	79.9
1.4	1.5	8.6	9.5	15.8	18.8	23.0	30.2	30.2	43.3	37.4	59.8	44.6	80.5
1.6	1.8	8.8	9.7	16.0	19.1	23.2	30.6	30.4	43.8	37.6	60.3	44.8	81.2
1.8	2.0	9.0	9.9	16.2	19.4	23.4	30.9	30.6	44.2	37.8	60.8	45.0	81.8
2.0	2.2	9.2	10.1	16.4	19.6	23.6	31.3	30.8	44.6	38.0	61.3	45.2	82.5
2.2	2.4	9.4	10.4	16.6	19.9	23.8	31.6	31.0	45.0	38.2	61.8	45.4	83.2
2.4	2.6	9.6	10.6	16.8	20.2	24.0	31.9	31.2	45.4	38.4	62.4	45.6	83.1
2.6	2.9	9.8	10.8	17.0	20.5	24.2	32.3	31.4	45.8	38.6	62.9	45.8	84.5
2.8	3.1	10.0	11.1	17.2	20.8	24.4	32.7	31.6	46.2	38.8	63.5	46.0	85.2
3.0	3.3	10.2	11.4	17.4	21.1	24.6	33.0	31.8	46.7	39.0	64.0	46.2	85.9
3.2	3.5	10.4	11.6	17.6	21.4	24.8	33.4	32.0	47.1	39.2	64.5	46.4	86.6
3.4	3.7	10.6	11.9	17.8	21.7	25.0	33.7	32.2	47.5	39.4	65.0	46.6	87.3
3.6	4.0	10.8	12.1	18.0	22.0	25.2	34.1	32.4	48.0	39.6	65.6	46.8	88.0
3.8	4.2	11.0	12.4	18.2	22.3	25.4	34.5	32.6	48.4	39.8	66.1	47.0	88.7
4.0	4.4	11.2	12.7	18.4	22.6	25.6	34.9	32.8	48.8	40.0	66.7	47.2	89.4
4.2	4.6	11.4	12.9	18.6	23.0	25.8	35.4	33.0	49.3	40.2	67.2	47.4	90.2
4.4	4.8	11.6	13.2	18.8	23.2	26.0	35.7	33.2	49.7	40.4	67.8	47.6	90.8
4.6	5.1	11.8	13.4	19.0	23.5	26.2	35.9	33.4	50.2	40.6	68.4	47.8	91.6
4.8	5.3	12.0	13.7	19.2	23.8	26.4	36.3	33.6	50.6	40.8	68.9	48.0	92.3
5.0	5.5	12.2	13.9	19.4	24.1	26.6	36.6	33.8	51.1	41.0	69.5	48.2	93.1
5.2	5.7	12.4	14.2	19.6	24.4	26.8	37.0	34.0	51.6	41.2	70.1	48.4	93.8
5.4	5.9	12.6	14.4	19.8	24.8	27.0	37.4	34.2	52.0	41.4	70.7	48.6	94.6
5.6	6.2	12.8	14.7	20.0	25.1	27.2	37.8	34.4	52.5	41.6	71.3	48.8	95.3
5.8	6.4	13.0	15.0	20.2				34.6	52.9	41.8	71.9	49.0	96.1
6.0	6.6	13.2	15.3	20.4				34.8	53.4	42.0	72.5	49.2	96.9
6.2	6.8	13.4	15.5	20.6				35.0	53.9	42.2	73.0	49.4	97.6
6.4	7.0	13.6	15.8	20.8	26.3	28.0	39.3	35.2	54.4	42.4	73.6	49.6	98.4
6.6	7.3	13.8	16.1	21.0	26.6	28.2	39.7	35.4	54.8	42.6	74.2	49.8	99.2
6.8	7.5	14.0	16.4	21.2	26.9	28.4	40.1	35.6	55.3	42.8	74.8	50.0	----
7.0	7.7	14.2	16.6	21.4	27.3	28.6	40.5	35.8	55.8	43.0	75.5		
7.2	7.9	14.4	16.9	21.6	27.6	28.8	40.9	36.0	56.3	43.2	76.1		
7.4	8.1	14.6	17.1	21.8	28.0	29.0	41.3	36.2	56.8	43.4	76.7		
7.6	8.4	14.8	17.4	22.0	28.3	29.2	41.5	36.4	57.2	43.6	77.3		
7.8	8.6	15.0	17.7	22.2	28.6	29.4	41.7	36.6	57.5	43.8	78.0		
8.0	8.8	15.2	18.0	22.4	28.9	29.6	42.1	36.8	58.3	44.0	78.6		

Speedy Reading for Proctor

Dial Reading = 13.2
Moisture Content = 15.3%



Curve	Max. Dry Weight	Optimum Moisture
	lb/ft³	%
A	141.8	6.1
B	139.1	6.7
C	136.3	7.4
D	134.1	8.0
E	132.0	8.5
F	129.3	9.2
G	126.6	10.0
H	124.2	10.7
I	121.7	11.4
J	119.3	12.2
K	117.0	13.0
L	114.6	14.1
M	112.0	15.2
N	109.6	16.4
O	107.1	17.6
P	104.7	19.2
Q	102.4	20.3
R	99.9	21.5
S	97.4	22.7
T	94.6	24.4
U	92.1	25.8
V	89.9	27.4
W	87.5	29.5
X	85.0	30.5
Y	83.0	31.5
Z	81.1	32.5

CHAPTER 5 – ANSWERS TO STUDY QUESTIONS (CONT.)

Chapter 5 – Practice Problem Number 2
Establishing Target Densities (One-Point Proctor)

A. Complete the one-point proctor form (Form TL-125A) on soil using the information provided.

Date: Today's Date
Compacted Depth of Lift: 6"

Weight of Mold + Weight of Soil = 13.56 lbs.
Weight of Mold = 9.51 lbs.
Speedy Dial Reading = 16.0

B. Answer the following questions.

a) What is the maximum dry density? 102.4 lb/ft^3

b) What is the optimum moisture and optimum moisture range? 20.3% (Range = 16.2% to 24.4%)

20.3 x 0.20 = 4.06
20.3 – 4.06 = 16.2
20.3 + 4.06 = 24.4

c) A nuclear density test determines the dry density to be 96.2 lb/ft^3 with a moisture content of 15.8%. Does this test pass? No, it does not meet density and moisture requirements.

1) (96.2 ÷ 102.4) x 100 = 93.9% (which is less than the minimum required density of 95.0%)
2) Moisture content of 15.8% does not fall within the optimum moisture range of 16.2% to 24.4%

Form TL-125A (Rev. 07/15)

CHAPTER 5 – ANSWERS TO STUDY QUESTIONS (CONT.)
PRACTICE PROBLEM #2

Route No. 635 **County** Amherst

Project No. 0635-005-187, C501 **Inspector**

FHWA No. FH-151(102)

Field Test No.		1	2	3
Date of Test				
Location of Test	Station Number – ft. (m)	87+50		
	Reference to Center Line – ft. (m)	10' Rt. C/L		
Reference Elevation	Original Ground – ft. (m)	+20 ft.		
	Finished Grade – ft. (m)	-23 ft.		
Type of Roller		Sheepsfoot		
A. Weight (mass) of mold and wet soil – lb. (kg)		13.56		
B. Weight (mass) of mold – lb. (kg)		9.51		
C. Weight (mass) of wet soil (A - B) – lb. (kg)		4.05		
D. Wet density of soil (Line C x 30 lb/ft^3) or (Line C x 1060 kg/m^3)		121.5		
E. "Speedy" Dial Reading		16.0		
F. Moisture Content (%) from Speedy Chart		19.1		
G. Maximum Dry Density – lb/ft^3 (kg/m^3)		102.4		
H. Optimum Moisture (%)		20.3		
I. Field Density – lb/ft^3 (kg/m^3) from TL-125				
J. No. 4 (+4.75 mm) material from field density hole				
K. Corrected Maximum Density – lb/ft^3 (kg/m^3)				
L. Compaction (%)				

Comments:

BY: _____

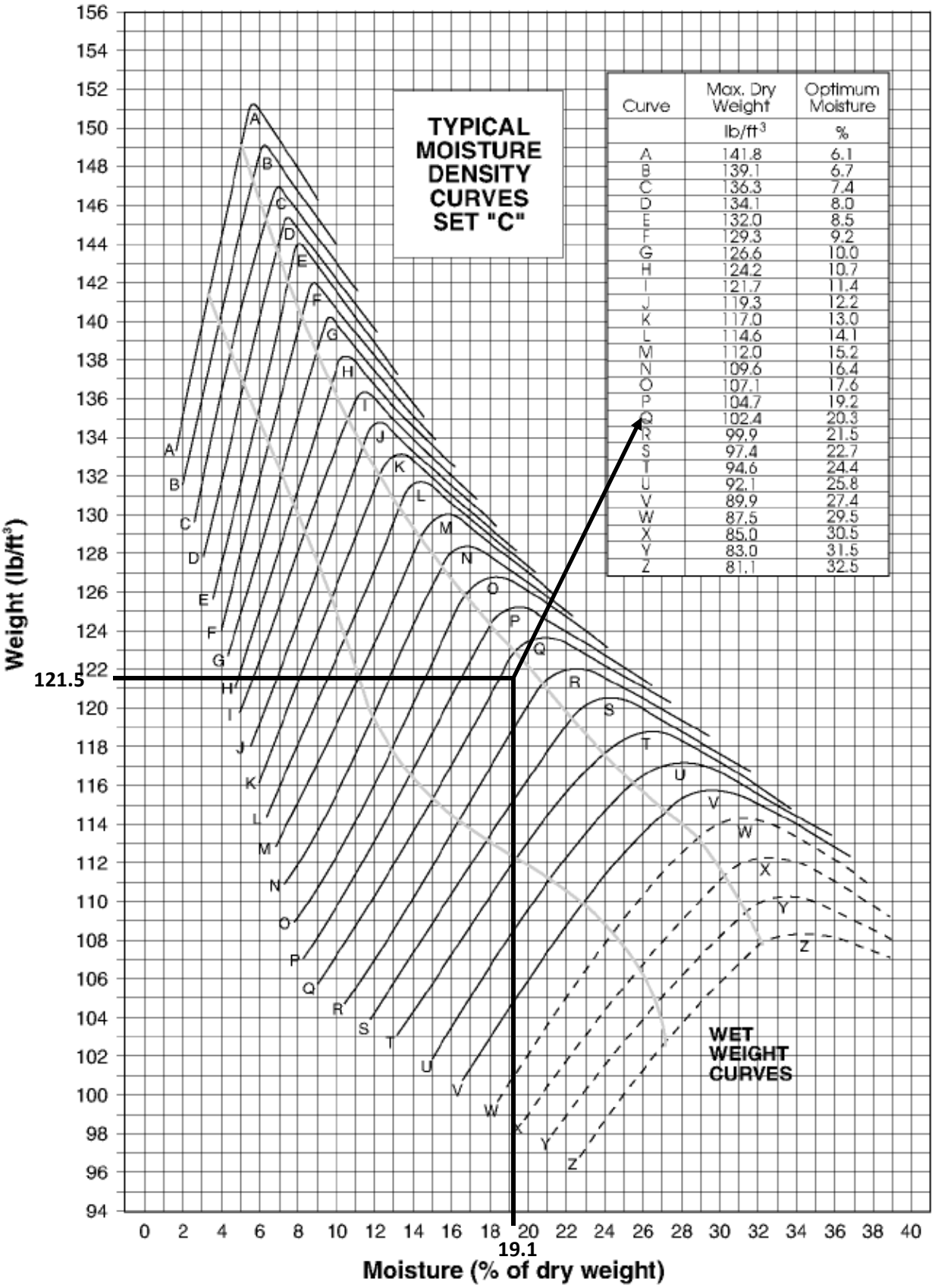
TITLE: _____

SPEEDY MOISTURE CHART

SPEEDY MOIST.		SPEEDY MOIST.		SPEEDY MOIST.		SPEEDY MOIST.		SPEEDY MOIST.		SPEEDY MOIST.		SPEEDY MOIST.	
READ.	CONT.	READ.	CONT.	READ.	CONT.	READ.	CONT.	READ.	CONT.	READ.	CONT.	READ.	CONT.
1.0	1.0	8.2	9.0	15.4	18.3	22.6	29.2	29.8	42.5	37.0	58.8	44.2	79.2
1.2	1.3	8.4	9.2	15.6	18.5	22.8	29.6	30.0	42.9	37.2	59.3	44.4	79.9
1.4	1.5	8.6	9.5	15.8	18.8	23.0				37.4	59.8	44.6	80.5
1.6	1.8	8.8	9.7	16.0	19.1	23.2				37.6	60.3	44.8	81.2
1.8	2.0	9.0	9.9	16.2	19.4	23.4				37.8	60.8	45.0	81.8
2.0	2.2	9.2	10.1	16.4	19.6	23.6	31.3	30.8	44.6	38.0	61.3	45.2	82.5
2.2	2.4	9.4	10.4	16.6	19.9	23.8	31.6	31.0	45.0	38.2	61.8	45.4	83.2
2.4	2.6	9.6	10.6	16.8	20.2	24.0	31.9	31.2	45.4	38.4	62.4	45.6	83.1
2.6	2.9	9.8	10.8	17.0	20.5	24.2	32.3	31.4	45.8	38.6	62.9	45.8	84.5
2.8	3.1	10.0	11.1	17.2	20.8	24.4	32.7	31.6	46.2	38.8	63.5	46.0	85.2
3.0	3.3	10.2	11.4	17.4	21.1	24.6	33.0	31.8	46.7	39.0	64.0	46.2	85.9
3.2	3.5	10.4	11.6	17.6	21.4	24.8	33.4	32.0	47.1	39.2	64.5	46.4	86.6
3.4	3.7	10.6	11.9	17.8	21.7	25.0	33.7	32.2	47.5	39.4	65.0	46.6	87.3
3.6	4.0	10.8	12.1	18.0	22.0	25.2	34.1	32.4	48.0	39.6	65.6	46.8	88.0
3.8	4.2	11.0	12.4	18.2	22.3	25.4	34.5	32.6	48.4	39.8	66.1	47.0	88.7
4.0	4.4	11.2	12.7	18.4	22.6	25.6	34.9	32.8	48.8	40.0	66.7	47.2	89.4
4.2	4.6	11.4	12.9	18.6	23.0	25.8	35.4	33.0	49.3	40.2	67.2	47.4	90.2
4.4	4.8	11.6	13.2	18.8	23.2	26.0	35.7	33.2	49.7	40.4	67.8	47.6	90.8
4.6	5.1	11.8	13.4	19.0	23.5	26.2	35.9	33.4	50.2	40.6	68.4	47.8	91.6
4.8	5.3	12.0	13.7	19.2	23.8	26.4	36.3	33.6	50.6	40.8	68.9	48.0	92.3
5.0	5.5	12.2	13.9	19.4	24.1	26.6	36.6	33.8	51.1	41.0	69.5	48.2	93.1
5.2	5.7	12.4	14.2	19.6	24.4	26.8	37.0	34.0	51.6	41.2	70.1	48.4	93.8
5.4	5.9	12.6	14.4	19.8	24.8	27.0	37.4	34.2	52.0	41.4	70.7	48.6	94.6
5.6	6.2	12.8	14.7	20.0	25.1	27.2	37.8	34.4	52.5	41.6	71.3	48.8	95.3
5.8	6.4	13.0	15.0	20.2	25.4	27.4	38.2	34.6	52.9	41.8	71.9	49.0	96.1
6.0	6.6	13.2	15.3	20.4	25.7	27.6	38.5	34.8	53.4	42.0	72.5	49.2	96.9
6.2	6.8	13.4	15.5	20.6	26.0	27.8	38.9	35.0	53.9	42.2	73.0	49.4	97.6
6.4	7.0	13.6	15.8	20.8	26.3	28.0	39.3	35.2	54.4	42.4	73.6	49.6	98.4
6.6	7.3	13.8	16.1	21.0	26.6	28.2	39.7	35.4	54.8	42.6	74.2	49.8	99.2
6.8	7.5	14.0	16.4	21.2	26.9	28.4	40.1	35.6	55.3	42.8	74.8	50.0	----
7.0	7.7	14.2	16.6	21.4	27.3	28.6	40.5	35.8	55.8	43.0	75.5		
7.2	7.9	14.4	16.9	21.6	27.6	28.8	40.9	36.0	56.3	43.2	76.1		
7.4	8.1	14.6	17.1	21.8	28.0	29.0	41.3	36.2	56.8	43.4	76.7		
7.6	8.4	14.8	17.4	22.0	28.3	29.2	41.5	36.4	57.2	43.6	77.3		
7.8	8.6	15.0	17.7	22.2	28.6	29.4	41.7	36.6	57.5	43.8	78.0		
8.0	8.8	15.2	18.0	22.4	28.9	29.6	42.1	36.8	58.3	44.0	78.6		

Speedy Reading for Proctor

Dial Reading = 16.0
Moisture Content = 19.1%



Curve	Max. Dry Weight	Optimum Moisture
	lb/ft³	%
A	141.8	6.1
B	139.1	6.7
C	136.3	7.4
D	134.1	8.0
E	132.0	8.5
F	129.3	9.2
G	126.6	10.0
H	124.2	10.7
I	121.7	11.4
J	119.3	12.2
K	117.0	13.0
L	114.6	14.1
M	112.0	15.2
N	109.6	16.4
O	107.1	17.6
P	104.7	19.2
Q	102.4	20.3
R	99.9	21.5
S	97.4	22.7
T	94.6	24.4
U	92.1	25.8
V	89.9	27.4
W	87.5	29.5
X	85.0	30.5
Y	83.0	31.5
Z	81.1	32.5

CHAPTER 5 – ANSWERS TO STUDY QUESTIONS (CONT.)

Chapter 5 – Practice Problem Number 3
Establishing Target Densities (One-Point Proctor)

A. Complete the one-point proctor form (Form TL-125A) on soil using the information provided.

Date: Today's Date
Compacted Depth of Lift: 6"

Weight of Mold + Weight of Soil = 8.43 lbs.
Weight of Mold = 4.40 lbs.
Speedy Dial Reading = 14.0

B. Answer the following questions.

a) What is the maximum dry density? 104.7 lb/ft^3

b) What is the optimum moisture and optimum moisture range? 19.2% (Range = 15.4% to 23.0%)

19.2 x 0.20 = 3.84
19.2 – 3.84 = 15.4
19.2 + 3.84 = 23.0

Form TL-125A (Rev. 07/15)

CHAPTER 5 – ANSWERS TO STUDY QUESTIONS (CONT.)
PRACTICE PROBLEM #3

Route No. 615 **County** Campbell

Project No. 0615-015-186, C501 **Inspector**

FHWA No. FH-132(104)

Field Test No.		1	2	3
Date of Test				
Location of Test	Station Number – ft. (m)	87+40		
	Reference to Center Line – ft. (m)	10' Rt. C/L		
Reference Elevation	Original Ground – ft. (m)	+13 ft.		
	Finished Grade – ft. (m)	-7 ft.		
Type of Roller		Sheepsfoot		
A. Weight (mass) of mold and wet soil – lb. (kg)		8.43		
B. Weight (mass) of mold – lb. (kg)		4.40		
C. Weight (mass) of wet soil (A - B) – lb. (kg)		4.03		
D. Wet density of soil (Line C x 30 lb/ft^3) or (Line C x 1060 kg/m^3)		120.9		
E. "Speedy" Dial Reading		14.0		
F. Moisture Content (%) from Speedy Chart		16.4		
G. Maximum Dry Density – lb/ft^3 (kg/m^3)		104.7		
H. Optimum Moisture (%)		19.2		
I. Field Density – lb/ft^3 (kg/m^3) from TL-125				
J. No. 4 (+4.75 mm) material from field density hole				
K. Corrected Maximum Density – lb/ft^3 (kg/m^3)				
L. Compaction (%)				

Comments:

BY: _____

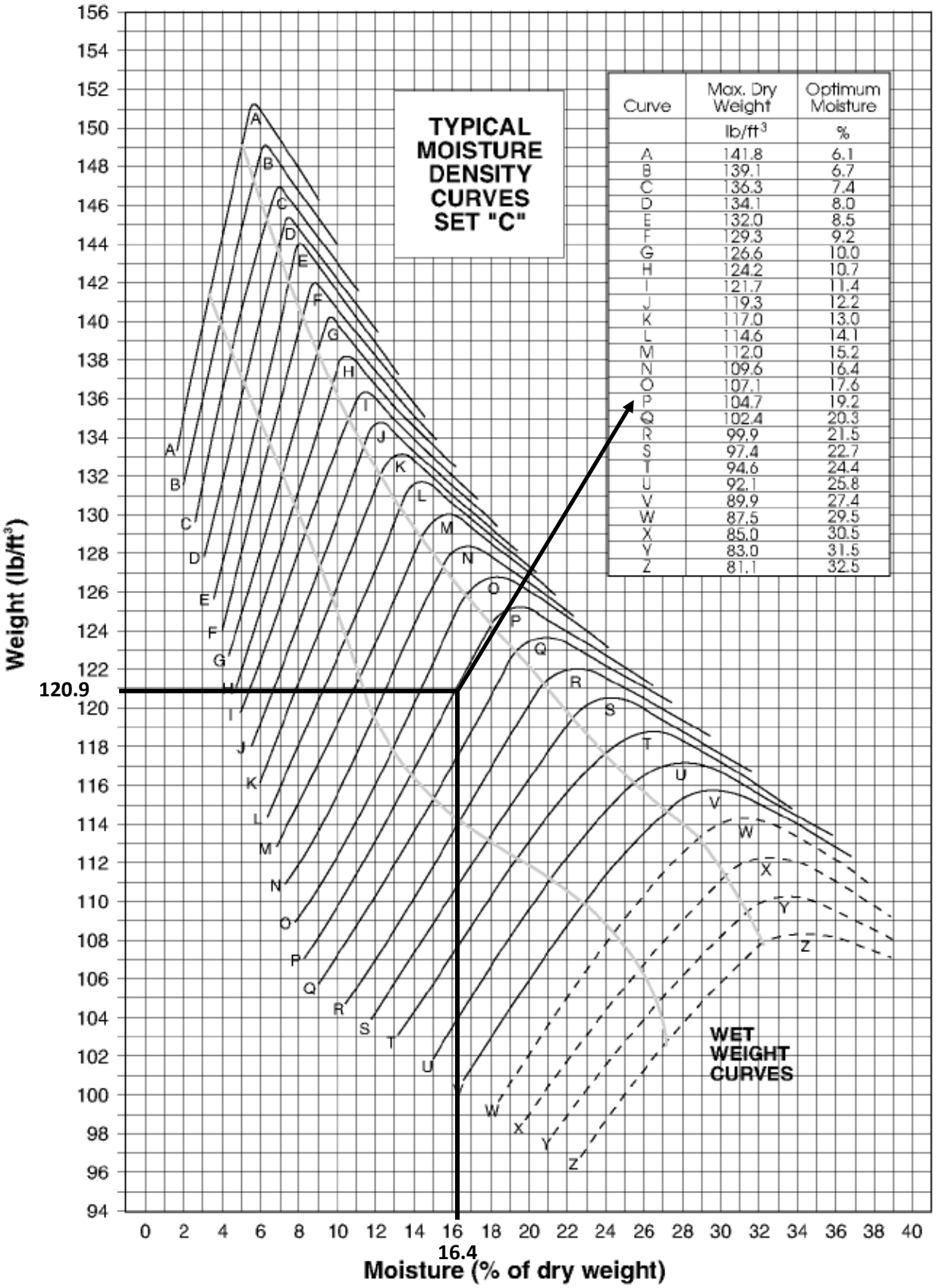
TITLE: _____

SPEEDY MOISTURE CHART

SPEEDY MOIST.		SPEEDY MOIST.		SPEEDY MOIST.		SPEEDY MOIST.		SPEEDY MOIST.		SPEEDY MOIST.		SPEEDY MOIST.	
READ.	CONT.	READ.	CONT.	READ.	CONT.	READ.	CONT.	READ.	CONT.	READ.	CONT.	READ.	CONT.
1.0	1.0	8.2	9.0	15.4	18.3	22.6	29.2	29.8	42.5	37.0	58.8	44.2	79.2
1.2	1.3	8.4	9.2	15.6	18.5	22.8	29.6	30.0	42.9	37.2	59.3	44.4	79.9
1.4	1.5	8.6	9.5	15.8	18.8	23.0	30.2	30.2	43.3	37.4	59.8	44.6	80.5
1.6	1.8	8.8	9.7	16.0	19.1	23.2	30.6	30.4	43.8	37.6	60.3	44.8	81.2
1.8	2.0	9.0	9.9	16.2	19.4	23.4	30.9	30.6	44.2	37.8	60.8	45.0	81.8
2.0	2.2	9.2	10.1	16.4	19.6	23.6	31.3	30.8	44.6	38.0	61.3	45.2	82.5
2.2	2.4	9.4	10.4	16.6	19.9	23.8	31.6	31.0	45.0	38.2	61.8	45.4	83.2
2.4	2.6	9.6	10.6	16.8	20.2	24.0	31.9	31.2	45.4	38.4	62.4	45.6	83.1
2.6	2.9	9.8	10.8	17.0	20.5	24.2	32.3	31.4	45.8	38.6	62.9	45.8	84.5
2.8	3.1	10.0	11.1	17.2	20.8	24.4	32.7	31.6	46.2	38.8	63.5	46.0	85.2
3.0	3.3	10.2	11.4	17.4	21.1	24.6	33.0	31.8	46.7	39.0	64.0	46.2	85.9
3.2	3.5	10.4	11.6	17.6	21.4	24.8	33.4	32.0	47.1	39.2	64.5	46.4	86.6
3.4	3.7	10.6	11.9	17.8	21.7	25.0	33.7	32.2	47.5	39.4	65.0	46.6	87.3
3.6	4.0	10.8	12.1	18.0	22.0	25.2	34.1	32.4	48.0	39.6	65.6	46.8	88.0
3.8	4.2	11.0	12.4	18.2	22.3	25.4	34.5	32.6	48.4	39.8	66.1	47.0	88.7
4.0	4.4	11.2	12.7	18.4	22.6	25.6	34.9	32.8	48.8	40.0	66.7	47.2	89.4
4.2	4.6	11.4	12.9	18.6	23.0	25.8	35.4	33.0	49.3	40.2	67.2	47.4	90.2
4.4	4.8	11.6	13.2	18.8	23.2	26.0	35.7	33.2	49.7	40.4	67.8	47.6	90.8
4.6	5.1	11.8	13.4	19.0	23.5	26.2	35.9	33.4	50.2	40.6	68.4	47.8	91.6
4.8	5.3	12.0	13.7	19.2	23.8	26.4	36.3	33.6	50.6	40.8	68.9	48.0	92.3
5.0	5.5	12.2	13.9	19.4	24.1	26.6	36.6	33.8	51.1	41.0	69.5	48.2	93.1
5.2	5.7	12.4	14.2	19.6	24.4	26.8	37.0	34.0	51.6	41.2	70.1	48.4	93.8
5.4	5.9	12.6	14.4	19.8	24.8	27.0	37.4	34.2	52.0	41.4	70.7	48.6	94.6
5.6	6.2	12.8	14.7	20.0	25.1	27.2	37.8	34.4	52.5	41.6	71.3	48.8	95.3
5.8	6.4	13.0	15.0	20.2	25.4	27.4	38.2	34.6	52.9	41.8	71.9	49.0	96.1
6.0	6.6	13.2	15.3	20.4	25.7	27.6	38.5	34.8	53.4	42.0	72.5	49.2	96.9
6.2	6.8	13.4	15.5	20.6	26.0	27.8	38.9	35.0	53.9	42.2	73.0	49.4	97.6
6.4	7.0	13.6	15.8	20.8	26.3	28.0	39.3	35.2	54.4	42.4	73.6	49.6	98.4
6.6	7.3	13.8	16.1	21.0				35.4	54.8	42.6	74.2	49.8	99.2
6.8	7.5	14.0	16.4	21.2				35.6	55.3	42.8	74.8	50.0	----
7.0	7.7	14.2	16.6	21.4				35.8	55.8	43.0	75.5		
7.2	7.9	14.4	16.9	21.6	27.6	28.8	40.9	36.0	56.3	43.2	76.1		
7.4	8.1	14.6	17.1	21.8	28.0	29.0	41.3	36.2	56.8	43.4	76.7		
7.6	8.4	14.8	17.4	22.0	28.3	29.2	41.5	36.4	57.2	43.6	77.3		
7.8	8.6	15.0	17.7	22.2	28.6	29.4	41.7	36.6	57.5	43.8	78.0		
8.0	8.8	15.2	18.0	22.4	28.9	29.6	42.1	36.8	58.3	44.0	78.6		

Speedy Reading for Proctor

Dial Reading = 14.0
Moisture Content = 16.4%



Curve	Max. Dry Weight	Optimum Moisture
	lb/ft³	%
A	141.8	6.1
B	139.1	6.7
C	136.3	7.4
D	134.1	8.0
E	132.0	8.5
F	129.3	9.2
G	126.6	10.0
H	124.2	10.7
I	121.7	11.4
J	119.3	12.2
K	117.0	13.0
L	114.6	14.1
M	112.0	15.2
N	109.6	16.4
O	107.1	17.6
P	104.7	19.2
Q	102.4	20.3
R	99.9	21.5
S	97.4	22.7
T	94.6	24.4
U	92.1	25.8
V	89.9	27.4
W	87.5	29.5
X	85.0	30.5
Y	83.0	31.5
Z	81.1	32.5

CHAPTER 5 – ANSWERS TO STUDY QUESTIONS (CONT.)

Chapter 5 – Practice Problem Number 4
Establishing Target Densities (One-Point Proctor)

A. Complete the one-point proctor form (Form TL-125A) on soil using the information provided.

Date: Today's Date
Compacted Depth of Lift: 6"

Weight of Mold + Weight of Soil = 13.56 lbs.
Weight of Mold = 9.51 lbs.
Speedy Dial Reading = 16.2

B. Answer the following questions.

a) What is the maximum dry density? 102.4 lb/ft^3

b) What is the optimum moisture and optimum moisture range? 20.3% (Range = 16.2% to 24.4%)

20.3 x 0.20 = 4.06
20.3 – 4.06 = 16.2
20.3 + 4.06 = 24.4

Form TL-125A (Rev. 07/15)

CHAPTER 5 – ANSWERS TO STUDY QUESTIONS (CONT.)
PRACTICE PROBLEM #4

Route No. 632 **County** Amherst

Project No. 0632-005-184, C501 **Inspector**

FHWA No. FH-130(101)

Field Test No.		7		
Date of Test				
Location of Test	Station Number – ft. (m)	120+40		
	Reference to Center Line – ft. (m)	13' Rt. C/L		
Reference Elevation	Original Ground – ft. (m)	+16 ft.		
	Finished Grade – ft. (m)	-7 ft.		
Type of Roller		Sheepsfoot		
A. Weight (mass) of mold and wet soil – lb. (kg)		13.56		
B. Weight (mass) of mold – lb. (kg)		9.51		
C. Weight (mass) of wet soil (A - B) – lb. (kg)		4.05		
D. Wet density of soil (Line C x 30 lb/ft^3) or (Line C x 1060 kg/m^3)		121.5		
E. "Speedy" Dial Reading		16.2		
F. Moisture Content (%) from Speedy Chart		19.4		
G. Maximum Dry Density – lb/ft^3 (kg/m^3)		102.4		
H. Optimum Moisture (%)		20.3		
I. Field Density – lb/ft^3 (kg/m^3) from TL-125				
J. No. 4 (+4.75 mm) material from field density hole				
K. Corrected Maximum Density – lb/ft^3 (kg/m^3)				
L. Compaction (%)				

Comments:

BY: _____

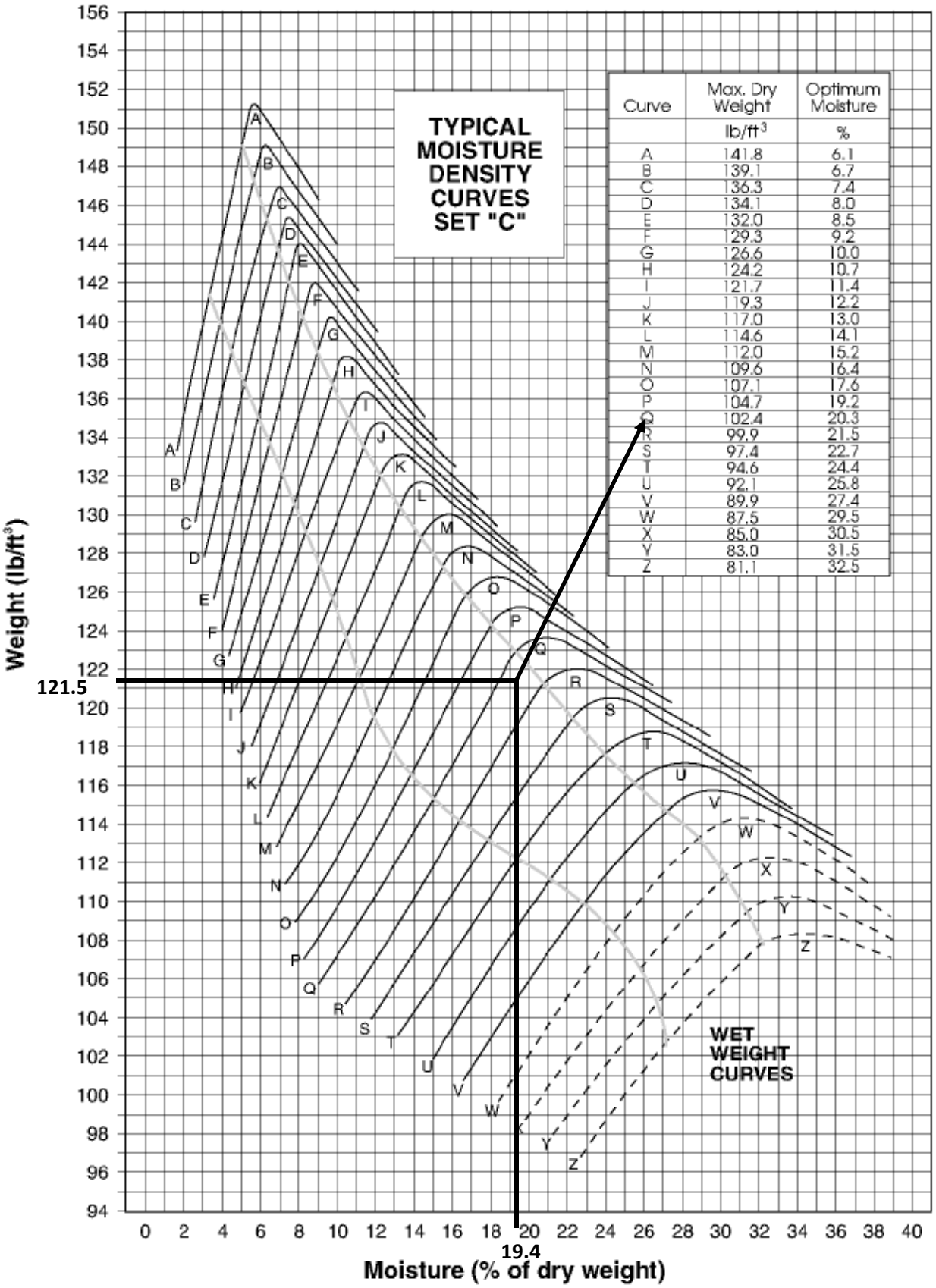
TITLE: _____

SPEEDY MOISTURE CHART

SPEEDY MOIST.		SPEEDY MOIST.		SPEEDY MOIST.		SPEEDY MOIST.		SPEEDY MOIST.		SPEEDY MOIST.		SPEEDY MOIST.	
READ.	CONT.	READ.	CONT.	READ.	CONT.	READ.	CONT.	READ.	CONT.	READ.	CONT.	READ.	CONT.
1.0	1.0	8.2	9.0	15.4	18.3	22.6	29.2	29.8	42.5	37.0	58.8	44.2	79.2
1.2	1.3	8.4	9.2	15.6	18.5	22.8	29.6	30.0	42.9	37.2	59.3	44.4	79.9
1.4	1.5	8.6	9.5	15.8	18.8	23.0	30.2	30.2	43.3	37.4	59.8	44.6	80.5
1.6	1.8	8.8	9.7	16.0	19.1	23.2				37.6	60.3	44.8	81.2
1.8	2.0	9.0	9.9	16.2	19.4	23.4				37.8	60.8	45.0	81.8
2.0	2.2	9.2	10.1	16.4	19.6	23.6				38.0	61.3	45.2	82.5
2.2	2.4	9.4	10.4	16.6	19.9	23.8	31.6	31.0	45.0	38.2	61.8	45.4	83.2
2.4	2.6	9.6	10.6	16.8	20.2	24.0	31.9	31.2	45.4	38.4	62.4	45.6	83.1
2.6	2.9	9.8	10.8	17.0	20.5	24.2	32.3	31.4	45.8	38.6	62.9	45.8	84.5
2.8	3.1	10.0	11.1	17.2	20.8	24.4	32.7	31.6	46.2	38.8	63.5	46.0	85.2
3.0	3.3	10.2	11.4	17.4	21.1	24.6	33.0	31.8	46.7	39.0	64.0	46.2	85.9
3.2	3.5	10.4	11.6	17.6	21.4	24.8	33.4	32.0	47.1	39.2	64.5	46.4	86.6
3.4	3.7	10.6	11.9	17.8	21.7	25.0	33.7	32.2	47.5	39.4	65.0	46.6	87.3
3.6	4.0	10.8	12.1	18.0	22.0	25.2	34.1	32.4	48.0	39.6	65.6	46.8	88.0
3.8	4.2	11.0	12.4	18.2	22.3	25.4	34.5	32.6	48.4	39.8	66.1	47.0	88.7
4.0	4.4	11.2	12.7	18.4	22.6	25.6	34.9	32.8	48.8	40.0	66.7	47.2	89.4
4.2	4.6	11.4	12.9	18.6	23.0	25.8	35.4	33.0	49.3	40.2	67.2	47.4	90.2
4.4	4.8	11.6	13.2	18.8	23.2	26.0	35.7	33.2	49.7	40.4	67.8	47.6	90.8
4.6	5.1	11.8	13.4	19.0	23.5	26.2	35.9	33.4	50.2	40.6	68.4	47.8	91.6
4.8	5.3	12.0	13.7	19.2	23.8	26.4	36.3	33.6	50.6	40.8	68.9	48.0	92.3
5.0	5.5	12.2	13.9	19.4	24.1	26.6	36.6	33.8	51.1	41.0	69.5	48.2	93.1
5.2	5.7	12.4	14.2	19.6	24.4	26.8	37.0	34.0	51.6	41.2	70.1	48.4	93.8
5.4	5.9	12.6	14.4	19.8	24.8	27.0	37.4	34.2	52.0	41.4	70.7	48.6	94.6
5.6	6.2	12.8	14.7	20.0	25.1	27.2	37.8	34.4	52.5	41.6	71.3	48.8	95.3
5.8	6.4	13.0	15.0	20.2	25.4	27.4	38.2	34.6	52.9	41.8	71.9	49.0	96.1
6.0	6.6	13.2	15.3	20.4	25.7	27.6	38.5	34.8	53.4	42.0	72.5	49.2	96.9
6.2	6.8	13.4	15.5	20.6	26.0	27.8	38.9	35.0	53.9	42.2	73.0	49.4	97.6
6.4	7.0	13.6	15.8	20.8	26.3	28.0	39.3	35.2	54.4	42.4	73.6	49.6	98.4
6.6	7.3	13.8	16.1	21.0	26.6	28.2	39.7	35.4	54.8	42.6	74.2	49.8	99.2
6.8	7.5	14.0	16.4	21.2	26.9	28.4	40.1	35.6	55.3	42.8	74.8	50.0	----
7.0	7.7	14.2	16.6	21.4	27.3	28.6	40.5	35.8	55.8	43.0	75.5		
7.2	7.9	14.4	16.9	21.6	27.6	28.8	40.9	36.0	56.3	43.2	76.1		
7.4	8.1	14.6	17.1	21.8	28.0	29.0	41.3	36.2	56.8	43.4	76.7		
7.6	8.4	14.8	17.4	22.0	28.3	29.2	41.5	36.4	57.2	43.6	77.3		
7.8	8.6	15.0	17.7	22.2	28.6	29.4	41.7	36.6	57.5	43.8	78.0		
8.0	8.8	15.2	18.0	22.4	28.9	29.6	42.1	36.8	58.3	44.0	78.6		

Speedy Reading for Proctor

Dial Reading = 16.2
Moisture Content = 19.4%


TYPICAL MOISTURE DENSITY CURVES SET "C"
Curve | Max. Dry Weight lb/ft³ | Optimum Moisture %
A 141.8 6.1
B 139.1 6.7
C 136.3 7.4
D 134.1 8.0
E 132.0 8.5
F 129.3 9.2
G 126.6 10.0
H 124.2 10.7
I 121.7 11.4
J 119.3 12.2
K 117.0 13.0
L 114.6 14.1
M 112.0 15.2
N 109.6 16.4
O 107.1 17.6
P 104.7 19.2
Q 102.4 20.3
R 99.9 21.5
S 97.4 22.7
T 94.6 24.4
U 92.1 25.8
V 89.9 27.4
W 87.5 29.5
X 85.0 30.5
Y 83.0 31.5
Z 81.1 32.5
WET WEIGHT CURVES
Weight (lb/ft³)
121.5
19.4
Moisture (% of dry weight)

CHAPTER 6 – ANSWERS TO STUDY QUESTIONS

1) Batteries should be charged when the battery indicator light comes on.

2) True or False. The nuclear gauge should be warmed-up first thing in the morning before using it. True.

3) True or False. The only maintenance performed in the field is cleaning the nuclear gauge and charging the batteries. True.

4) When taking a standard count, the nuclear gauge should be a minimum of 10 ft. from any structure and 33 ft. from any other radioactive source.

5) True or False. Cesium-137 is located in the tip of the stainless steel rod which is used in taking moisture determinations and Americium-241:Beryllium is located inside the nuclear gauge and is used for density testing. False – Cesium-137 is located in the tip of the stainless steel rod and is used for density determinations and the Americium-241:Beryllium is located inside the gauge and is used for moisture determinations.

6) When taking Standard Counts the Reference Standard should be placed on what type of surface? Smooth, flat, and dry surface with a minimum density of 100 lb/ft^3.

7) Three ways to limit exposure to radiation are time, distance, and shielding.

8) If the soil material fails a nuclear test because of excessive moisture, the first step taken is to run another test, while checking test methods to ensure they are correct.

9) A testing method for testing densities whereby the source rod is inserted into the material to be tested at a depth of 4, 6, or 8 inches is direct transmission method.

10) If, during construction, the density results either change suddenly, or simply don't make sense, you should check your math and the test itself, including test procedures to ensure that the test was run properly.

11) If the moisture results from the nuclear test appear high, the "Speedy" Moisture Test could be used to check the moisture.

12) When a nuclear gauge is operated within 24" of a vertical structure, the moisture and density readings are influenced by the structure.

Form TL-124 (Rev. 07/15)

CHAPTER 6 – ANSWERS TO STUDY QUESTIONS (CONT.)

REPORT ON NUCLEAR EMBANKMENT DENSITIES (UNIT MASSES)

Report No.	45	**Date**	06/22/2015	**Sheet No.**	1	**of**	1
Route No.	252	**County**	Augusta				
Project No.	0252-132-101, C501						
FHWA No.	None						
Testing for	Embankment						
Model No.	3440	**Serial No.**	23456	**Calibration Date**	02/10/2015		

STANDARD COUNT DATA

Density 2844 **Moisture** 701

Test No.			**1**	**2**	**3**	**4**
Location	Station ft. (m)		305+00	305+60	306+20	
of	Ref. to center line ft. (m)		at. C/L	10′ Lt.	7′ Lt.	
Test	Elevation		+10 / -7	+3 / -10	+3 / -3	
Compaction Depth of Lift in. (mm)			6″	6″	6″	
Method of Compaction			Sheepsfoot	Sheepsfoot	Sheepsfoot	
A. Wet Density (lbs/ft^3), Wet Unit Mass (kg/m^3)		=	133.3	123.6	128.2	
B. Moisture Unit Mass (lbs/ft^3 or kg/m^3)		=	19.1	17.9	18.6	
C. Dry Density (lbs/ft^3), Dry Unit Mass (kg/m^3) (A-B)		=	114.2	105.7	109.6	
D. Moisture Content (B ÷ C) x 100		=	16.7	16.9	17.0	
E. Maximum Dry Density (lbs/ft^3), Dry Unit Mass (kg/m^3) Lab Proctor or One Point Proctor		=	114.6	106.9	112.1	
F. Percent Optimum Moisture from Lab or One Point Proctor		=	14.1 11.3 – 16.9	17.6 14.1 – 21.1	15.2 12.2 – 18.2	
G. Percent of Plus #4, (plus 4.75 mm)		=				
H. Corrected Max. Dry Density (lbs/ft^3), Dry Unit Mass (kg/m^3)		=				
I. Corrected Optimum Moisture		=				
J. Percent Dry Density (lbs/ft^3), Dry Unit Mass (kg/m^3) (C ÷ E) x 100 or (C ÷ H) x 100		=	99.7	98.9	97.8	
K. Percent Minimum Density Required		=	95.0	95.0	95.0	

Comments: All density test results are above the minimum 95% requirement, and all moisture test results are within the acceptable optimum moisture ranges

BY: _____

TITLE: _____

Form TL-124 (Rev. 07/15)

CHAPTER 6 – ANSWERS TO STUDY QUESTIONS (CONT.)

REPORT ON NUCLEAR EMBANKMENT DENSITIES (UNIT MASSES)

Report No.	1-17-1	**Date**	06/22/2015	**Sheet No.**	1	**of**	1
Route No.	17	**County**	Campbell				
Project No.	0017-015-104, C503						
FHWA No.	None						
Testing for	Embankment						
Model No.	3440	**Serial No.**	23456	**Calibration Date**	02/10/2015		

STANDARD COUNT DATA

Density 2830 **Moisture** 701

		1	2	3	4
Location	Station ft. (m)	85+00			
of	ter line ft. (m)	at. C/L			
Test	Elevation	+9 / -3			
Compaction Depth of		6”			
Method of Compaction		Sheepsfoot			
A. Wet Density	=	141.0	141.0		
B. Moisture Ur	=	~~23.1~~	13.5		
C. Dry Density	=	~~117.9~~	127.5		
D. Moisture Co	=	~~19.6~~	10.6		
E. Maximum D … (lbs/ft^3) Lab Proctor or One Point Proctor	=	132.4	132.4		
F. Percent Optimu … r	=	9.2 7.4 – 11.0	9.2 7.4 – 11.0		
G. Percent of Plus	=				
H. Corrected Max. Dry Density (lbs/ft^3), Dry Unit Mass (kg/m^3)	=				
I. Corrected Optimum Mo	=				
J. Percent Dry Density (lbs … (C ÷ E) x 100 or (C ÷ H) x	=	~~89.0~~	96.3		
K. Percent Minimum Dens	=	95.0	95.0		

Step 3 - Adjust Moisture Mass

MM = WD - DD

MM = 141.0 – 127.5

MM = 13.5 lbs/ft³

Step 2 – Adjust Dry Density

DD = WD ÷ (1 + M%)

DD = 141.0 ÷ (1 + 0.106)

DD = 127.5 lbs/ft³

Step 1 – Conduct a Speedy Moisture Test to correct Moisture Content

Step 4 – Correct Percent Density

%PR = (DD ÷ Max. DD) x 100

%PR = (127.5 ÷ 132.4) x 100

%PR = 96.3%

Comments:

BY: _____

TITLE: _____

Form TL-124 (Rev. 07/15)

CHAPTER 7 – ANSWERS TO STUDY QUESTIONS
PRACTICE PROBLEM #1

Report No.	1-117-1	**Date**	06/22/2015	**Sheet No.**	1	**of**	1
Route No.	117	**County**	Roanoke				
Project No.	0117-080-105, C501						
FHWA No.	None						
Testing for	Embankment						
Model No.	3440	**Serial No.**	23456	**Calibration Date**	02/10/2015		

STANDARD COUNT DATA

Density 2844 **Moisture** 701

Test No.			**1**	**2**	**3**	**4**
Location	Station ft. (m)		90+45			
of	Ref. to center line ft. (m)		6' Rt. C/L			
Test	Elevation		+8 / -6			
Compaction Depth of Lift in. (mm)			6"			
Method of Compaction			Sheepsfoot			
A. Wet Density (lbs/ft^3), Wet Unit Mass (kg/m^3)		=	127.4			
B. Moisture Unit Mass (lbs/ft^3 or kg/m^3)		=	12.6			
C. Dry Density (lbs/ft^3), Dry Unit Mass (kg/m^3) (A-B)		=	114.8			
D. Moisture Content (B ÷ C) x 100		=	11.0			
E. Maximum Dry Density (lbs/ft^3), Dry Unit Mass (kg/m^3) Lab Proctor or One Point Proctor		=	112.6			
F. Percent Optimum Moisture from Lab or One Point Proctor		=	14.5 11.6 – 17.4			
G. Percent of Plus #4, (plus 4.75 mm)		=	15.0			
H. Corrected Max. Dry Density (lbs/ft^3), Dry Unit Mass (kg/m^3)		=	118.1			
I. Corrected Optimum Moisture		=	12.8 10.2 – 15.4			
J. Percent Dry Density (lbs/ft^3), Dry Unit Mass (kg/m^3) (C ÷ E) x 100 or (C ÷ H) x 100		=	97.2			
K. Percent Minimum Density Required		=	95.0			

Comments: Moisture content of 11.0% falls within the optimum moisture range of 10.2% to 15.4%
Density achieved 97.2% and minimum density required is 95.0%

BY: _____

TITLE: _____

CALCULATION #1
Amount of +4 Material in Total Soil

	Weight of Dry Soil + Dish	9.29	lb.	Weight of +4 Material + Dish	3.63	lb.
-	Weight of Dish Only	2.62	lb.	Weight of Dish Only	2.62	lb.
	Total Weight of Dry Soil	6.67	lb.	Total Weight of +4 Material	1.01	lb.

$$\frac{\text{Total Weight of +4 Material}}{\text{Total Weight of Dry Soil}} = \frac{1.01}{6.67} = 0.151 \times 100 = 15\% \text{ (Enter on Line G)}$$

CALCULATION #2
Total Density of Soils with +4 Material

Needed Information:

P_c = Percent of +4 material expressed as a decimal = 0.15 (Taken from Sieve Analysis)

D_c = 2.63 Sp. Gr. of +4 Material x 62.4 lbs/ft^3 = 164.1 lbs/ft^3

P_f = Percent of -4 material expressed as a decimal = 0.85 (Taken from Sieve Analysis)

D_f = Maximum Dry Density of the -4 material = 112.6 (Taken from Proctor)

$$\frac{D_f \times D_c}{(P_c \times D_f) + (P_f \times D_c)} = \underset{\text{Step 1}}{\frac{112.6 \times 164.1}{(0.15 \times 112.6) + (0.85 \times 164.1)}} = \underset{\text{Step 2}}{\frac{18477.7}{(16.9) + (139.5)}} = \underset{\text{Step 3}}{\frac{18477.7}{156.4}} = 118.1$$

Maximum Dry Density of Total Soil = 118.1 lb/ft^3 (Enter on Line H)

CALCULATION #3
Optimum Moisture Content of Soils with +4 Material

Needed Information:

P_c = Percent of +4 material expressed as a decimal = 0.15 (Taken from Sieve Analysis)

W_c =Absorption of the +4 Material expressed as a decimal = 0.03 (Taken from Material Division)

P_f = Percent of -4 material expressed as a decimal = 0.85 (Taken from Sieve Analysis)

W_f = Optimum Moisture of the -4 material expressed as a decimal = 0.145 (Taken from Proctor)

$$(P_cW_c + P_fW_f) \times 100 = \underset{\text{Step 1}}{[(0.15 \times 0.03) + (0.85 \times 0.145)] \times 100} = \underset{\text{Step 2}}{[(0.005) + (0.123)] \times 100} = \underset{\text{Step 3}}{(0.128) \times 100} = 12.8$$

Optimum Moisture Content of Total Soil = 12.8% (Enter on Line I)

Form TL-124 (Rev. 07/15)

CHAPTER 7 – ANSWERS TO STUDY QUESTIONS (CONT.)
PRACTICE PROBLEM #2

Report No.	1-117-1	**Date**	06/22/2015	**Sheet No.**	1	**of**	1
Route No.	117	**County**	Roanoke				
Project No.	0117-080-105, C501						
FHWA No.	None						
Testing for	Embankment						
Model No.	3440	**Serial No.**	23456	**Calibration Date**	02/10/2015		

STANDARD COUNT DATA

Density 2844 **Moisture** 701

Test No.			**1**	**2**	**3**	**4**
Location	Station ft. (m)		90+45			
of	Ref. to center line ft. (m)		6' Rt. C/L			
Test	Elevation		+8 / -6			
Compaction Depth of Lift in. (mm)			6"			
Method of Compaction			Sheepsfoot			
A. Wet Density (lbs/ft^3), Wet Unit Mass (kg/m^3)		=	127.9			
B. Moisture Unit Mass (lbs/ft^3 or kg/m^3)		=	12.2			
C. Dry Density (lbs/ft^3), Dry Unit Mass (kg/m^3) (A-B)		=	115.7			
D. Moisture Content (B ÷ C) x 100		=	10.5			
E. Maximum Dry Density (lbs/ft^3), Dry Unit Mass (kg/m^3) Lab Proctor or One Point Proctor		=	110.5			
F. Percent Optimum Moisture from Lab or One Point Proctor		=	14.3 11.4 – 17.2			
G. Percent of Plus #4, (plus 4.75 mm)		=	15.0			
H. Corrected Max. Dry Density (lbs/ft^3), Dry Unit Mass (kg/m^3)		=	116.5			
I. Corrected Optimum Moisture		=	12.5 10.0 – 15.0			
J. Percent Dry Density (lbs/ft^3), Dry Unit Mass (kg/m^3) (C ÷ E) x 100 or (C ÷ H) x 100		=	99.3			
K. Percent Minimum Density Required		=	95.0			

Comments: Moisture content of 10.5% falls within the optimum moisture range of 10.0% to 15.0%
Density achieved 99.3% and minimum density required is 95.0%

BY: _____

TITLE: _____

CALCULATION #1
Amount of +4 Material in Total Soil

	Weight of Dry Soil + Dish	9.30	lb.	Weight of +4 Material + Dish	3.65	lb.
-	Weight of Dish Only	2.62	lb.	Weight of Dish Only	2.62	lb.
	Total Weight of Dry Soil	6.68	lb.	Total Weight of +4 Material	1.03	lb.

$$\frac{\text{Total Weight of +4 Material}}{\text{Total Weight of Dry Soil}} = \frac{1.03}{6.68} = 0.154 \times 100 = 15\% \text{ (Enter on Line G)}$$

CALCULATION #2
Total Density of Soils with +4 Material

Needed Information:

P_c = Percent of +4 material expressed as a decimal = 0.15 (Taken from Sieve Analysis)

D_c = 2.70 Sp. Gr. of +4 Material x 62.4 lbs/ft^3 = 168.5 lbs/ft^3

P_f = Percent of -4 material expressed as a decimal = 0.85 (Taken from Sieve Analysis)

D_f = Maximum Dry Density of the -4 material = 110.5 (Taken from Proctor)

$$\frac{D_f \times D_c}{(P_c \times D_f) + (P_f \times D_c)} = \underset{\text{Step 1}}{\frac{110.5 \times 168.5}{(0.15 \times 110.5) + (0.85 \times 168.5)}} = \underset{\text{Step 2}}{\frac{18619.3}{(16.6) + (143.2)}} = \underset{\text{Step 3}}{\frac{18619.3}{159.8}} = 116.5$$

Maximum Dry Density of Total Soil = 116.5 lb/ft^3 (Enter on Line H)

CALCULATION #3
Optimum Moisture Content of Soils with +4 Material

Needed Information:

P_c = Percent of +4 material expressed as a decimal = 0.15 (Taken from Sieve Analysis)

W_c =Absorption of the +4 Material expressed as a decimal = 0.02 (Taken from Material Division)

P_f = Percent of -4 material expressed as a decimal = 0.85 (Taken from Sieve Analysis)

W_f = Optimum Moisture of the -4 material expressed as a decimal = 0.143 (Taken from Proctor)

$$(P_cW_c + P_fW_f) \times 100 = \underset{\text{Step 1}}{[(0.15 \times 0.02) + (0.85 \times 0.143)] \times 100} = \underset{\text{Step 2}}{[(0.003) + (0.122)] \times 100} = \underset{\text{Step 3}}{(0.125) \times 100} = 12.5$$

Optimum Moisture Content of Total Soil = 12.5% (Enter on Line I)

Form TL-124 (Rev. 07/15)

CHAPTER 7 – ANSWERS TO STUDY QUESTIONS (CONT.)
PRACTICE PROBLEM #3

Report No.	1-117-1	**Date**	06/22/2015	**Sheet No.**	1	**of**	1
Route No.	117	**County**	Roanoke				
Project No.	0117-080-105, C501						
FHWA No.	None						
Testing for	Embankment						
Model No.	3440	**Serial No.**	23456	**Calibration Date**	02/10/2015		

STANDARD COUNT DATA

Density 2844 **Moisture** 701

Test No.			**1**	**2**	**3**	**4**
Location	Station ft. (m)		90+45			
of	Ref. to center line ft. (m)		6' Rt. C/L			
Test	Elevation		+8 / -6			
Compaction Depth of Lift in. (mm)			6"			
Method of Compaction			Sheepsfoot			
A. Wet Density (lbs/ft^3), Wet Unit Mass (kg/m^3)		=	127.5			
B. Moisture Unit Mass (lbs/ft^3 or kg/m^3)		=	12.8			
C. Dry Density (lbs/ft^3), Dry Unit Mass (kg/m^3) (A-B)		=	114.7			
D. Moisture Content (B ÷ C) x 100		=	11.2			
E. Maximum Dry Density (lbs/ft^3), Dry Unit Mass (kg/m^3) Lab Proctor or One Point Proctor		=	109.9			
F. Percent Optimum Moisture from Lab or One Point Proctor		=	13.9 11.1 – 16.7			
G. Percent of Plus #4, (plus 4.75 mm)		=	13.0			
H. Corrected Max. Dry Density (lbs/ft^3), Dry Unit Mass (kg/m^3)		=	115.0			
I. Corrected Optimum Moisture		=	12.4 9.9 – 14.9			
J. Percent Dry Density (lbs/ft^3), Dry Unit Mass (kg/m^3) (C ÷ E) x 100 or (C ÷ H) x 100		=	99.7			
K. Percent Minimum Density Required		=	95.0			

Comments: Moisture content of 11.2% falls within the optimum moisture range of 9.9% to 14.9%
Density achieved 99.7% and minimum density required is 95.0%

BY: _____

TITLE: _____

CALCULATION #1
Amount of +4 Material in Total Soil

	Weight of Dry Soil + Dish	9.29	lb.	Weight of +4 Material + Dish	3.51	lb.
-	Weight of Dish Only	2.62	lb.	Weight of Dish Only	2.62	lb.
	Total Weight of Dry Soil	6.67	lb.	Total Weight of +4 Material	0.89	lb.

$$\frac{\text{Total Weight of +4 Material}}{\text{Total Weight of Dry Soil}} = \frac{0.89}{6.67} = 0.133 \times 100 = 13\% \text{ (Enter on Line G)}$$

CALCULATION #2
Total Density of Soils with +4 Material

Needed Information:

P_c = Percent of +4 material expressed as a decimal = 0.13 (Taken from Sieve Analysis)

D_c = 2.68 Sp. Gr. of +4 Material x 62.4 lbs/ft^3 = 167.2 lbs/ft^3

P_f = Percent of -4 material expressed as a decimal = 0.87 (Taken from Sieve Analysis)

D_f = Maximum Dry Density of the -4 material = 109.9 (Taken from Proctor)

$$\frac{D_f \times D_c}{(P_c \times D_f) + (P_f \times D_c)} = \underset{\text{Step 1}}{\frac{109.9 \times 167.2}{(0.13 \times 109.9) + (0.87 \times 167.2)}} = \underset{\text{Step 2}}{\frac{18375.3}{(14.3) + (145.5)}} = \underset{\text{Step 3}}{\frac{18375.3}{159.8}} = 115.0$$

Maximum Dry Density of Total Soil = 115.0 lb/ft^3 (Enter on Line H)

CALCULATION #3
Optimum Moisture Content of Soils with +4 Material

Needed Information:

P_c = Percent of +4 material expressed as a decimal = 0.13 (Taken from Sieve Analysis)

W_c =Absorption of the +4 Material expressed as a decimal = 0.02 (Taken from Material Division)

P_f = Percent of -4 material expressed as a decimal = 0.87 (Taken from Sieve Analysis)

W_f = Optimum Moisture of the -4 material expressed as a decimal = 0.139 (Taken from Proctor)

$$(P_cW_c + P_fW_f) \times 100 = \underset{\text{Step 1}}{[(0.13 \times 0.02) + (0.87 \times 0.139)] \times 100} = \underset{\text{Step 2}}{[(0.003) + (0.121)] \times 100} = \underset{\text{Step 3}}{(0.124) \times 100} = 12.4$$

Optimum Moisture Content of Total Soil = 12.4% (Enter on Line I)

Form TL-124 (Rev. 07/15)

CHAPTER 7 – ANSWERS TO STUDY QUESTIONS (CONT.)
PRACTICE PROBLEM #4

Report No.	1-21A-1	**Date**	06/22/2015	**Sheet No.**	1	**of**	1
Route No.	95	**County**	Fairfax				
Project No.	0095-029-F15, C502						
FHWA No.	None						
Testing for	Direct Transmission on Aggregate Base Type I (21A)						
Model No.	3440	**Serial No.**	23456	**Calibration Date**	02/10/2015		

STANDARD COUNT DATA

Density 2844 **Moisture** 701

Test No.			**1**	**2**	**3**	**4**
Location	Station ft. (m)		24+35			
of	Ref. to center line ft. (m)		5' Rt. C/L			
Test	Elevation					
Compaction Depth of Lift in. (mm)			6"			
Method of Compaction			Vibratory			
A. Wet Density (lbs/ft^3), Wet Unit Mass (kg/m^3)		=	140.0			
B. Moisture Unit Mass (lbs/ft^3 or kg/m^3)		=	6.9			
C. Dry Density (lbs/ft^3), Dry Unit Mass (kg/m^3) (A-B)		=	133.1			
D. Moisture Content (B ÷ C) x 100		=	5.2			
E. Maximum Dry Density (lbs/ft^3), Dry Unit Mass (kg/m^3) Lab Proctor or One Point Proctor		=	124.4			
F. Percent Optimum Moisture from Lab or One Point Proctor		=	7.4 5.4 – 9.4			
G. Percent of Plus #4, (plus 4.75 mm)		=	37.0			
H. Corrected Max. Dry Density (lbs/ft^3), Dry Unit Mass (kg/m^3)		=	138.2			
I. Corrected Optimum Moisture		=	5.2 3.2 – 7.2			
J. Percent Dry Density (lbs/ft^3), Dry Unit Mass (kg/m^3) (C ÷ E) x 100 or (C ÷ H) x 100		=	96.3			
K. Percent Minimum Density Required		=	95.0			

Comments: Moisture content of 5.2% falls within the optimum moisture range of 3.2% to 7.2%
Density achieved 96.3% and minimum density required is 95.0%

BY: _____

TITLE: _____

CALCULATION #1
Amount of +4 Material in Total Soil

	Weight of Dry Soil + Dish	5.41	lb.	Weight of +4 Material + Dish	3.01	lb.
-	Weight of Dish Only	1.61	lb.	Weight of Dish Only	1.61	lb.
	Total Weight of Dry Soil	3.80	lb.	Total Weight of +4 Material	1.40	lb.

$$\frac{\text{Total Weight of +4 Material}}{\text{Total Weight of Dry Soil}} = \frac{1.40}{3.80} = 0.368 \times 100 = 37\% \text{ (Enter on Line G)}$$

CALCULATION #2
Total Density of Soils with +4 Material

Needed Information:

P_c = Percent of +4 material expressed as a decimal = 0.37 (Taken from Sieve Analysis)

D_c = 2.73 Sp. Gr. of +4 Material x 62.4 lbs/ft^3 = 170.4 lbs/ft^3

P_f = Percent of -4 material expressed as a decimal = 0.63 (Taken from Sieve Analysis)

D_f = Maximum Dry Density of the -4 material = 124.4 (Taken from Proctor)

$$\frac{D_f \times D_c}{(P_c \times D_f) + (P_f \times D_c)} = \underset{\text{Step 1}}{\frac{124.4 \times 170.4}{(0.37 \times 124.4) + (0.63 \times 170.4)}} = \underset{\text{Step 2}}{\frac{21197.8}{(46.0) + (107.4)}} = \underset{\text{Step 3}}{\frac{21197.8}{153.4}} = 138.2$$

Maximum Dry Density of Total Soil = 138.2 lb/ft^3 (Enter on Line H)

CALCULATION #3
Optimum Moisture Content of Soils with +4 Material

Needed Information:

P_c = Percent of +4 material expressed as a decimal = 0.37 (Taken from Sieve Analysis)

W_c = Absorption of the +4 Material (+1) expressed as a decimal = 0.013 (Taken from Material Division)

P_f = Percent of -4 material expressed as a decimal = 0.63 (Taken from Sieve Analysis)

W_f = Optimum Moisture of the -4 material expressed as a decimal = 0.074 (Taken from Proctor)

$$(P_cW_c + P_fW_f) \times 100 = \underset{\text{Step 1}}{[(0.37 \times 0.013) + (0.63 \times 0.074)] \times 100} = \underset{\text{Step 2}}{[(0.005) + (0.047)] \times 100} = \underset{\text{Step 3}}{(0.052) \times 100} = 5.2$$

Optimum Moisture Content of Total Soil = 5.2% (Enter on Line I)

Form TL-124 (Rev. 07/15)

CHAPTER 7 – ANSWERS TO STUDY QUESTIONS (CONT.)
PRACTICE PROBLEM #5

Report No.	1-21A-1	**Date**	06/22/2015	**Sheet No.**	1	**of**	1
Route No.	7	**County**	Loudon				
Project No.	0007-053-121, C501						
FHWA No.	None						
Testing for	Direct Transmission on Aggregate Base Type I (21A)						
Model No.	3440	**Serial No.**	23456	**Calibration Date**	02/10/2015		

STANDARD COUNT DATA

Density 2864 **Moisture** 709

Test No.			**1**	**2**	**3**	**4**
Location	Station ft. (m)		901+25			
of	Ref. to center line ft. (m)		3' Lt. C/L			
Test	Elevation					
Compaction Depth of Lift in. (mm)			6"			
Method of Compaction			Vibratory			
A. Wet Density (lbs/ft^3), Wet Unit Mass (kg/m^3)		=	155.3			
B. Moisture Unit Mass (lbs/ft^3 or kg/m^3)		=	5.1			
C. Dry Density (lbs/ft^3), Dry Unit Mass (kg/m^3) (A-B)		=	150.2			
D. Moisture Content (B ÷ C) x 100		=	3.4			
E. Maximum Dry Density (lbs/ft^3), Dry Unit Mass (kg/m^3) Lab Proctor or One Point Proctor		=	134.6			
F. Percent Optimum Moisture from Lab or One Point Proctor		=	8.4 6.4 – 10.4			
G. Percent of Plus #4, (plus 4.75 mm)		=	60.0			
H. Corrected Max. Dry Density (lbs/ft^3), Dry Unit Mass (kg/m^3)		=	156.4			
I. Corrected Optimum Moisture		=	4.2 2.2 – 6.2			
J. Percent Dry Density (lbs/ft^3), Dry Unit Mass (kg/m^3) (C ÷ E) x 100 or (C ÷ H) x 100		=	96.0			
K. Percent Minimum Density Required		=	90.0			

Comments: Moisture content of 3.4% falls within the optimum moisture range of 2.2% to 6.2%
Density achieved 96.0% and minimum density required is 90.0%

BY: _____

TITLE: _____

CALCULATION #1
Amount of +4 Material in Total Soil

	Weight of Dry Soil + Dish	8.43	lb.	Weight of +4 Material + Dish	5.71	lb.
-	Weight of Dish Only	1.61	lb.	Weight of Dish Only	1.61	lb.
	Total Weight of Dry Soil	6.82	lb.	Total Weight of +4 Material	4.10	lb.

$$\frac{\text{Total Weight of +4 Material}}{\text{Total Weight of Dry Soil}} = \frac{4.10}{6.82} = 0.601 \times 100 = 60\% \text{ (Enter on Line G)}$$

CALCULATION #2
Total Density of Soils with +4 Material

Needed Information:

P_c = Percent of +4 material expressed as a decimal = 0.60 (Taken from Sieve Analysis)

D_c = 2.81 Sp. Gr. of +4 Material x 62.4 lbs/ft^3 = 175.3 lbs/ft^3

P_f = Percent of -4 material expressed as a decimal = 0.40 (Taken from Sieve Analysis)

D_f = Maximum Dry Density of the -4 material = 134.6 (Taken from Proctor)

$$\frac{D_f \times D_c}{(P_c \times D_f) + (P_f \times D_c)} = \underset{\text{Step 1}}{\frac{134.6 \times 175.3}{(0.60 \times 134.6) + (0.40 \times 175.3)}} = \underset{\text{Step 2}}{\frac{23595.4}{(80.8) + (70.1)}} = \underset{\text{Step 3}}{\frac{23595.4}{150.9}} = 156.4$$

Maximum Dry Density of Total Soil = 156.4 lb/ft^3 (Enter on Line H)

CALCULATION #3
Optimum Moisture Content of Soils with +4 Material

Needed Information:

P_c = Percent of +4 material expressed as a decimal = 0.60 (Taken from Sieve Analysis)

W_c = Absorption of the +4 Material (+1) expressed as a decimal = 0.013 (Taken from Material Division)

P_f = Percent of -4 material expressed as a decimal = 0.40 (Taken from Sieve Analysis)

W_f = Optimum Moisture of the -4 material expressed as a decimal = 0.084 (Taken from Proctor)

$$(P_cW_c + P_fW_f) \times 100 = \underset{\text{Step 1}}{[(0.60 \times 0.013) + (0.40 \times 0.084)] \times 100} = \underset{\text{Step 2}}{[(0.008) + (0.034)] \times 100} = \underset{\text{Step 3}}{(0.042) \times 100} = 4.2$$

Optimum Moisture Content of Total Soil = 4.2% (Enter on Line I)

Form TL-124 (Rev. 07/15)

CHAPTER 7 – ANSWERS TO STUDY QUESTIONS (CONT.)
PRACTICE PROBLEM #6

Report No.	1-21A-1	**Date**	06/22/2015	**Sheet No.**	1	**of**	1
Route No.	265	**County**	Pittsylvania				
Project No.	6265-071-102, G302						
FHWA No.	None						
Testing for	Direct Transmission on Aggregate Base Type I (21A)						
Model No.	3440	**Serial No.**	23456	**Calibration Date**	02/10/2015		

STANDARD COUNT DATA

Density 2844 **Moisture** 701

Test No.			**1**	**2**	**3**	**4**
Location	Station ft. (m)		609+10			
of	Ref. to center line ft. (m)		6' Rt. C/L			
Test	Elevation					
Compaction Depth of Lift in. (mm)			6"			
Method of Compaction			Vibratory			
A. Wet Density (lbs/ft^3), Wet Unit Mass (kg/m^3)		=	150.2			
B. Moisture Unit Mass (lbs/ft^3 or kg/m^3)		=	6.1			
C. Dry Density (lbs/ft^3), Dry Unit Mass (kg/m^3) (A-B)		=	144.1			
D. Moisture Content (B ÷ C) x 100		=	4.2			
E. Maximum Dry Density (lbs/ft^3), Dry Unit Mass (kg/m^3) Lab Proctor or One Point Proctor		=	132.1			
F. Percent Optimum Moisture from Lab or One Point Proctor		=	7.2 5.2 – 9.2			
G. Percent of Plus #4, (plus 4.75 mm)		=	46.0			
H. Corrected Max. Dry Density (lbs/ft^3), Dry Unit Mass (kg/m^3)		=	148.8			
I. Corrected Optimum Moisture		=	4.6 2.6 – 6.6			
J. Percent Dry Density (lbs/ft^3), Dry Unit Mass (kg/m^3) (C ÷ E) x 100 or (C ÷ H) x 100		=	96.8			
K. Percent Minimum Density Required		=	95.0			

Comments: Moisture content of 4.2% falls within the optimum moisture range of 2.6% to 6.6%
Density achieved 96.8% and minimum density required is 95.0%

BY: _____

TITLE: _____

CALCULATION #1
Amount of +4 Material in Total Soil

	Weight of Dry Soil + Dish	8.40	lb.	Weight of +4 Material + Dish	4.75	lb.
-	Weight of Dish Only	1.63	lb.	Weight of Dish Only	1.63	lb.
	Total Weight of Dry Soil	6.77	lb.	Total Weight of +4 Material	3.12	lb.

$$\frac{\text{Total Weight of +4 Material}}{\text{Total Weight of Dry Soil}} = \frac{3.12}{6.77} = 0.461 \times 100 = 46\% \text{ (Enter on Line G)}$$

CALCULATION #2
Total Density of Soils with +4 Material

Needed Information:

P_c = Percent of +4 material expressed as a decimal = 0.46 (Taken from Sieve Analysis)

D_c = 2.80 Sp. Gr. of +4 Material x 62.4 lbs/ft^3 = 174.7 lbs/ft^3

P_f = Percent of -4 material expressed as a decimal = 0.54 (Taken from Sieve Analysis)

D_f = Maximum Dry Density of the -4 material = 132.1 (Taken from Proctor)

$$\frac{D_f \times D_c}{(P_c \times D_f) + (P_f \times D_c)} = \underset{\text{Step 1}}{\frac{132.1 \times 174.7}{(0.46 \times 132.1) + (0.54 \times 174.7)}} = \underset{\text{Step 2}}{\frac{23077.9}{(60.8) + (94.3)}} = \underset{\text{Step 3}}{\frac{23077.9}{155.1}} = 148.8$$

Maximum Dry Density of Total Soil = 148.8 lb/ft^3 (Enter on Line H)

CALCULATION #3
Optimum Moisture Content of Soils with +4 Material

Needed Information:

P_c = Percent of +4 material expressed as a decimal = 0.46 (Taken from Sieve Analysis)

W_c = Absorption of the +4 Material (+1) expressed as a decimal = 0.016 (Taken from Material Division)

P_f = Percent of -4 material expressed as a decimal = 0.54 (Taken from Sieve Analysis)

W_f = Optimum Moisture of the -4 material expressed as a decimal = 0.072 (Taken from Proctor)

$$(P_cW_c + P_fW_f) \times 100 = \underset{\text{Step 1}}{[(0.46 \times 0.016) + (0.54 \times 0.072)] \times 100} = \underset{\text{Step 2}}{[(0.007) + (0.039)] \times 100} = \underset{\text{Step 3}}{(0.046) \times 100} = 4.6$$

Optimum Moisture Content of Total Soil = 4.6% (Enter on Line I)

CHAPTER 8 – ANSWERS TO STUDY QUESTIONS

1) True or False. Before a Roller Pattern can be set the subgrade must be approved, compaction equipment must be approved and material to be tested must be placed at uniform depth. True.

2) Roller pattern compares compactive effort vs. density.

3) When must a new Roller Pattern be set up?
   - Multiple lifts of material
   - Change in source of material
   - Change in compaction equipment
   - Visual change in the subsurface or subgrade
   - Change in the gradation or type of material

4) Backscatter method is the testing method in which the gauge is placed on the surface of the material to be tested and the source rod is lowered to the first notch.

5) When taking a nuclear reading near an unsupported edge, 18 inches is the minimum distance from the edge that an accurate nuclear reading can be taken.

6) A direct transmission test is taken at the end of the control strip to verify the results.

7) The control strip dry density must be within 3.0 lb/ft^3 of the roller pattern peak density.

8) A roller pattern on aggregate covers 75 feet, a control strip covers 300 feet and a test section covers half a mile per paver width.

9) The Contractor has applied the dense graded aggregate layer to the right lane of a two-lane roadway beginning at Station 25 + 25. Using the numbers from the Random Number Table given below, calculate and determine the test location for each density and moisture reading for this test section, which is 12 feet wide. Remember not to test any closer than 18 inches to an unsupported edge.

Distance from Start of Sublot	Distance from Reference Line
181	3
252	3
96	2
43	6
71	4

There are 5,280 feet in a mile. A Test Section is 0.5 mile per paver width or 2640 feet. Five (5) tests will be performed in the test section. 2640 ÷ 5 = 528 feet.

Sublot 1 ___528____ Feet	Beginning Station No. 25+25
Sublot 2 ___528____ Feet	Station No. 30+53
Sublot 3 ___528____ Feet	Station No. 35+81
Sublot 4 ___528____ Feet	Station No. 41+09
Sublot 5 ___528____ Feet	Station No. 46+37
	Ending Station No. 51+65

Test No.	Station No. at Start of Each Sublot	+	Distance from Start of Sublot	=	Station No. of Each Test Location	Distance from Reference Line (ft)
1	25+25	+	181	=	27+06	3
2	30+53	+	252	=	33+05	3
3	35+81	+	96	=	36+77	2
4	41+09	+	43	=	41+52	6
5	46+37	+	71	=	47+08	4

CHAPTER 8 – ANSWERS TO STUDY QUESTIONS (CONT.)

NOTE: Each Practice Problem contains 4 Parts

Chapter 8 – Practice Problem Number 1
Nuclear Density Testing of Aggregates
Step 1 – Roller Pattern

A. Given the following information, complete the following worksheet (Form TL-53)

B. How many passes should be made for Test 5? Why?

Two more passes should be made for Test 5 for a total of 10V passes because the increase in density was greater than 1 lb/ft^3 between Test 3 and Test 4

How many passes should be made for Test 6? Why?

One more pass should be made for Test 6 for a total of 11 passes (10V, 1S) because the increase in density was less than 1 lb/ft^3 between Test 4 and Test 5

C. Should this be considered an acceptable Roller Pattern? Why?

Yes, the density curve drops off properly without dropping over 1.5 lb/ft^3

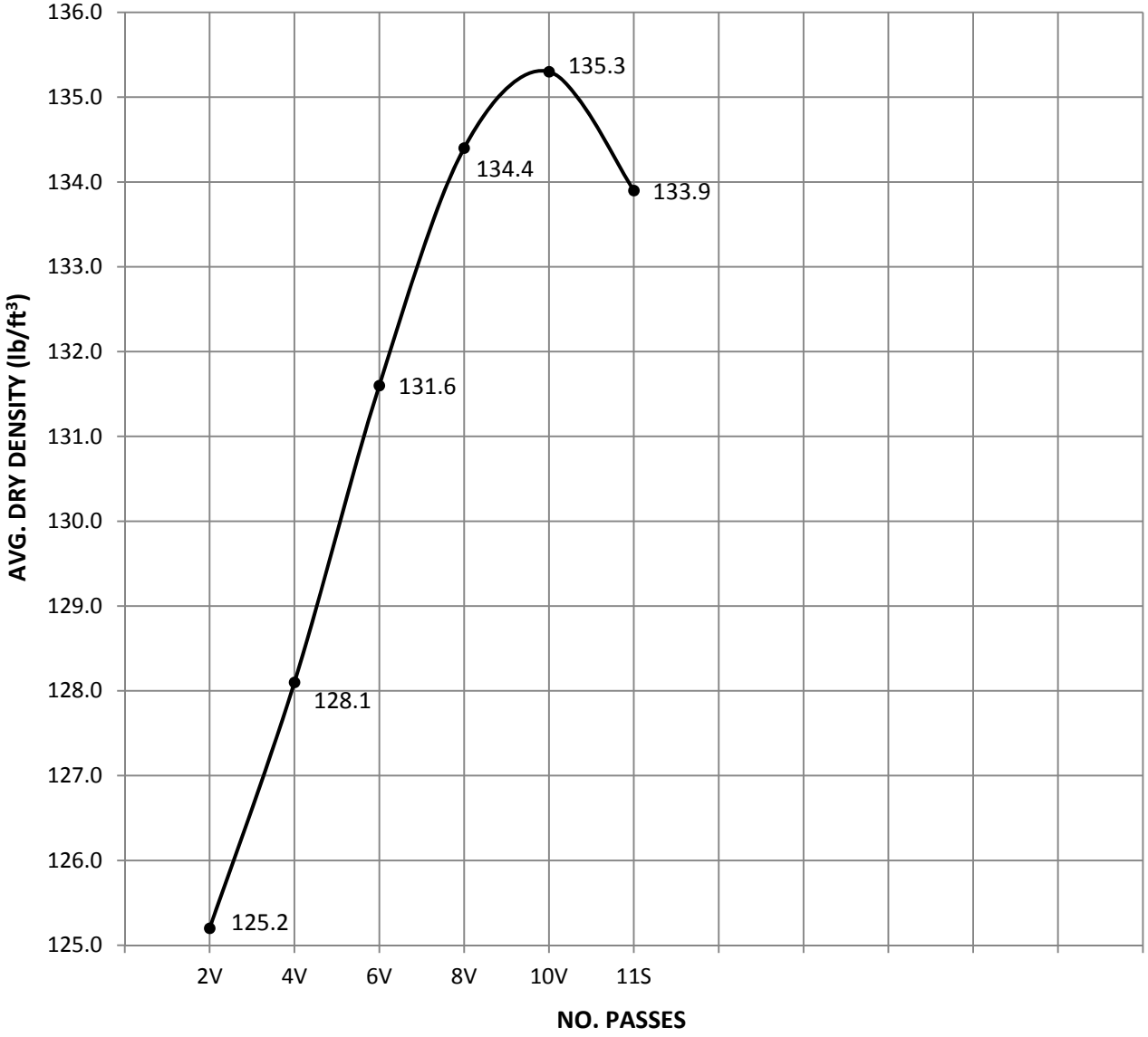
Form TL-53 (Rev. 07/15)

VIRGINIA DEPARTMENT OF TRANPORTATION
MATERIALS DIVISION
REPORT ON NUCLEAR ROLLER PATTERN

Report No.	1-21A-1	**Nuclear Gauge Model No.**	3440	**Serial No.**	23456		
Date	06/22/2015	**Project No.**	0095-029-F14, C502	**Route No.**	95		
FHWA No.	NH (95) - 1	**County**	Fairfax				
Section No.	1	**Station No.**	21+00	**ft. (m.) to Station**	21+75	**ft. (m.)**	
Type Material	Aggregate Base Type I (21A)			**Width**	12	**ft. (m.)**	
Optimum Moisture		**Optimum Moisture Range**					
Remarks							

STANDARD COUNT DATA					
Density	2847		**Moisture**	695	
TEST NO.	**DRY DENSITY**	**MOISTURE**	**TEST NO.**	**DRY DENSITY**	**MOISTURE**
Test No. 1 No. of Passes 2V			**Test No. 6 No. of Passes 11S**		
Sta. 21+00	125.4	5.1	**Sta. 21+00**	134.0	4.9
Sta. 21+35	124.9	5.2	**Sta. 21+35**	133.5	5.0
Sta. 21+75	125.3	5.6	**Sta. 21+75**	134.1	5.1
Total	375.6	15.9	**Total**	401.6	15.0
Average	125.2	5.3	**Average**	133.9	5.0
Test No. 2 No. of Passes 4V			**Test No. 7 No. of Passes**		
Sta. 21+00	128.4	5.4	**Sta.**		
Sta. 21+35	127.5	5.1	**Sta.**		
Sta. 21+75	128.5	4.9	**Sta.**		
Total	384.4	15.4	**Total**		
Average	128.1	5.1	**Average**		
Test No. 3 No. of Passes 6V			**Test No. 8 No. of Passes**		
Sta. 21+00	131.8	5.1	**Sta.**		
Sta. 21+35	131.0	5.0	**Sta.**		
Sta. 21+75	132.1	4.9	**Sta.**		
Total	394.9	15.0	**Total**		
Average	131.6	5.0	**Average**		
Test No. 4 No. of Passes 8V			**Test No. 9 No. of Passes**		
Sta. 21+00	134.7	5.5	**Sta.**		
Sta. 21+35	133.7	4.9	**Sta.**		
Sta. 21+75	134.8	5.1	**Sta.**		
Total	403.2	15.5	**Total**		
Average	134.4	5.2	**Average**		
Test No. 5 No. of Passes 10V			**Test No. 10 No. of Passes**		
Sta. 21+00	135.5	5.2	**Sta.**		
Sta. 21+35	135.0	5.1	**Sta.**		
Sta. 21+75	135.4	4.9	**Sta.**		
Total	405.9	15.2	**Total**		
Average	135.3	5.1	**Average**		

ROLLER PATTERN CURVE



Comments:

By: _____

Title: _____

CHAPTER 8 – ANSWERS TO STUDY QUESTIONS (CONT.)

NOTE: Each Practice Problem contains 4 Parts

Chapter 8 – Practice Problem Number 1
Nuclear Density Testing of Aggregates
Step 2 – Control Strip

A. Complete the following worksheet (Form TL-54) using the data below and answer the following questions.

B. How many roller passes were required to attain the maximum density on the Control Strip (Use the information from Step 1 – Form TL-53)
10V – determined by the roller pattern

C. Does the test pass the moisture criteria?
Yes, all moisture contents fall within ±2 percentage points of the optimum moisture (3.2% to 7.2%)

D. Is the Control Strip within tolerance of the Roller Pattern?
Yes, the maximum dry density of 135.3 lb/ft^3 is within 3.0 lb/ft^3 of the roller pattern peak density

Form TL-54 (Rev. 07/15)

VIRGINIA DEPARTMENT OF TRANPORTATION
MATERIALS DIVISION
REPORT ON NUCLEAR CONTROL STRIP

Report No.	1-21A-2	**Date**	06/22/2015
Route No.	95	**Project No.**	0095-029-F14, C502
FHWA No.	NH(95)-1	**County**	Fairfax
Type Material	Aggregate Base Type I (21A)	**Width**	12
Station No.	22+25 **ft. (m.) to Station**	25+25	**ft. (m.) to Nuclear Gauge**
Model No.	3440	**Serial No.**	23456
Remarks			

STANDARD COUNT DATA

Density 2847 **Moisture** 695

	STATION	REFERENCE TO CENTER LINE FT. (M)	LANE	DRY DENSITY (LB/FT^3) DRY UNIT MASS (KG/M^3)	MOISTURE CONTENT
1	22+25	3 FT. RT.	WBL	134.8	5.4
2	22+65	9 FT. RT.	WBL	135.2	5.3
3	23+00	6 FT. RT.	WBL	135.6	5.4
4	23+35	9 Ft. Rt.	WBL	135.5	5.4
5	23+70	3 Ft. Rt.	WBL	135.3	5.4
6	24+00	9 Ft. Rt.	WBL	135.3	5.1
7	24+35	6 Ft. Rt.	WBL	135.2	5.5
8	24+70	9 Ft. Rt.	WBL	135.8	5.4
9	25+00	6 Ft. Rt.	WBL	135.3	5.1
10	25+25	3 Ft. Rt.	WBL	134.7	5.0
			TOTAL:	1352.7	
			AVERAGE:	135.3	

5.2 **OPTIMUM MOSTURE REQUIRED (From Producer or Materials Division)**

3.2 – 7.2 **OPTIMUM MOISTURE RANGE**

(135.3) x 0.95 = Dens. Avg. 128.5 **INDIVIDUAL DRY DENSITY (lbs/ft^3), DRY UNIT MASS (kg/m^3) REQUIREMENT FOR TEST SECTION**

(135.3) x 0.98 = Dens. Avg. 132.6 **AVERAGE DRY DENSITY (lbs/ft^3), DRY UNIT MASS (kg/m^3) REQUIREMENT FOR TEST SECTION**

BY: _____

TITLE: _____

CHAPTER 8 – ANSWERS TO STUDY QUESTIONS (CONT.)

NOTE: Each Practice Problem contains 4 Parts

Chapter 8 – Practice Problem Number 1
Nuclear Density Testing of Aggregates
Step 3 – Control Strip (Direct Transmission Test)

A. Use the information below to complete the following worksheet (Form TL-124) and answer the following questions.

Information from Quarry or Materials Lab:

Percent Passing the No. 4 Sieve = 46%
Therefore, the percent of +4 Material = 54%

Specific Gravity of the +4 Material = 2.40
Therefore, the density of the +4 Material = 149.8

Absorption Rate of the +4 Material = 0.2%

Lab Proctor Information
Maximum Dry Density of the -4 Material = 133.0 lbs/ft^3
Optimum Moisture of the -4 Material = 10.1%

Nuclear Gauge Display Panel

% PR = 97.9%

DD = 130.2
WD = 137.1

M = 6.9 **M% = 5.3**

B. What is the minimum density required?
The minimum density required is 90.0% because 54% of the material was retained on the No. 4 Sieve

C. Does the test pass?
Yes, the actual density was 91.9%, which was above the minimum of 90.0%

D. Does this test validate the Control Strip?
Yes

Form TL-124 (Rev. 07/15)

VIRGINIA DEPARTMENT OF TRANPORTATION
MATERIALS DIVISION
REPORT ON NUCLEAR EMBANKMENT DENSITIES (UNIT MASSES)

Report No.	1-21A-3	**Date**	06/22/2015	**Sheet No.**	1	**of**	1
Route No.	95	**County**	Fairfax				
Project No.	0095-029-F14, C502						
FHWA No.	NH(95)-1						
Testing for	Aggregate Base Type I (21A)						
Model No.	3440	**Serial No.**	23456	**Calibration Date**	02/10/2015		

STANDARD COUNT DATA

Density 2847 **Moisture** 695

Test No.			**1**	**2**	**3**	**4**
Location	Station ft. (m)		22+25			
of	Ref. to center line ft. (m)		2' Rt. C/L			
Test	Elevation					
Compaction Depth of Lift in. (mm)			6"			
Method of Compaction			Vibratory			
A.		=	137.1			
B.		=	6.9			
C.		=	130.2			
D.		=	5.3			
E.	m^3)	=	133.0			
F.	Proctor	=	10.1			
G. Percent of Plus #4, (plus 4.75 mm)		=	54			
H.	s (kg/m^3)	=	141.6			
I.		=	5.2 3.2 – 7.2			
J.	^{3})	=	91.9			
K.		=	90.0			

Corrected Dry Density for +4 Aggregate

$$\frac{D_f \times D_c}{(P_c \times D_f) + (P_f \times D_c)}$$

$$\frac{133.0 \times 149.8}{(0.54 \times 133.0) + (0.46 \times 149.8)}$$

$$\frac{19{,}923}{(71.8 + 68.9)} = \frac{19{,}923}{140.7} = 141.6 \text{ lbs/ft}^3$$

Corrected Moisture for +4 Aggregate

$$(P_c W_c + P_f W_f) \times 100$$

$$[(0.54 \times 0.012) + (0.46 \times 0.101)] \times 100$$

$$[(0.006) + (0.046)] \times 100$$

$$[0.052] \times 100 = 5.2\%$$

Corrected Percent Density

(Dry Density ÷ Corrected +4 Density) x 100

(130.2 ÷ 141.7) x 100

(0.919) x 100

% Density = 91.9%

Comments:

BY: _____

TITLE: _____

CHAPTER 8 – ANSWERS TO STUDY QUESTIONS (CONT.)

NOTE: Each Practice Problem contains 4 Parts

Chapter 8 – Practice Problem Number 1
Nuclear Density Testing of Aggregates
Step 4 – Test Section

A. Transfer the Optimum Moisture, Optimum Moisture Range, Individual Dry Density Requirement, and Average Dry Density Requirement from the Control Strip (Form TL-54) to the proper place on the Test Section worksheet (Form TL-55).

B. Given the following nuclear density and moisture readings, complete the Form TL-55.

C. Does this test pass? Why?

Yes, each of the moisture contents falls within the optimum moisture range. Each individual density test exceeds 95%, and the overall average of the 5 density readings exceed 98%

D. If the test does not pass, what corrective action should be taken?

Retest the area, checking math and testing procedures before advising the contractor.

E. What are the beginning and ending station numbers of the first Test Section?

Beginning Station Number = 25+25; Ending Station Number is 51+65

Form TL-55 (Rev. 07/15)

VIRGINIA DEPARTMENT OF TRANPORTATION
MATERIALS DIVISION
REPORT ON NUCLEAR TEST SECTION

Report No.	1-21A-4	**Date**	06/22/2015
Route No.	95	**Project No.**	0095-029-F14, C502
FHWA No.	NH(95)-1	**County**	Fairfax
Type Material	Aggregate Base Type I (21A)	**Width**	12
Section No.	1	**Station No.**	25+25 **ft. (m.) to Station** 51+65 **ft. (m.)**
Model No.	3440	**Serial No.**	23456
Remarks			

STANDARD COUNT DATA

Density 2830 **Moisture** 701

5.2 **OPTIMUM MOISTURE REQUIRED % (From Producer or Materials Division)**

3.2 – 7.2 **OPTIMUM MOISTURE RANGE**

128.5 **INDIVIDUAL DRY DENSITY (lbs/ft^3), DRY UNIT MASS (kg/m^3) REQUIRED (95% of Control Strip Density from TL-54A)**

132.6 **AVERAGE DRY DENSITY (lbs/ft^3), DRY UNIT MASS (kg/m^3) REQUIRED (98% of Control Strip Density from TL-54A)**

Test No.	Station ft. (m)	Lane	Dry Density (lbs/ft^3), Dry Unit Mass (kg/m^3)	Moisture Content	Pass (P) Fail (F)
1	27+06	WBL	136.4	5.1	P
2	33+05	WBL	135.0	5.4	P
3	36+77	WBL	136.5	5.0	P
4	41+52	WBL	133.2	5.3	P
5	47+08	WBL	136.0	5.1	P
Average			135.4		P

Comments:

BY: _____

TITLE: _____

CHAPTER 8 – ANSWERS TO STUDY QUESTIONS (CONT.)

NOTE: Each Practice Problem contains 4 Parts

Chapter 8 – Practice Problem Number 2
Nuclear Density Testing of Aggregates
Step 1 – Roller Pattern

A. Given the following information, complete the following worksheet (Form TL-53)

B. Should this be considered an acceptable Roller Pattern? Why?

Yes, the density curve drops off properly without dropping over 1.5 lb/ft^3

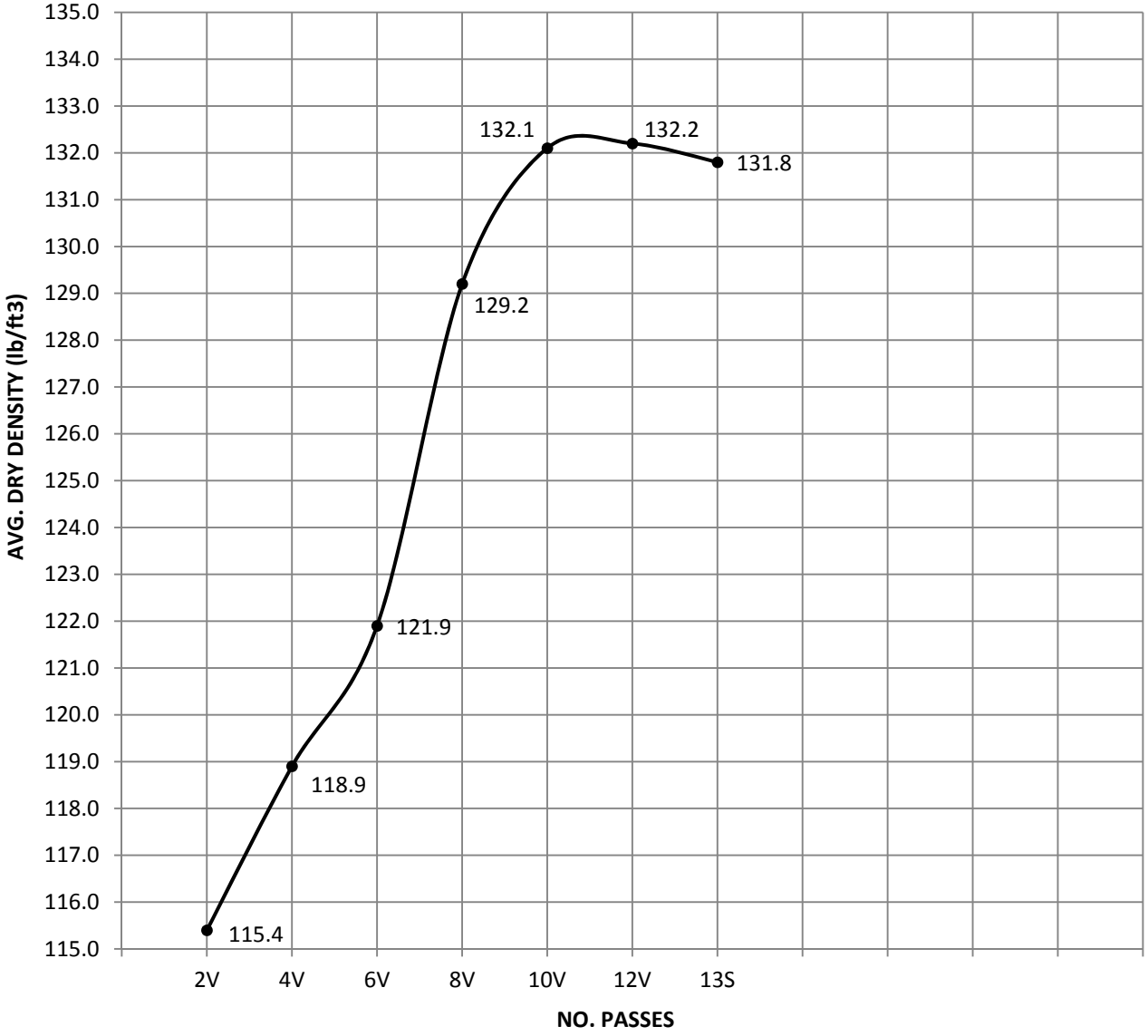
Form TL-53 (Rev. 07/15)

VIRGINIA DEPARTMENT OF TRANPORTATION
MATERIALS DIVISION
REPORT ON NUCLEAR ROLLER PATTERN

Report No.	3-21ACTA-1	**Nuclear Gauge Model No.**	3440	**Serial No.**	23456		
Date	Today	**Project No.**	0007-053-121, C501	**Route No.**	7		
FHWA No.	None	**County**	Loudon				
Section No.	1	**Station No.**	900+00	**ft. (m.) to Station**	900+75	**ft. (m.)**	
Type Material	Type 21A with 4% cement			**Width**	12	**ft. (m.)**	
Optimum Moisture	5.1	**Optimum Moisture Range**			3.1 – 7.1		
Remarks							

STANDARD COUNT DATA					
Density	2864		**Moisture**	709	
TEST NO.	**DRY DENSITY**	**MOISTURE**	**TEST NO.**	**DRY DENSITY**	**MOISTURE**
Test No. 1 No. of Passes 2V			**Test No. 6 No. of Passes 12V**		
Sta. 900+00	115.4	5.3	**Sta. 900+00**	132.2	5.2
Sta. 900+35	114.6	5.1	**Sta. 900+35**	131.7	5.0
Sta. 900+75	116.1	4.9	**Sta. 900+75**	132.8	5.2
Total	346.1	15.3	**Total**	396.7	15.4
Average	115.4	5.1	**Average**	132.2	5.1
Test No. 2 No. of Passes 4V			**Test No. 7 No. of Passes 13S**		
Sta. 900+00	118.9	5.3	**Sta. 900+00**	131.8	4.4
Sta. 900+35	118.6	5.2	**Sta. 900+35**	131.7	5.2
Sta. 900+75	119.1	5.3	**Sta. 900+75**	131.8	5.8
Total	356.6	15.8	**Total**	395.3	15.4
Average	118.9	5.3	**Average**	131.8	5.1
Test No. 3 No. of Passes 6V			**Test No. 8 No. of Passes**		
Sta. 900+00	121.9	5.1	**Sta.**		
Sta. 900+35	121.0	4.9	**Sta.**		
Sta. 900+75	122.9	5.3	**Sta.**		
Total	365.8	15.3	**Total**		
Average	121.9	5.1	**Average**		
Test No. 4 No. of Passes 8V			**Test No. 9 No. of Passes**		
Sta. 900+00	129.2	5.5	**Sta.**		
Sta. 900+35	128.1	4.8	**Sta.**		
Sta. 900+75	130.2	5.0	**Sta.**		
Total	387.5	15.3	**Total**		
Average	129.2	5.1	**Average**		
Test No. 5 No. of Passes 10V			**Test No. 10 No. of Passes**		
Sta. 900+00	132.1	5.3	**Sta.**		
Sta. 900+35	131.6	4.3	**Sta.**		
Sta. 900+75	132.6	5.9	**Sta.**		
Total	396.3	15.5	**Total**		
Average	132.1	5.2	**Average**		

ROLLER PATTERN CURVE



Comments:

By: _____

Title: _____

CHAPTER 8 – ANSWERS TO STUDY QUESTIONS (CONT.)

NOTE: Each Practice Problem contains 4 Parts

Chapter 8 – Practice Problem Number 2
Nuclear Density Testing of Aggregates
Step 2 – Control Strip

A. Using the same "header" information in Step 1, as well as the given below, complete the Control Strip (Form TL-54) and Direct Transmission (Form TL-124) worksheets.

B. How many roller passes were required to attain the maximum density on the Control Strip (Use the information from Step 1 – Form TL-53)
12V – that is the optimum number determined by the roller pattern

C. Does the test pass the moisture criteria?
Yes, the individual moisture contents fall within the optimum moisture range of 3.0% to 7.0%

D. Is the Control Strip within tolerance of the Roller Pattern?
Yes, the max. dry density of 132.7 lb/ft^3 is within 3.0 lb/ft^3 of the roller pattern peak density

E. Does the Direct Transmission Test validate the Control Strip Dry Density? (See Page 8-49)
Yes

Form TL-54 (Rev. 07/15)

VIRGINIA DEPARTMENT OF TRANPORTATION
MATERIALS DIVISION
REPORT ON NUCLEAR CONTROL STRIP

Report No.	3-21ACTA-2	**Date**	Today
Route No.	7	**Project No.**	0007-053-121, C501
FHWA No.	None	**County**	Loudon
Type Material	Type 21A w/ 4% cement	**Width**	12
Station No.	901+25 **ft. (m.) to Station**	904+25	**ft. (m.) to Nuclear Gauge**
Model No.	3440	**Serial No.**	23456
Remarks	6" Depth, Roller Pattern No. 3		

STANDARD COUNT DATA

Density 2864 **Moisture** 709

	STATION	REFERENCE TO CENTER LINE FT. (M)	LANE	DRY DENSITY (LB/FT^3) DRY UNIT MASS (KG/M^3)	MOISTURE CONTENT
1	901+25	3' LT.	WBL	132.8	5.6
2	901+75	9' LT.	WBL	132.7	5.7
3	902+00	6' LT.	WBL	132.9	5.6
4	902+30	3' LT.	WBL	132.6	5.8
5	902+70	6' LT.	WBL	133.0	5.2
6	903+00	9' LT.	WBL	132.5	5.7
7	903+35	9' LT.	WBL	132.7	5.1
8	903+70	3' LT.	WBL	132.7	5.8
9	904+00	6' LT.	WBL	132.5	5.2
10	904+25	9' LT.	WBL	132.8	5.5
			TOTAL:	1327.2	
			AVERAGE:	132.7	

5.0 **OPTIMUM MOSTURE REQUIRED (From Producer or Materials Division)**

3.0 – 7.0 **OPTIMUM MOISTURE RANGE**

(132.7) x 0.95 = Dens. Avg. 126.1 **INDIVIDUAL DRY DENSITY (lbs/ft^3), DRY UNIT MASS (kg/m^3) REQUIREMENT FOR TEST SECTION**

(132.7) x 0.98 = Dens. Avg. 130.0 **AVERAGE DRY DENSITY (lbs/ft^3), DRY UNIT MASS (kg/m^3) REQUIREMENT FOR TEST SECTION**

BY: _____

TITLE: _____

CHAPTER 8 – ANSWERS TO STUDY QUESTIONS (CONT.)

NOTE: Each Practice Problem contains 4 Parts

Chapter 8 – Practice Problem Number 2
Nuclear Density Testing of Aggregates
Step 3 – Control Strip (Direct Transmission Test)

A. Use the information below to complete the following worksheet (Form TL-124) and answer the following questions.

Information from Quarry or Materials Lab:

Percent Passing the No. 4 Sieve = 43%
Therefore, the percent of +4 Material = 57%

Specific Gravity of the +4 Material = 2.50
Therefore, the density of the +4 Material = 156.0

Absorption Rate of the +4 Material = 0.3%

Lab Proctor Information
Maximum Dry Density of the -4 Material = 133.0 lbs/ft^3
Optimum Moisture of the -4 Material = 10.1%

Nuclear Gauge Display Panel

% PR = 100.5%

DD = 133.6
WD = 140.8

M = 7.2 **M% = 5.4**

B. What is the minimum density required?
The minimum density required is 90.0%

C. Does the test pass?
Yes.

Form TL-124 (Rev. 07/15)

VIRGINIA DEPARTMENT OF TRANPORTATION
MATERIALS DIVISION
REPORT ON NUCLEAR EMBANKMENT DENSITIES (UNIT MASSES)

Report No.	3-21ACTA-2	**Date**	Today	**Sheet No.**	1	**of**	1
Route No.	7	**County**	Loudon				
Project No.	0007-053-121, C501						
FHWA No.	None						
Testing for	Aggregate Subbase						
Model No.	3440	**Serial No.**	23456	**Calibration Date**	12/10/2015		

STANDARD COUNT DATA

Density _____ **Moisture** _____

Test No.			**1**	**2**	**3**	**4**
Location	Station ft. (m)		902+70			
of	Ref. to center line ft. (m)		9' Lt.			
Test	Elevation					
Compaction Depth of Lift in. (mm)			6"			
Method of Compaction			Vibratory			
A.		=	140.8			
B.		=	7.2			
C.		=	133.6			
D.		=	5.4			
E.		=	133.0			
F.	t Proctor	=	10.1			
G. Percent of Plus #4, (plus 4.75 mm)		=	57			
H.	ss (kg/m^3)	=	145.2			
I.		=	5.0 3.0 – 7.0			
J.		=	92.0			
K.		=	90.0			

Corrected Dry Density for +4 Aggregate

$$\frac{D_f \times D_c}{(P_c \times D_f) + (P_f \times D_c)}$$

$$\frac{133.0 \times 156.0}{(0.57 \times 133.0) + (0.43 \times 156.0)}$$

$$\frac{20{,}748}{(75.8 + 67.1)} = \frac{20{,}748}{142.9} = 145.2 \text{ lbs/ft}^3$$

Corrected Moisture for +4 Aggregate

$$(P_c W_c + P_f W_f) \times 100$$

$$[(0.57 \times 0.013) + (0.43 \times 0.101)] \times 100$$

$$[(0.007) + (0.043)] \times 100$$

$$[0.050] \times 100 = 5.0\%$$

Corrected Percent Density

(Dry Density ÷ Corrected +4 Density) x 100

(133.6 ÷ 145.2) x 100

(0.920) x 100

% Density = 92.0%

Comments:

BY: _____

TITLE: _____

CHAPTER 8 – ANSWERS TO STUDY QUESTIONS (CONT.)

NOTE: Each Practice Problem contains 4 Parts

Chapter 8 – Practice Problem Number 2
Nuclear Density Testing of Aggregates
Step 4 – Test Section

A. Testing at the minimum frequency: With the Test Section beginning at Station No. 904+25 and having a paving width 12 feet, choose five (5) test site location using the following random numbers.

Distance from Start of Sublot	Distance from Reference Line
101	4
106	8
27	3
140	3
182	10

There are 5,280 feet in a mile. A Test Section is 0.5 mile per paver width or 2640 feet. Five (5) tests will be performed in the test section. 2640 ÷ 5 = 528.

Beginning Station No. 904+25

Sublot 1 ___528___ Feet

Station No. 909+53

Sublot 2 ___528___ Feet

Station No. 914+81

Sublot 3 ___528___ Feet

Station No. 920+09

Sublot 4 ___528___ Feet

Station No. 925+37

Sublot 5 ___528___ Feet

Ending Station No. 930+65

Test No.	Station No. at Start of Each Sublot	+	Distance from Start of Sublot	=	Station No. of Each Test Location	Distance from Reference Line (ft)
1	904+25	+	101	=	905+26	4
2	909+53	+	106	=	910+59	8
3	914+81	+	27	=	915+08	3
4	920+09	+	140	=	921+49	3
5	925+37	+	182	=	927+19	10

B. Transfer the Optimum Moisture, Optimum Moisture Range, Individual Dry Density Requirement, and Average Dry Density Requirement from the Control Strip (Form TL-54) to the proper place on the Test Section worksheet (Form TL-55).

C. Given the following nuclear density and moisture readings, complete the Form TL-55 using the same header information from the preceding problems (except use the correct Report Number: 3-21ACTA-4).

Test 1

Nuclear Gauge Display Panel

% PR = _____%

DD = 132.3
WD = 139.8

M = 7.5 M% = 5.7

Test 2

Nuclear Gauge Display Panel

% PR = _____%

DD = 131.2
WD = 138.4

M = 7.2 M% = 5.5

Test 3

Nuclear Gauge Display Panel

% PR = _____%

DD = 130.6
WD = 137.4

M = 6.8 M% = 5.2

Test 4

Nuclear Gauge Display Panel

% PR = _____%

DD = 131.3
WD = 138.0

M = 6.7 M% = 5.1

Test 5

Nuclear Gauge Display Panel

% PR = _____%

DD = 129.6
WD = 137.4

M = 7.8 M% = 6.0

D. Does this test pass? Why?
Yes, each of the individual density test exceed the minimum density requirement, and the average of the 5 readings exceeds the average requirement and all moisture contents fall within the optimum range

E. At what station is Test 4 to be taken from?
921+49

F. At what station does Sublot 2 begin?
909+53

G. How many feet from the reference line is Test 5 to be taken?
10 feet

Form TL-55 (Rev. 07/15)

VIRGINIA DEPARTMENT OF TRANPORTATION
MATERIALS DIVISION
REPORT ON NUCLEAR TEST SECTION

Report No.	3-21ACTA-4	**Date**	Today		
Route No.	7	**Project No.**	0007-053-121, C501		
FHWA No.	None	**County**	Loudon		
Type Material	Type 21A w/ 4% cement	**Width**	12		
Section No.	1	**Station No.**	904+25	**ft. (m.) to Station** 930+65	**ft. (m.)**
Model No.	3440	**Serial No.**	23456		
Remarks	6” Depth, Roller Pattern No 3				

STANDARD COUNT DATA

Density 2864 **Moisture** 709

5.0 **OPTIMUM MOISTURE REQUIRED % (From Producer or Materials Division)**

5.0 – 7.0 **OPTIMUM MOISTURE RANGE**

126.1 **INDIVIDUAL DRY DENSITY (lbs/ft^3), DRY UNIT MASS (kg/m^3) REQUIRED (95% of Control Strip Density from TL-54A)**

130.0 **AVERAGE DRY DENSITY (lbs/ft^3), DRY UNIT MASS (kg/m^3) REQUIRED (98% of Control Strip Density from TL-54A)**

Test No.	Station ft. (m)	Lane	Dry Density (lbs/ft^3), Dry Unit Mass (kg/m^3)	Moisture Content	Pass (P) Fail (F)
1	905+26	WBL	132.3	5.7	p
2	910+59	WBL	131.2	5.5	P
3	915+08	WBL	130.6	5.2	P
4	921+49	WBL	131.3	5.1	P
5	927+19	WBL	129.6	6.0	P
Average			131.0		P

Comments:

BY: _____

TITLE: _____