Appendix B Worksheets

The following worksheets are designed to assist quality assurance (QA) inspectors in performing inspections of construction of NRCS projects. Blank worksheets are provided along with instructions on completing the worksheets and a sample of completed worksheets,

Maintain completed worksheets at the jobsite with the inspector's records, and submit them to the contracting officer's representative (COR)/government representative (GR) along with the job diary when the work is completed. Document in the job diary when each worksheet is completed.

Each worksheet is designated NEH 645 WS #.#. The first number corresponds to the NEH 645 chapter to which the worksheet is directly associated. Some worksheets will apply to work that is described in more than one chapter, but are designated with the number of the chapter being the most relevant to the worksheet.

Electronic spreadsheets and programs corresponding to some of the worksheets are available to NRCS personnel at: https://nrcs.sc.egov.usda.gov/st/ndcsmc/construction/default.aspx. This can only be accessed from an agency computer.

Appendix B Worksheets

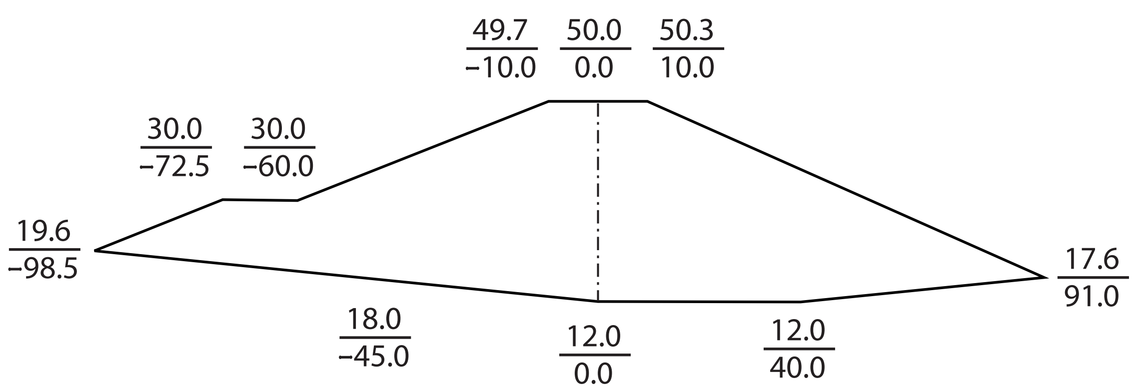
Contents

NEH 645 WS 5.1 Earthwork Survey Data and Computation Sheet

WS 5.1, Earthwork Survey Data and Computation Sheet, is used to compute the volume of earthfill or excavation using the double end area method. The double end area method is similar to the average end area method described in chapter 5. In the sample WS 5.1, the double end area method, a value equal to twice (double) the cross-sectional area is computed by the rectangular coordinate method. The value is then added to the same value attained for the next cross section. The result is a value that is four times the average of the cross-sectional areas of the two sections. This value is divided by 4 and multiplied by the distance between the stations to arrive at the volume between the two stations. The steps are explained below.

Step 1 Using WS 5.1, record the rectangular coordinates that define each section in feet to the nearest tenth of a foot. These coordinates are determined by the limits of excavation or earthfill, which are generally stated in the construction specifications for excavation and earthfill. For example, the limits for stations shown on sample WS 5.1 were specified to be "the measured surface of the foundation when approved for placement of the earthfill and the specified neat lines of the earthfill surface." Thus, the foundation limits are obtained from a field survey of the ground after the foundation excavation is completed and prior to beginning earthfill placement. The upper limits of the sections are obtained from the drawings. This is illustrated in figure B5–1. In figure B5–1, the foundation limits are defined by the lines connecting the points $\frac{19.6}{-98.5}$, $\frac{18.0}{-45.0}$, $\frac{12.0}{0.0}$, $\frac{12.0}{40.0}$, and $\frac{17.6}{91.0}$; the upper limits are defined by the lines connecting the points $\frac{19.6}{-98.5}$, $\frac{30.0}{-72.5}$, $\frac{30.0}{-60.0}$, $\frac{49.7}{-10.0}$, $\frac{50.0}{-0.0}$, $\frac{50.3}{-10.0}$, and $\frac{17.6}{-91.0}$.

Figure B5–1 Cross section at Station 5+00



Step 2 Compute the double end areas of each section by the rectangular coordinate method.

Step 3 Add the double end areas of consecutive sections.

Step 4 Multiply the value obtained in step 3 by the distance between the two sections and divide by 4 to determine the cross-sectional area in square feet.

Step 5 Divide the value obtained in step four by 27 to convert to cubic yards.

Step 6 Add the volumes computed between each station to determine the total volume of the earthfill or excavation.

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Sample NEH 645 WS 5.1

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NEH 645 WS 5.1

EARTHWORK SURVEY DATA AND COMPUTATION SHEET

Location *Hardin, Montana* Owner *John Doe* Contractor *Crow Construction* Contract no. *WC-82-12*

Watershed *Big Horn* Item *7* Computed by *J. Gray* Date *11-30-2011*

Subwatershed *Winona Creek* Site no. *4* Final quantity (yd^3) *15,887* Checked by *N. Ricks* Date *12-01-2011*

Station			Lt *			℄ *			Rt *				Double end areas	∑	Distance	Product ÷ 4	÷27
5+00	50.0	50.3	17.6	12.0	12.0	18.0	19.6	30.0	30.0	49.7	50.0						
	0.0	10.0	91.0	40.0	0.0	-45.0	-98.5	-72.5	-60.0	-10.0	0.0		7,693.3				
5+50	50.0	50.3	15.4	14.3	12.5	13.9	14.0	30.0	30.0	49.7	50.0			16,081.4	50.0	201,018	7,445.1
	0.0	10.0	96.5	51.0	0.0	-50.0	-112.0	-72.5	-60.0	-10.0	0.0		8,388.1				
6+00	50.0	50.3	11.4	8.6	12.8	30.0	30.0	49.7	50.0					18,234.5	50.0	227,931	8,441.9
	0.0	10.0	107.3	0.0	-115.5	-72.5	-60.0	-10.0	0.0				9,846.4				
														Total			15,887.0

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NEH 645 WS 5.1

EARTHWORK SURVEY DATA AND COMPUTATION SHEET

Location ________________________ Owner ___________________________ Contractor _________________________ Contract no. _____________

Watershed _______________________ Item _____________ Computed by _________________ Date ___________________

Subwatershed _____________________ Site no. ________ Final quantity (yd^3) ________ Checked by ___________________ Date ___________________

Station			_______*			_______*			_______*				Double end areas				

* Provide appropriate headings for use of offset, centerline, or baseline.

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NEH 645 WS 5.2 Earthwork Volume Computation Sheet

WS 5.2, Earthwork Volume Computation Sheet, is used to compute the volume of earthfill or excavation when the cross-sectional area at each station is predetermined. Methods for computing cross-sectional area are described in chapter 5.

When the cross-sectional area at each station is determined by the planimeter method, it will be given in square inches. The conversion to square feet will require multiplying the area in square inches by a conversion factor. This factor is contingent on the scale of the map or plotted cross section that was traced by the planimeter to determine the area in square inches.

If the cross-sectional area at each station was determined by a method that yields values in square feet, the second column in WS 5.2 is not needed. The following steps describe the process of computing volumes using WS 5.2.

Step 1 Record the station numbers in the first column and the distance between cross sections in the fifth column. Record these numbers in feet to the nearest tenth of a foot.

Step 2 If the cross-sectional areas are given in square inches, record the values in the second column, multiply the value by the conversion factor mentioned above, and record the converted square foot value in the third column. If the cross-sectional areas are given in square feet, leave the second column blank and record the square foot values in the third column.

Step 3 Add the square foot cross-sectional areas of consecutive stations and record the sum in the fourth column.

Step 5 Multiply the values in columns 4 and 5; record this value in the sixth column. This value represents the section product which is double the volume in square feet. Complete this computation for all consecutive pairs of stations.

Step 6 Add all section products in column 6, and divide the total by 54 to convert to volume in cubic yards. Record this number in the seventh column. If desired, the sum of all the values recorded in the sixth column divided by two gives the volume of the earthwork in cubic feet.

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Sample NEH 645 WS 5.2

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NEH 645 WS 5.2

EARTHWORK VOLUME COMPUTATION SHEET

Project: Town Creek Watershed, Site 5 | Job No. 12-10-330-43

Location: Benton, Indiana | Contractor: Elkhart Construction

Item: Excavation | Sheet 1 of 1

By: D. Shanklin | Date: 11-30-11 | Checked by: D. McCook | Date: 12-01-11

Station	End area (in^2)	End area (ft^2)	Sum of end areas (ft^2)	Distance (ft)	Section product (ft^3)	Volume (yd^3)	Remarks
12+40	0.00	0					
			245	60	14,700		
13+00	2.45	245					
			495	50	24,750		
13+50	2.50	250					
			507	50	25,350		
14+00	2.57	257					
			497	50	24,850		
14+50	2.40	240					
			316	100	31,600		
15+50	0.76	76					
			186	50	9,300		
16+00	1.10	110					
			164	100	16,400		
17+00	0.54	54					
			139	50	6,950		
17+50	0.85	85					
			187	50	9,350		
18+00	1.02	102					
			102	40	4,080		
18+40	0.00	0					
					167,330		
			Total	$\frac{167,330}{(2)(27)}$	$=3,099\ yd^3$		

Cross section scale: 1 inch = 10 ft vertical; 1 inch = 10 ft horizontal

($1\ in^2 = 100\ ft^2$)

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NEH 645 WS 5.2

EARTHWORK VOLUME COMPUTATION SHEET

Project ______________________________ Job No. __________

Location ______________________ Contractor ______________________

Item ______________________________ Sheet _____ of _____

By ______________ Date ________ Checked by ______________ Date ________

Station	End area (in^2)	End area (ft^2)	Sum of end areas (ft^2)	Distance (ft)	Section product (ft^3)	Volume (yd^3)	Remarks

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NEH 645 WS 5.3 Payment Quantity Computations Summary

WS 5.3, Payment Quantity Computations Summary, is used to record computed quantities for payment. It is generally filed with the payment quantity computations that are with for contract records. The worksheet is typically used for jobs where there are several variable quantity contract items that require final quantity computations. It is simply a tool for organizing and keeping up with quantity computation progress.

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Sample NEH 645 WS 5.3

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NEH 645 WS 5.3

PAYMENT QUANTITY COMPUTATIONS SUMMARY

Location Putnam County, Georgia Owner Luke Dunn

Watershed Rooty Creek Subwatershed —

Site No. 25 Contract No. 6-GA-SC0-5

Item No.	Work or material	Computed			Checked		
		Date	Name	Quantity	Date	Name	Quantity
1	Clearing	5-1-63	L.A.H.	11.2 acres	5-4-63	W.J.P.	11.2 acres
2	Clearing and grubbing						
	Embankment area	5-1-63	L.A.H.	1.6 acres	5-4-63	W.J.P.	1.6 acres
	Emergency spillway	5-1-63	L.A.H.	2.5	5-4-63	W.J.P.	2.5
	Total	5-1-63	L.A.H.	4.1 acres	5-4-63	W.J.P.	4.1 acres
3	Evacation						
	Conduit strip out	5-1-63	L.A.H.	19.9 yd^3	5-4-63	W.J.P.	19.9 yd^3
	Key way	5-1-63	L.A.H.	2,533	5-4-63	W.J.P.	2,533
	Old channel	5-1-63	L.A.H.	1,172	5-4-63	W.J.P.	1172
	Tail ditch	5-1-63	L.A.H.	196	5-4-63	W.J.P.	196
	Total	5-1-63	L.A.H.	5,620 yd^3	5-4-63	W.J.P.	5,620 yd^3
4	Earthfill						
	Embankment	5-11-63	L.A.H.	15,267 yd^3	5-11-63	W.J.P.	15,267 yd^3
	Condiut strip out	5-11-63	L.A.H.	1,919	5-11-63	W.J.P.	1,919
	Key way	5-11-63	L.A.H.	2,335	5-11-63	W.J.P.	2,335
	Old channel	5-11-63	L.A.H.	1,172	5-11-63	W.J.P.	1,172
	Total	5-11-63	L.A.H.	20,691 yd^3	5-11-63	W.J.P.	20,691 yd^3
5	Concrete-Class B						
	Riser	5-11-63	L.A.H.	5.47 yd^3	5-11-63	W.J.P.	5.47 yd^3
	Anti-seep collars	5-11-63	L.A.H.	3.15	5-11-63	W.J.P.	3.15
	Anti-kortex baffle	5-11-63	L.A.H.	2.54	5-11-63	W.J.P.	2.54
	Sill	5-11-63	L.A.H.	2.96	5-11-63	W.J.P.	2.96
	Total	5-11-63	L.A.H.	14.12 yd^3	5-11-63	W.J.P.	14.12 yd^3
	Drainage filter						
	Material	5-5-63	L.A.H.	178 yd^3	5-5-63	W.J.P.	178 yd^3

Sheet: 1 of 1 sheets

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NEH 645 WS 5.3

PAYMENT QUANTITY COMPUTATIONS SUMMARY

Location ______________________________ Owner ______________________________

Watershed ______________________________ Subwatershed ______________________________

Site No. ______________________________ Contract No. ______________________________

Item No.	Work or material	Computed			Checked		
		Date	Name	Quantity	Date	Name	Quantity

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NEH 645 WS 7.1 Materials Testing Report—Visual Soil Classification

WS 7.1 is used for field classifying soils according to the procedure detailed in ASTM D2488 Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). The worksheet is divided into five major columns, each divided by a double vertical line. The major columns are entitled: Identification, Coarse Fraction, Fine Fraction, Total Soil, and Classification.

Identification—The first major column is labeled "Identification." Under the Identification heading, there are two columns with blank headings that must be filled in. In the example, the first heading is recorded as "Dam Centerline Station," and the second heading is recorded as "Distance Upstream (ft)." The distance upstream is the distance to the sample location from the centerline in the upstream direction. Any reference line and offset distance could be used. Northing and easting coordinates are commonly used for establishing horizontal control and could be used instead of a reference line and offset distance. The objective is to provide a reference that can easily be documented and reestablished if necessary. Fill in the headings of these two columns with a clear description such as "Northing" and "Easting," "Baseline" and "Distance L or R from Baseline," "X" and "Y," etc.

The third column under the Identification heading is for recording a sample number, and the fourth column is for recording the depth below the surface at which the soil is sampled.

Coarse Fraction—For soils containing sands and gravels, there are five columns under this major heading. The first is the maximum particle size, which can be determined by sieves or estimated with a pocket millimeter scale or ruler. The other columns are particle shape, particle condition, % gravel, and % sand. Particle shape and condition are recorded by symbols listed on the second page of WS 7.1. These are described in more detail in ASTM D2488. The % gravel and % sand are recorded as a percentage of the total soil sample. So, the percentage of gravel and sand would be subtracted by 100 to determine the % fines to be recorded for the fine fraction. Sieving the soils to determine these percentages will only require having two sieve sizes: #4 and #200. Particles retained on the #4 sieve are gravel, particles retained on the #200 are sand, and particles passing the #200 sieve are fines. If it is apparent there are no sand and gravel particles, record N.A. (not applicable) in the first coarse fraction column, and draw a line through the remaining four columns under the coarse fraction heading.

Fine Fraction—Record the % fines in the first column under this major heading. Record the symbol for plasticity, dry strength, and dilatence, which are found on the second page of WS 7.1. A short description of each of these is also given on the second page of WS 7.1. These are described in detail in ASTM D2488.

Total Soil—The three columns under this major heading are organic odor, reaction to HCL, and color (wet). Organic odor symbols are listed on the second page of WS 7.1 as "S, W, or N" for strong, weak, or none respectively. Record the reaction with HCL as "+" if there is an effervescence or "-" if no apparent reaction occurs from a few drops of HCL dropped onto the soil. (Note that the reaction with HCL is an option in ASTM D2488; testing and recording the reaction to HCL is not required. A reaction with HCL infers the potential for soil cementation, which may be useful to know in some instances.) A dark brown to black color indicates the potential for organic materials in the soil.

Classification—This final major heading contains two columns. The first is a description to include such items as classification, grading, structure, consistency, moisture condition, inclusions, etc. The first sample entry on the example worksheet describes the soil as "fine grained, grading N.A., soft, wet, no inclusions." Only receord the items needed to determine the classification. Since the sample contained 100 percent fines, it is classified as a fine-grained soil. Grading only applies to sands and gravels that are either poorly graded or well graded; thus,

NEH 645 WS 7.1 Materials Testing Report—Visual Soil Classification—continued

grading does not apply for this soil. On the second sheet of WS 7.1 in the lower third of the sheet is a table that summarizes the field classification. All soils with over 50 percent fines fall in one of five groups: ML; CL; CH; MH; or OL, OH. The table shows that the soil would need to have a strong odor to be considered OL, OH. Since this soil has a weak odor, the potential group symbols for this soil are reduced to four groups: ML, CL, CH, or MH. The table shows that “None – Slow” dilatence is characteristic of a CL or MH. Since this soil has an “S” or slow dilatence, it is either a CL or MH. Only a CL can have a high dry strength, and the dry strength of this soil was recorded as high; thus, the soil is classified as a CL.

Sample NEH 645 WS 7.1

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NEH 645 WS 7.1

MATERIALS TESTING REPORT
Visual Soil Classification

Project *Cow Bayou Site 4* Tested by *Earl Grey* Date *January 4, 2012* Sheet *3* of *7*

Identification				Coarse Fraction					Fine Fraction				Total Soil			Classification	
Dam CL Sta.	*Dist. Upstream (ft)*	Field sample No.	Depth (ft)	Maximum size (mm)	Particle shape	Particle condition	% Gravel (3-inch to #4)	% Sand (#4 to #200)	% Fines (minus #200)	Plasticity	Dry Strength	Dilatence	Organic odor (wet)	Reaction to HCl	Color (wet)	Description (classification, grading, structure, consistency, moisture condition, inclusions, etc.)	Group symbol
4+80	200	5	10	N.A.	→	→	→	→	100	M	H	S	Weak	No	Black	Fine grained, grading N.A., very soft, wet, no inclusions	CL
6+50	250	10		8	R	D	5	75	20	L	L	N	Weak	No	Light Brown	Coarse grained, grading N.A., soft, moist, no inclusions	SM
8+90	425	12	15	60	1/3 flat and long	D	90	10	0	N.A.	N.A.	N.A.	None	N.A.	Grey	Clean gravel, all about 1" in size	GP

Remarks____________________

Sample NEH 645 WS 7.1—continued

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Natural Resources Conservation Service

Page 2 of 2

NEH 645 WS 7.1

SOIL DESCRIPTION

	Test	Description	Symbol	Identification or test reaction
Coarse Fraction	Particle Shape	Angular	A	Irregular shape: sharp edges
		Subangular	SA	Irregular shape: fairly sharp edges
		Subrounded	SR	Irregular shape: rounded edges
		Rounded	R	Fairly regular shape: rounded edges
	Particle Condition	Soft	S	Rubber pestle will break particles
		Vesicular	V	Individual grains contain air voids
		Dense	D	Massive: grains contain no air voids
Fine Fraction	Plasticity	High	H	Tough thread, will remold below plastic limit
		Medium	M	Medium tough thread, crumbles below plastic limit
		Low	L	Weak thread, will not remold at plastic limit
		None	N	Will not form thread
	Dry Strength	High	H	Difficult to break by finger pressure
		Medium	M	Considerable finger pressure to crumble
		Low	L	Will crumble at light finger pressure
		None	N	Will not form soil pat
	Dilatence	Rapid	R	Water surfaces immediately
		Slow	S	Water surfaces slowly
		None	N	Water will not surface
Total Soil	HCl	Positive	+	Effervescence
		Negative	-	No reaction
	Organic Odor	Strong	S	Strong odor when moist and hot
		Weak	W	Weak odor when moist and hot
		None	N	No organic odor

Classification

Group	Organic odor	Visual examination			Character of fines (< No. 40)		
		Grading	Percent fines	Dominant fraction	Dilatence	Dry strength	Plasticity
ML	Weak	Not a criterion for classification	Over 50	Fines	Rapid	None-Low	None-Low
CL	"		"	"	None-Slow	Med.-High	Medium
CH	"		"	"	None	High	High
MH	"		"	"	None-Slow	Low-Med	Low-Med.
OL,OH	Strong		"	"	None	Low-Med	Med.
SM	Weak		12-50	Sand	Fines classify as ML or MH		
GM	"		"	Gravel			
SC	"		"	Sand	Fines classify as CL or CH		
GC	"		"	Gravel			
SP	"	Poor	Under 5	Sand	Not a criterion for classification		
GP	"	"	"	Gravel			
SW	"	Well	"	Sand			
GW				Gravel			
Pt	Strong	Identify by high fibrous organic content					

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NEH 645 WS 7.1

MATERIALS TESTING REPORT
Visual Soil Classification

Project__________ Tested by__________ Date__________ Sheet_____ of_____

Identification				Coarse Fraction					Fine Fraction				Total Soil			Classification	
		Field sample No.	Depth (ft)	Maximum size (mm)	Particle shape	Particle condition	% Gravel (3-inch to #4)	% Sand (#4 to #200)	% Fines (minus #200)	Plasticity	Dry Strength	Dilatence	Organic odor (wet)	Reaction to HCl	Color (wet)	Description (classification, grading, structure, consistency, moisture condition, inclusions, etc.)	Group symbol

Remarks__________

NEH 645 WS 7.1

SOIL DESCRIPTION

Test		Description	Symbol	Identification or test reaction
Coarse Fraction	Particle Shape	Angular	A	Irregular shape: sharp edges
		Subangular	SA	Irregular shape: fairly sharp edges
		Subrounded	SR	Irregular shape: rounded edges
		Rounded	R	Fairly regular shape: rounded edges
	Particle Condition	Soft	S	Rubber pestle will break particles
		Vesicular	V	Individual grains contain air voids
		Dense	D	Massive: grains contain no air voids
Fine Fraction	Plasticity	High	H	Tough thread, will remold below plastic limit
		Medium	M	Medium tough thread, crumbles below plastic limit
		Low	L	Weak thread, will not remold at plastic limit
		None	N	Will not form thread
	Dry Strength	High	H	Difficult to break by finger pressure
		Medium	M	Considerable finger pressure to crumble
		Low	L	Will crumble at light finger pressure
		None	N	Will not form soil pat
	Dilatence	Rapid	R	Water surfaces immediately
		Slow	S	Water surfaces slowly
		None	N	Water will not surface
Total Soil	HCl	Positive	+	Effervescence
		Negative	-	No reaction
	Organic Odor	Strong	S	Strong odor when moist and hot
		Weak	W	Weak odor when moist and hot
		None	N	No organic odor

Classification

Group	Organic odor	Visual examination			Character of fines (< No. 40)		
		Grading	Percent fines	Dominant fraction	Dilatence	Dry strength	Plasticity
ML	Weak	Not a criterion for classification	Over 50	Fines	Rapid	None-Low	None-Low
CL	"		"	"	None-Slow	Med.-High	Medium
CH	"		"	"	None	High	High
MH	"		"	"	None-Slow	Low-Med	Low-Med.
OL,OH	Strong		"	"	None	Low-Med	Med.
SM	Weak		12-50	Sand	Fines classify as ML or MH		
GM	"		"	Gravel			
SC	"		"	Sand	Fines classify as CL or CH		
GC	"		"	Gravel			
SP	"	Poor	Under 5	Sand	Not a criterion for classification		
GP	"	"	"	Gravel			
SW	"	Well	"	Sand			
GW				Gravel			
Pt	Strong	Identify by high fibrous organic content					

NEH 645 WS 7.2 Field Density and Water Content by the Clod Method (ASTM D7263)

One of the better methods for determining the moisture and density of an undisturbed sample of soil is ASTM D7263, Laboratory Determination of Density (Unit Weight) of Soil Specimens (Method A—Water Displacement) commonly referred to as the “clod test.” This method determines the density of an irregularly shaped clod. The general steps for the procedure are listed and illustrated in 645.0702. Refer to ASTM D7263 for standard test method details.

This test method is useful for obtaining the density of any soil or material. It is very useful when testing for collapsible soils. Collapsible soils are soils that, in their natural state, have a low density (dry density less than 90 lb/ft^3) and generally have low moisture content (less than 10%). Collapsible soils generally contain air holes that are visible to the naked eye. There are a couple of photos of collapsible soils in 645.0701 (see figs. 7–2 and 7–3).

A sample of soil that has minimum dimensions of approximately 4 inches in length, width, and depth is desired. It must be undisturbed and protected from moisture loss prior to obtaining a clod for the test. It must be transported in a manner that will protect it from impact or significant vibration or jarring to avoid collapse before the test is conducted. The clod used for the test is then obtained from this sample. At the time the clod is cut or broken out of the sample, a moisture sample is also obtained, placed in a container, and immediately weighed to determine the initial mass of moist soil + container. The clod should be weighed and the clod coated in wax before any moisture is lost.

Note in the sample calculations that the values are given to four significant digits. ASTM D7263 requires this level of accuracy which is needed because of the small clod size. Once the moist density is determined in grams per cubic centimeter, it is converted to pounds per cubic foot by multiplying by 62.4 and reported to the nearest 10th. In the sample calculations, the moisture content determined by ASTM D2216 (oven) was reported to the nearest 100th because the value is 14.65 percent. Anything from 14.6 to 14.64 can be rounded down to 14.6 and from 14.66 to 14.7 rounded up to 14.7.

Also note in the sample calculations, the technician obtained the moisture content by two methods. ASTM D2216 (the oven method) is considered the most accurate of all of the ASTM test methods for determining soil moisture. The oven method requires the soil to remain in the oven overnight. The other method used here was the microwave method (D4643); results can be obtained in a few minutes using a microwave oven. It resulted in slightly lower moisture content than that obtained using the oven. However, the difference in the values of dry density (85.1 lb/ft^3 verses 85.4 lb/ft^3) computed by using moisture values from the two methods is negligible for the purpose of confirming the low soil density.

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Sample NEH 645 WS 7.2

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NEH 645 WS 7.2

FIELD DENSITY AND WATER CONTENT BY THE CLOD METHOD
ASTM D7263

Project *Cow Bayou Site 4* Sheet *1* of *1*

Computed by *Earl Grey* Date *1/4/2012*

Checked by *Floyd Jones* Date ______

Density of the wax used for the test, (ρ_ρ) = *0.8812* g/cm³ ______

Density of the water used for the test, (ρ_w) = *0.9976* g/cm³ ______

In-place Density Measurement (nongravelly soils)

	Sample identification		3	
	Location sampled		CL 5+80 10 ft Left	
	USGS classification of sample		CL	
(1)	M_t = Mass of clod in air, grams		56.1013	
(2)	M_c = Mass of clod + wax in air, grams		61.0293	
(3)	M_{sub} = Mass of clod + wax submerged, grams		19.6683	
(4)	M_c – Mt = Mass of wax, grams	(2) – (1)	4.9280	
(5)	$(M_c – M_t)/\rho_\rho$ = Volume of wax, cm³	(4) / ρ_ρ	5.5924	
(6)	$(M_c – M_{sub})/\rho_w$ = Volume of clod, cm³	[(2) – (3)] / ρ_w	41.4605	
(7)	ρ_m = Moist density, g/cm³	(1) / [(6) – (5)]	1.5641	
(8)	ρ_m = Moist density, lb/ft³	(7) x 62.4	97.6	97.6
(9)	ρ_d = Dry density, lb/ft³	(8) / (1 + w%/100)	85.1	85.4

Water Content Measurement

	Method used	D2216	D4643
	Container or can no.	101	N.A.
(1)	Mass of container, grams	46.4322	20.2236
(2)	Mass of moist soil + container, grams	72.7102	41.5405
(3)	Mass of dry soil + container, grams	69.3522	38.8736
(4)	Water content, % [((2) – (3)) / ((3) – (1))] x 100	14.65	14.3

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U.S. Department of Agriculture
Natural Resources Conservation Service

NEH 645 WS 7.2

FIELD DENSITY AND WATER CONTENT BY THE CLOD METHOD
ASTM D7263

Project________________________________ Sheet_____of______

Computed by____________________________ Date______________

Checked by_____________________________ Date______________

Density of the wax used for the test, (ρ_ρ) =________________ g/cm³___________

Density of the water used for the test, (ρ_w) =________________ g/cm³__________

In-place Density Measurement (nongravelly soils)

	Sample identification		
	Location sampled		
	USGS classification of sample		
(1)	M_t = Mass of clod in air, grams		
(2)	M_c = Mass of clod + wax in air, grams		
(3)	M_{sub} = Mass of clod + wax submerged, grams		
(4)	M_c – Mt = Mass of wax, grams (2) – (1)		
(5)	$(M_c – M_t)/\rho_\rho$ = Volume of wax, cm^3 (4) / ρ_ρ		
(6)	$(M_c – M_{sub})/\rho_w$ = Volume of clod, cm^3 [(2) – (3)] / ρ_w		
(7)	ρ_m = Moist density, g/cm^3 (1) / [(6) – (5)]		
(8)	ρ_m = Moist density, lb/ft^3 (7) x 62.4		
(9)	ρ_d = Dry density, lb/ft^3 (8) / (1 + w%/100)		

Water Content Measurement

	Method used		
	Container or can no.		
(1)	Mass of container, grams		
(2)	Mass of moist soil + container, grams		
(3)	Mass of dry soil + container, grams		
(4)	Water content, % [((2)–(3)) / ((3)–(1))] x 100		

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NEH 645 WS 7.3 Report of Blasting Operation

A description of methods for developing a blasting plan is beyond the scope of this handbook; however, the inspector must have enough knowledge of blasting terminology to oversee the operation, understand how the plan may be revised to achieve more desirable results, and document the operation on WS 7.3 and in the diary. To that end, the inspector should study the information on blasting provided in chapter 7 and below, and consult with the responsible engineer.

The first three lines of the worksheet are self-explanatory. The fourth line is for describing the blast location. In the sample on page B–7.3–6, the location is clearly described as "50 to 66 feet left of auxiliary spillway CL Sta. 3+00 to 3+24." Attach and make reference to an additional sheet if more space or an illustration is needed to adequately describe the location.

Much of the remaining information can be obtained from the blasting plan. Keep in mind that the blasting plan is generally adjusted from one blast to the next as necessary to attain the desired results. Therefore, the data reported here will differ somewhat from that planned.

The reverse side of sample worksheet includes several sketches of general blasting patterns identified as Plans A through G. The sample information filled in on the front side of the worksheet refers to blasting pattern identified as Plan A.

Blasting agents—Black powder, dynamite, Ammonium Nitrate-Fuel Oil-Prill (ANFO), and water gels are common blasting agents. ANFO is a blasting agent most commonly used in excavation. It can only be used in dry conditions unless it is encapsulated in cartridge form to keep it dry. Water gels are, like ANFO, made from ammonium nitrate but, unlike ANFO, can be used in wet conditions without being encapsulated. Black powder and dynamite are no longer commonly used for mining or construction.

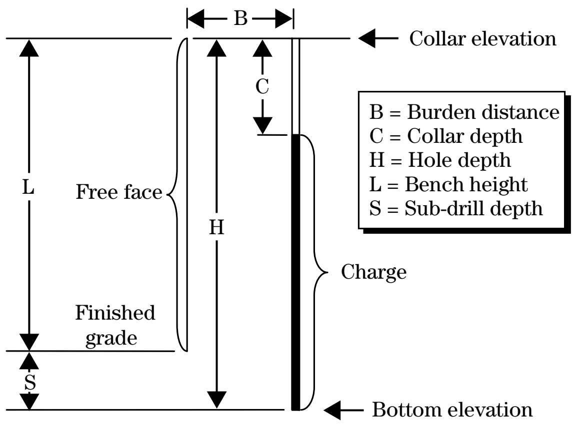
The amount of blasting agent used depends on several factors. One of these is the density of the blasting agent. Density is generally reported in grams per cubic centimeter (g/cm^3) and can be converted to pounds per cubic foot (lb/ft^3) by multiplying by 62.4. Blasting agent density ranges from 0.4 to 1.4 g/cm^3 (25 to 90 lb/ft^3) depending on the agent used. The blasting agent shown in the sample worksheet is ANFO–P (the P indicates poured or granular) with a density of 0.85 g/cm^3. It can be compacted to a density of 0.95 g/cm^3. There are other ANFO products, each having a different density.

Powder factor—The powder factor is the ratio of the amount of blasting agent to the amount of rock to be broken. The term "powder" originated from the use of black powder and refers to any solid blasting agent such as ANFO or water gel. The powder factor in the sample worksheet is 1 lb/yd^3. Overblasting will occur if the powder factor is too high. If the powder factor is too low, the rock will not be broken up enough and will be difficult to remove. The powder factor may be adjusted from one blast to the next to achieve the desired results.

Burden/spacing—Burden is the distance measured perpendicular from the nearest free face to the blast hole as shown in figure 7B.1. The generalized blasting patterns shown on the back of the sample WS 7.3 illustrate the relationship between burden and spacing.

NEH 645 WS 7.3 Report of Blasting Operation—continued

Figure 7B–1 Bench cross section showing blast hole geometry



Stemming—Stemming is used to fill the collar. The collar is the portion of the blast hole that is not charged (i.e., filled with blasting agent). Crusher fines, sand, and other inert granular materials are used for stemming materials.

Method of initiation—Blasting agents are ignited by an electric or nonelectric initiation device. Electric blasting caps are initiated by an electric charge. Nonelectric devices are initiated by a detonating cord that is generally a small plastic tube containing a flammable material.

Delay types—Both electric and nonelectric initiation can be delayed. The delay may be placed “in-line” between caps or be built into a “delay cap.” An illustration of how both in-line delays and delay caps are used is seen in chapter 7, figure 7–11. In this figure, the point of initiation is at hole number 47. A 25-ms cap is used in each of the blast holes. The line from hole number 46 to holes 37 and 57 contain a 17-ms in-line delay.

The sample worksheet entry shows 10-ms caps. Generally an 8-ms delay is considered the shortest acceptable delay period. If the charges are closer together, the delay will not be effective. Delays that are too long can result in poor rock breakage or otherwise less desirable results.

Type of circuit—For electric initiation, there are three types of circuits: series, parallel, and series-in-parallel. Figure 7B–2 illustrates the series-in-parallel circuit commonly used in blasting for excavation. Individually, each row is a series circuit where the electric current enters one end of the row and flows out the opposite end. Current is supplied to each row independent of the other rows. Figure 7B–3 illustrates a series circuit. Figure 7B–4 illustrates a parallel circuit.

NEH 645 WS 7.3 Report of Blasting Operation—continued

Figure 7B–2 Series-in-parallel circuit

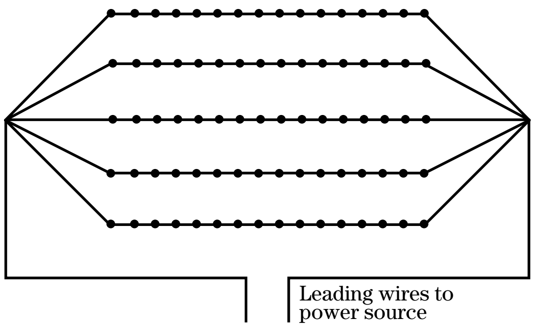


Figure 7B–3 Series circuit

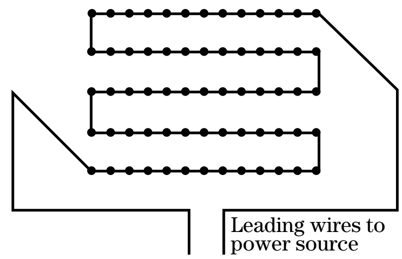


Figure 7B–4 Parallel circuit

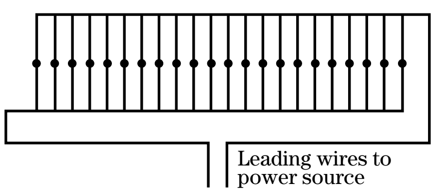


Table showing details of blast holes—The table is set up so that information can be input for up to four rows of 17 holes. There is a continuation sheet WS 7.3 (cont.) that can be attached if there are more rows or holes than space provided in the table.

The sample shows three rows and the holes are identified by a number that corresponds to the firing sequence. This corresponds to Plan A on the reverse side of the sample form. There is no set numbering convention for identifying blast holes, use your judgment as to what makes sense.

The collar elevation is the elevation at the top of the collar (i.e., top of the blast hole) at the ground surface. The bottom elevation is simply the bottom of the blast hole or bottom of the charge. These are identified in figure 7B.1. Note in figures 7B.1 and 7B.5 the holes are drilled some distance (S) below the desired finished grade elevation. This may be necessary because there will be unbroken rock (also known as tights or high points) between holes that extend above the bottom elevation. The upper limit of this unbroken rock increases as the distance between holes increases. A higher powder factor may reduce the amount of unbroken rock between holes but will generally fracture the rock that is to remain in place. Thus, spacing holes closer together is generally required when it is necessary to control the grade with minimal damage to rock that is to remain in place.

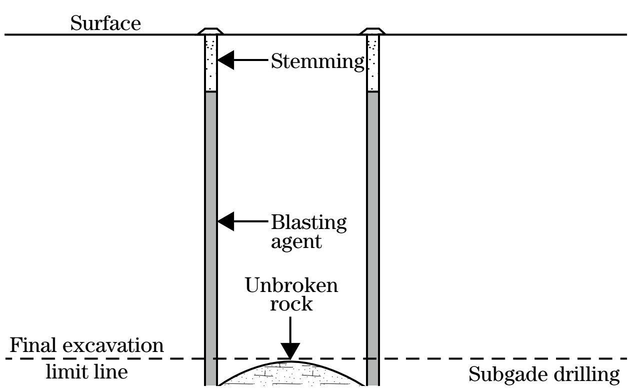
The charge may vary with hole depth. In the example used for the sample worksheet, all of the holes bottomed at the same elevation, but the ground was rising from Row 1 to Row 3. The charge required per hole is based

NEH 645 WS 7.3 Report of Blasting Operation—continued

on the amount of rock that is to be broken by the blast in that hole. This is figured by multiplying the free face height by the distance from the free face to the hole and by the hole spacing. As the blast progresses, the free face progresses back into the rock mass. In the case of Plan A, the beginning free face is represented by the heavy line in front of the blast. The first hole that fires in the middle of Row 1 breaks up the rock around it, and the free face (unconfined face) relocates in between the #1 hole and the #2 set of holes. When the holes designated #2 fire the free face relocates to in between the #2 and #3 holes, etc. For Plan A, as the ground rises the free face height increases requiring more blasting agent in the corresponding holes.

The delay period is a cumulative number. In the sample worksheet example, the hole denoted by a 1 is the POI, or point of initiation, so it has a zero delay period. The #2 holes fire next after a 10-ms delay. There is a 10-ms delay between the #2 and #3 holes, so the delay period for the #3 holes is the sum of previous delay periods (10 ms from #1 to #2 + 10 ms for #2 to #3), etc.

Figure 7B–5 Subgrade drilling



Maximum No. of holes per delay is the maximum number of holes that will ignite (detonate) at any one time. This should be stated or otherwise denoted in the blasting plan.

Maximum weight of blasting agent per delay is the maximum weight of blasting agent ignited at any one time. This should also be stated or otherwise denoted in the blasting plan. This is a significant value because an increase in this value will result in an increase in ground vibrations and air blast that may damage nearby buildings, structures, or utilities. See section 645.0701(c), Blast monitoring.

Distance, direction, and identification of nearest building, structure, or utility should be addressed when designing the blast. This value along with the rock characteristics can be used to determine the maximum weight of blasting agent per delay to avoid damage to the building, structure, or utility.

Type of material blasted should be noted in the blasting plan. The type of material being blasted must be known when designing the blast. And records of previous blasts of similar materials are valuable when designing future blasts. Good finished grade of a homogeneous rock is easier to accomplish than that of a material that is

NEH 645 WS 7.3 Report of Blasting Operation—continued

layered with materials of various hardness and density. It may be helpful to describe the material being blasted in more detail and sketch a cross section of the material if it is not homogeneous. Such details may be sketched on the back side of the worksheet or on an attached separate sheet. Note on the front of the worksheet if additional sheets are attached.

Mats or other precautions used—Mats are sometimes used to cover the blast area to prevent fly rock and reduce air blast. Mats are generally required when blasting near buildings, structures or utilities that could be damaged from fly rock or air blast. They are less likely to be required or needed on work in rural areas.

Seismograph Records where required—The information required here is self explanatory. See section 645.0701(c) for more information on blast monitoring.

Sketch on revise side of WS 7.3—The layout of blast holes should be sketched on the grid paper on the back of WS 7.3. Include a scale for measuring distances. Indicate the burden distance (B) and hole spacing (S). Include the numerical delay sequence showing when each blast hole will ignite relative to the other holes. The examples shown on the sample worksheet were taken from a document about quarry blasting. These are shown to illustrate several different blast patterns (identified as Plan A through Plan G) depending on the geometry of the area to be blasted. These are all plan views. Section views may also be helpful to fully describe the blast. Note that plan A corresponds with the sample report for Cow Bayou Site 4.

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Sample NEH 645 WS 7.3

U.S. Department of Agriculture
Natural Resources Conservation Service

NEH 645 WS 7.3

REPORT OF BLASTING OPERATION

Project Cow Bayou Site 4 Reported by: Earl Grey Date 1/6/2012

Time of blast 10:00 a.m. Weather conditions Dry (X) Foggy ( ) Clear (X) Cloudy ( ) Rain ( ) Snow ( )

Temperature 58 (°F) Wind direction SW Approximate wind velocity 5 (mph)

Exact location of blast 50 to 100 feet left of auxillary spillway CL sta. 3+100 to 3+40

Company A.B. Donegan, Inc. Address 349 Frisco St., Anytown, USA 76000

Name of blaster Burt Donegan Blaster's license number BR549

Blasting agent #1 and density ANFO-P 0.85 g/cm^3 Powder factor 1 (lb/yd^3) Dia. of holes 3 (in)

Blasting agent #2 and density ______ Powder factor ______ (lb/yd^3) Dia. of holes ______ (in)

Burden/spacing 4 (ft)/ 8 (ft) Type/depth of stemming ASTM C33 sand / 6 (ft)

Method of initiation: Electric (X) Nonelectric ( ) Other ______

Delay types 10-ms caps Type of circuit, if electric Series-in-parallel

Row #																		
	Hole I.D.	3	2	1	2	3												
1	Collar elev.	92.1	92.0	91.8	91.9	91.9												
	Bottom elev.	82.0	82.0	82.0	82.0	82.0												
	Charge (lb)	12	12	12	12	12												
	Delay period (ms)	20	10	0	10	20												
	Hole I.D.	4	3	2	3	4												
2	Collar elev.	93.3	93.1	93.0	93.1	93.1												
	Bottom elev.	82.0	82.0	82.0	82.0	82.0												
	Charge (lb)	13	13	13	13	13												
	Delay period (ms)	30	20	10	20	30												
	Hole I.D.	5	4	3	4	5												
3	Collar elev.	94.5	94.3	94.2	94.2	94.1												
	Bottom elev.	82.0	82.0	82.0	82.0	82.0												
	Charge (lb)	14	14	14	14	14												
	Delay period (ms)	40	30	20	30	40												
	Hole I.D.																	
	Collar elev.																	
	Bottom elev.																	
	Charge (lb)																	
	Delay period (ms)																	

Maximum no. of holes per delay 5 Maximum weight of blasting agent per delay 64 (lb)

Distance, direction, and identification of nearest building, structure, or utility N.A.

Type of material blasted: Limestone X Shale ____ Sandstone ____ Slate ____ Other ______

Mats or other precautions used ______

Seismograph records where required

Location of seismograph(s) used N.A.

Distance of seismograph from blast ______ Seismic data ______

Name of the person taking seismograph reading ______

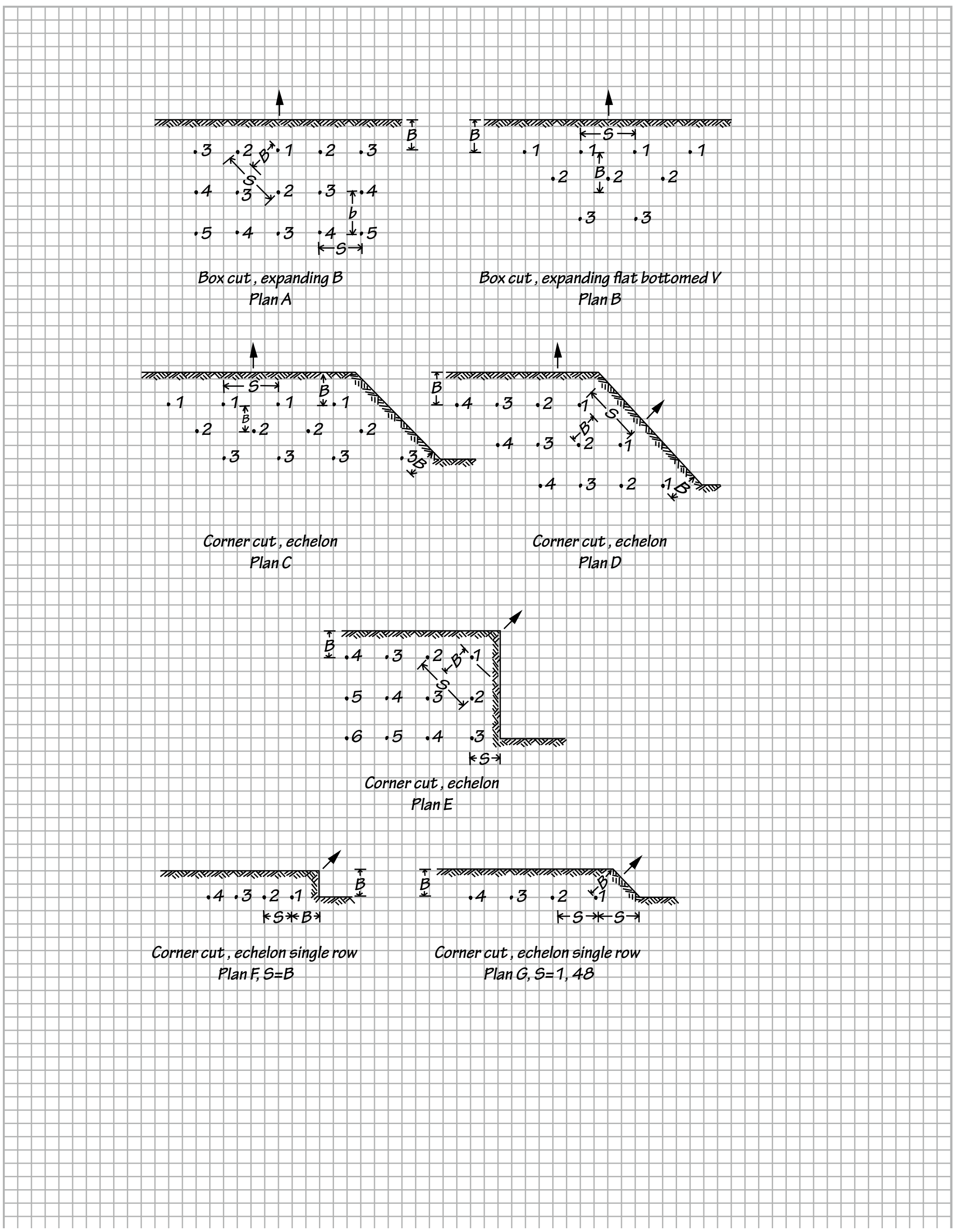
Sample NEH 645 WS 7.3—continued

U.S. Department of Agriculture
Natural Resources Conservation Service

Page 2 of 2

NEH 645 WS 7.3

Draw a sketch of the general location and layout. Include the numerical delay sequence. Show location of free faces and trend of backslope as applicable.



Box cut, expanding B
Plan A

Box cut, expanding flat bottomed V
Plan B

Corner cut, echelon
Plan C

Corner cut, echelon
Plan D

Corner cut, echelon
Plan E

Corner cut, echelon single row
Plan F, S=B

Corner cut, echelon single row
Plan G, S=1, 48

NEH 645 WS 7.3

REPORT OF BLASTING OPERATION

Project________________________ Reported by: ________________Date __________

Time of blast _______ Weather conditions Dry ( ) Foggy ( ) Clear ( ) Cloudy ( ) Rain ( ) Snow ( )

Temperature _______ (°F) Wind direction __________ Approximate wind velocity _______ (mph)

Exact location of blast ____

Company __________________________ Address __________________________

Name of blaster __________________________ Blaster's license number ______________

Blasting agent #1 and density________________ Powder factor _____ (lb/yd³) Dia. of holes _____ (in)

Blasting agent #2 and density________________ Powder factor _____ (lb/yd³) Dia. of holes _____ (in)

Burden/spacing ______ (ft)/ ______ (ft) Type/depth of stemming ______________ /______ (ft)

Method of initiation: Electric ( ) Nonelectric ( ) Other ______________________

Delay types __________________________ Type of circuit, if electric ______________

Row #	Hole I.D.																	
	Collar elev.																	
	Bottom elev.																	
	Charge (lb)																	
	Delay period (ms)																	
	Hole I.D.																	
	Collar elev.																	
	Bottom elev.																	
	Charge (lb)																	
	Delay period (ms)																	
	Hole I.D.																	
	Collar elev.																	
	Bottom elev.																	
	Charge (lb)																	
	Delay period (ms)																	
	Hole I.D.																	
	Collar elev.																	
	Bottom elev.																	
	Charge (lb)																	
	Delay period (ms)																	

Maximum no. of holes per delay ______________ Maximum weight of blasting agent per delay ____ (lb)

Distance, direction, and identification of nearest building, structure, or utility ______________

____

____

Type of material blasted: Limestone _____ Shale _____ Sandstone _____ Slate _____ Other __________

Mats or other precautions used ____

Seismograph records where required

Location of seismograph(s) used ____

Distance of seismograph from blast ____________________ Seismic data ______________

Name of the person taking seismograph reading ______________________________

Name of the person/firm analyzing seismograph record ________________________

NEH 645 WS 7.3

Draw a sketch of the general location and layout. Include the numerical delay sequence. Show location of free faces and trend of backslope as applicable.

U.S. Department of Agriculture
Natural Resources Conservation Service

Sheet _____ of_____

NEH 645 WS 7.3

REPORT OF BLASTING OPERATION

Project ______________________________________ Reported by ___________________ Date ________________

Row #	Hole I.D.																	
	Collar elev.																	
	Bottom elev.																	
	Charge (lb)																	
	Delay period (ms)																	
	Hole I.D.																	
	Collar elev.																	
	Bottom elev.																	
	Charge (lb)																	
	Delay period (ms)																	
	Hole I.D.																	
	Collar elev.																	
	Bottom elev.																	
	Charge (lb)																	
	Delay period (ms)																	
	Hole I.D.																	
	Collar elev.																	
	Bottom elev.																	
	Charge (lb)																	
	Delay period (ms)																	
	Hole I.D.																	
	Collar elev.																	
	Bottom elev.																	
	Charge (lb)																	
	Delay period (ms)																	
	Hole I.D.																	
	Collar elev.																	
	Bottom elev.																	
	Charge (lb)																	
	Delay period (ms)																	
	Hole I.D.																	
	Collar elev.																	
	Bottom elev.																	
	Charge (lb)																	
	Delay period (ms)																	
	Hole I.D.																	
	Collar elev.																	
	Bottom elev.																	
	Charge (lb)																	
	Delay period (ms)																	

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NRCS–ENG–005

The NRCS–ENG–005 form is used to notify the landowner-operator or sponsoring organization of their responsibilities when buried utilities are known to be in the vicinity of proposed work. The attendant form NRCS–ENG–006 is a check sheet used to verify and document that NRCS actions related to buried utilities in the vicinity of the proposed work comply with NRCS policy.

NRCS policy set forth in the National Engineering Manual (NEM) requires the responsible NRCS employee to notify the landowner-operator or sponsoring organization if buried utilities are known to be in the vicinity of proposed work. Policy requires that they be notified of their responsibility to take the following actions:

Step 1 Notify the Utility Notification Center (i.e., One Call Center, Dig Safe, or equivalent) or the affected utility company of time, place, and type of work to be performed.

Step 2 Request that the utility owner locate and stake the buried utility on the ground, both horizontally and vertically.

Step 3 Request that a representative of the utility company be present during any excavation operations.

Step 4 Notify the contractor of the location of the utility in relation to the job work area.

Step 5 Supply to the NRCS in writing either the ticket number from the Utility Notification Center or a certification that the affected utility company has been notified. States may set up their own procedures, with the aforementioned being the minimum requirement. Failure to notify the NRCS that utilities have been contacted will result in termination of NRCS assistance.

The NEM states that the responsible NRCS employee must ensure that these steps are carried out by the landowner-operator or sponsoring organization before beginning work in the vicinity of the buried utility and document any action taken pertaining to work in the vicinity of buried utilities. Documentation may be in the job diary, conservation assistance notes, or a separate checklist.

One option for documenting these actions is completion of the NRCS–ENG–005 and NRCS–ENG-006. NRCS–ENG–005 is a notification to the landowner-operator or sponsoring organization of their responsibilities and provides a means for them to certify that they have completed the items for which they are responsible. NRCS–ENG–005 is mailed to the landowner-operator or sponsoring organization, returned to the NRCS, and filed with other documentation pertaining to work in the vicinity of the buried utility. A sample illustrating and describing the completion of the NRCS–ENG–006 is also provided in NEH 645, Appendix B.

The steps for completing NRCS–ENG–005 are:

Steps performed by the NRCS:

Step 1 Enter the name of the utility company and type of utility in the blanks provided in the paragraph above the list of responsibilities.

Step 2 Have the District Conservationist or other responsible NRCS employee sign on the line provided below the list of responsibilities.

Step 3 Fold the form so that the list of responsibilities can be seen and staple or tape the form to ensure that it remains folded in the mail.

Step 4 Address and mail the form to the landowner-operator or sponsoring organization.

NRCS–ENG–005—continued

Steps performed by the landowner-operator or sponsoring organization:

Step 1 Complete the portion listing the landowner's name and address, the name and address of the utility company, the name and title of the utility representative, etc.

Step 2 Sign and date at the bottom of the form.

Step 3 Fold the form so that the portion completed by the landowner-operator or sponsoring organization can be seen and staple or tape the form to ensure that it remains folded in the mail.

Step 4 Address and mail the form back to the originating NRCS office.

Steps performed by NRCS upon receipt of the returned form:

Step 1 Verify and document on the NRCS–ENG–006 that NRCS–ENG–005 has been completed and signed by the landowner-operator or sponsoring organization.

Step 2 File the form with other documentation pertaining to work in the vicinity of the buried utility.

Sample NRCS–ENG–005

U.S. Department of Agriculture
Natural Resources Conservation Service

NRCS-ENG-005

U.S. Department of Agriculture
Natural Resources Conservation Service

Ray Handcock
Rt. 1, Box 27A
Jewett, TX 75861

OFFICIAL BUSINESS
Penalty for Private Use, $300

TO: Mr. John Evans
District Conservationist
USDA-NRCS
P.O. Box 101A
Centerville, TX 75902

Landowner's name Ray Handcock	Address Rt. 1, Box 27A Jewett, TX 75861
Utility company XTO Energy	Address P.O. Box 767 Hearn, TX 75961
Utility representative notified (*Name*) Elmer Justis	Title Public Liaison
If Utility notified by letter, date of acknowledgement of receipt	NA
Utility representative will locate and stake	Yes ☑ No ☐
Utility representative will be present during construction	Yes ☐ No ☑
Contractor notified (*Name & Title*) Larry Cordel, Owner	Date 7/30/2012
Owner—Operator—Sponsor (*Signature*) Ray Handcock	Date 7/30/2012

Sample NRCS–ENG–005—continued

U.S. Department of Agriculture
Natural Resources Conservation Service

NRCS-ENG-005

Dear

Because of the great hazard to life and property from the disturbance of utilities by construction or foundation investigation equipment and because the conservation work to be done on land controlled by you is in the vicinity of *XTO Energy* (UTILITY CO.) *Gas Pipeline* (TYPE OF UTILITY), before work proceeds it is your responsibility to do the following:

1. Notify the utility company of the location and kind of work to be done and the proposed date that work will start.
2. Request that the utility owner assist in locating and staking the utility on-site.
3. Request that a utility company employee be present during construction within the utility right-of-way.
4. Notify contractor of location of utility.
5. Fill out and sign the attached postcard and return to the Natural Resources Conservation Service.

John Evans
DISTRICT CONSERVATIONIST

U.S. Department of Agriculture
Natural Resources Conservation Service

P.O. Box 101A
Centerville, TX 75902

OFFICIAL BUSINESS

Ray Handcock
Rt. 1, Box 27A
Jewett, TX 75861

U.S. Department of Agriculture
Natural Resources Conservation Service

NRCS-ENG-005

U.S. Department of Agriculture
Natural Resources Conservation Service

OFFICIAL BUSINESS
Penalty for Private Use, $300

TO:

Landowner's name	Address
Utility company	Address
Utility representative notified (*Name*)	Title
If Utility notified by letter, date of acknowledgement of receipt	
Utility representative will locate and stake	Yes ☐ No ☐
Utility representative will be present during construction	Yes ☐ No ☐
Contractor notified (*Name & Title*)	Date
Owner—Operator—Sponsor (*Signature*)	Date

Dear

Because of the great hazard to life and property from the disturbance of utilities by construction or foundation investigation equipment and because the conservation work to be done on land controlled by you is in the vicinity of ______________________________,
UTILITY CO. TYPE OF UTILITY
before work proceeds it is your responsibility to do the following:

1. Notify the utility company of the location and kind of work to be done and the proposed date that work will start.
2. Request that the utility owner assist in locating and staking the utility on-site.
3. Request that a utility company employee be present during construction within the utility right-of-way.
4. Notify contractor of location of utility.
5. Fill out and sign the attached postcard and return to the Natural Resources Conservation Service.

____
DISTRICT CONSERVATIONIST

U.S. Department of Agriculture
Natural Resources Conservation Service

OFFICIAL BUSINESS

NRCS–ENG–006, Utility Check Sheet

The NRCS–ENG–006 form is a check sheet used to verify and document that NRCS actions related to buried utilities in the vicinity of the proposed work comply with NRCS policy.

NRCS policy set forth in the National Engineering Manual (NEM) requires the responsible NRCS employee to notify the landowner-operator or sponsoring organization if buried utilities are known to be in the vicinity of proposed work. Policy requires that they be notified of their responsibility to take the following actions:

Step 1 Notify the Utility Notification Center (i.e., One Call Center, Dig Safe, or equivalent) or the affected utility company of time, place, and type of work to be performed.

Step 2 Request that the utility owner locate and stake the buried utility on the ground, both horizontally and vertically.

Step 3 Request that a representative of the utility company be present during any excavation operations.

Step 4 Notify the contractor of the location of the utility in relation to the job work area.

Step 5 Supply to NRCS in writing either the ticket number from the Utility Notification Center or a certification that the affected utility company has been notified. States may set up their own procedures, with the aforementioned being the minimum requirement. Failure to notify the NRCS that utilities have been contacted will result in termination of NRCS assistance.

The NEM states that the responsible NRCS employee must ensure that these steps are carried out by the landowner-operator or sponsoring organization before beginning work in the vicinity of the buried utility and document any action taken pertaining to work in the vicinity of buried utilities. Documentation may be in the job diary, conservation assistance notes, or a separate checklist.

One option for documenting these actions is completion of the NRCS–ENG–005 and NRCS–ENG–006. A sample illustrating and describing the completion of the NRCS–ENG–005 is also provided in NEH 645, Appendix B.

The steps for completing NRCS–ENG–006, Utility Check Sheet are:

Steps performed by NRCS:

Step 1 Upon return of the NRCS–ENG–005 or after notifying the landowner-operator or sponsoring organization by another means, begin filling out the NRCS–ENG–006. Recording the farm name, location, utilities involved and location of utilities involved, and the name of the notified landowner-operator or sponsoring organization representative. Also record how and when the landowner-operator or sponsoring organization was notified.

Step 2 Record items listed on the utility check sheet as they are completed.

Step 3 When all items on the check sheet have been completed, sign and file the form with other documentation pertaining to work in the vicinity of the buried utility.

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Sample NRCS–ENG–006

U.S. Department of Agriculture
Natural Resources Conservation Service

NRCS-ENG-006

NEH 645 WS NRCS-ENG-006

UTILITY CHECK SHEET

Farm Name: Ray Handcock   Location: Leon County, Texas

Utilities Involved and Location: Underground natural gas line
ETO Energy   Located approximately 200 feet east of excavation

Landowner or operator notified: Ray Hancock (Who)   John Evans (By whom)

How: NRCS-ENG-005   Date: 7-26-2012

Work to be done: Pit-type pond   When: 8-6-9-2012

Utility Company Notified: Elmer Jones (Who)   Ray Handcock (By whom)

How: Telephone   Date: 7-30-2012

Request to locate utility: Yes

Work to be done: Location flagged   When: 8-1-2012

Request for Company representative to be present: Yes

Utility marked or staked: Yes   Date: 8-1-2012

Representative present during construction: ______

Contractor Notified: Larry Cordel (Who)   Ray Handcock (By whom)

How: In person   Date: 7-30-2012

Type of utility: Buried gas line   Location: Outside of work area

Vertical location in relation to work: 6 feer below surface

Horizontal location in relation to work: 200 feet east of exc. limits

Contractor shown markings or stakes: Yes

Utility location shown on plans: Yes

Other remarks: Utility well marked. No excavation or earthfill will occur on utility right-of-way.

John Evans
Signature

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NEH 645 WS NRCS-ENG-006

UTILITY CHECK SHEET

Farm Name ______________________ Location ______________________

Utilities Involved and Location ______________________

____

Landowner or operator notified ______________________ ______________________
Who By whom

How ______________________ Date ______________________

Work to be done ______________________ When ______________________

Utility Company Notified ______________________ ______________________
Who By whom

How ______________________ Date ______________________

Request to locate utility ______________________

Work to be done ______________________ When ______________________

Request for Company representative to be present ______________________

Utility marked or staked ______________________ Date ______________________

Representative present during construction ______________________

Contractor Notified ______________________ ______________________
Who By whom

How ______________________ Date ______________________

Type of utility ______________________ Location ______________________

Vertical location in relation to work ______________________

Horizontal location in relation to work ______________________

Contractor shown markings or stakes ______________________

Utility location shown on plans ______________________

Other remarks ______________________

____

____
Signature

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NEH 645 WS 8.1 Test Fill Report

Test fills are sometimes required by the design engineer to develop workable design values for borrow containing appreciable amounts of oversized material or to verify that the method of compacting the fill can attain the desired density. The contract will specify the procedures required to construct the test fill. The following are common in most test fill requirements:

- Material shall be taken from the appropriate borrow source or adjacent identical deposits.
- Test fill shall be constructed, if possible, such that it can be incorporated into the structure.
- Test fill shall be a minimum of 2 feet thick or greater, if needed, due to a soft foundation.
- Minimum size of test section shall be 30 feet wide and 200 feet long.
- Evaluation of test fill shall include:
  * In-place dry density and moisture content of the mass
  * Type and kind of compaction equipment
  * Sequence of placement and compaction process
  * Number of passes and forward speed of compactor
  * Lift thickness before and after compaction
  * When compacted materials are to be sent to the soil mechanics lab, collect undisturbed cores or hand-cut samples of shales, sandstones, or other degradable material from the test fill as required by the lab to determine design values.
- Test at least four locations at any time there is a material change or change in the placement or compaction method.
- Test at least 5 feet from the sides and 25 feet from the ends of the test section.
- Make tests in at least three separate lifts.

It is important to keep complete and accurate records during performance of the test fill. The design engineer and/or other technical specialists should be given the opportunity to attend and observe construction of the test section.

This worksheet may need to be adapted to fit the test fill conditions and specific contract requirements. More than one copy of the worksheet may be needed to document the complete test fill process. The inspector should record the compaction equipment, settings and number of passes required to achieve the desired density. In order for this test fill to be representative of the actual compaction process during placement of earthfill, the same compaction equipment must be used.

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Sample NEH 645 WS 8.1

U.S. Department of Agriculture
Natural Resources Conservation Service

NEH 645 WS 8.1

TEST FILL REPORT

Project name Rusty Creek Site II Location Haley, OK

Contract no. 52-7335-4-104 Contractor Ramp Construction

Inspector J. Smith Date 9-14-14 Time 10:30 am

Location of test fill Sta. 7+50 - 9+50 ℄ Embankment Elev. 917.0

Specified lift thickness (in) 9 Specified mass dry density (lb/ft^3) 105.0 Specified moisture content 12.0–17.0

Material

Placing method	Types of fill	Unified classification	% Oversized fraction	Maximum particle size (in)
Dump trucks	Earthfill	SM	45	6

Test Fill Field Data

Thickness of fill (in)	Length and width (ft)	Lift thickness before/after (in)	Location of test			In-place mass dry density (lb/ft^3)	Moisture content of test fill (%)	Test no.
			Station (X)	Offset (Y)	Elevation (Z)			
40	200 x 30	9/6	8+25	℄	917.0	106.1	13.1	01
40	200 x 30	9/6	8+75	10' L	917.0	105.7	12.9	02
40	200 x 30	9/6	9+00	10' R	917.0	107.0	13.4	03
40	200 x 30	9/6	9+20	℄	917.0	105.5	12.6	04

Equipment

Type of compaction equipment	Amplitude setting[1]	Frequency setting[1]	Operational seed (mph)	Number of passes[2]
Acme TB 91 Sheepsfoot Roller	High	4	2.5	4

[1]Does not apply to plastic materials.
[2]The act of rolling forward past a point and then rolling in reverse past the same point is considered two passes.

Remarks

Signature of inspector J. Smith Date 9-14-14

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U.S. Department of Agriculture
Natural Resources Conservation Service

NEH 645 WS 8.1

TEST FILL REPORT

Project name ____ Location ________________________

Contract no. _______________________ Contractor ____

Inspector ____ Date ________________ Time ________________

Location of test fill ____

Specified lift thickness (in) _______ Specified mass dry density (lb/ft^3) ________ Specified moisture content __________

Material

Placing method	Types of fill	Unified classification	% Oversized fraction	Maximum particle size (in)

Test Fill Field Data

Thickness of fill (in)	Length and width (ft)	Lift thickness before/after (in)	Location of test			In-place mass dry density (lb/ft^3)	Moisture content of test fill (%)	Test no.
			Station (X)	Offset (Y)	Elevation (Z)			

Equipment

Type of compaction equipment	Amplitude setting[1]	Frequency setting[1]	Operational seed (mph)	Number of passes[2]

[1]Does not apply to plastic materials.
[2]The act of rolling forward past a point and then rolling in reverse past the same point is considered two passes.

Remarks ____

____

Signature of inspector ____ Date ______________________

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NEH 645 WS 8.2 Weekly Summary of Density Determinations

This worksheet is useful in providing intermittent reports to others on the results of compaction and moisture tests on a construction project. The following information is recorded on this form:

Test no.—Usually sequential numbered tests are recorded, but any format is acceptable as long as it references back to the individual test.

Date—The date the test was performed in the field.

Location—The location on the project where the test was taken (dam, auxiliary spillway dike, cutoff trench, bottom of pit, side of pit).

Station no.—The station number along the centerline of the structure or the X-coordinate.

Distance right or left of centerline—The distance the test was offset from the centerline or the Y-coordinate.

Elevation—The ground surface elevation at the location of the test or the Z-coordinate.

Lab or field curve no.—The laboratory or field curve number for the compaction curve that was used to determine the optimum moisture content and maximum dry density.

Moisture (%)—The actual moisture content of the soil measured in this test. This will be the corrected moisture content if the moisture test requires a correction factor such as the quick dry method or nuclear moisture offset.

Optimum moisture (%)—The optimum moisture from the applicable lab or field curve.

Moisture range specified (%)—The allowable moisture range for this project.

Dry density (lb/ft^3)—The actual dry density obtained from your density test.

Maximum dry density (lb/ft^3)—The maximum dry density from the applicable lab or field curve.

Compaction (%)—Compute the percent compaction by dividing the actual dry density by the maximum dry density (dry density ÷ maximum dry density).

Compaction specified (%)—The minimum required density as a percentage of the maximum dry density from the requirements for this project.

Instructions to contractor—Record anything that was communicated to the contractor as a result of this test.

Tested by—The name or initials of the inspection personnel who conducted this test.

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Sample NEH 645 WS 8.2

U.S. Department of Agriculture
Natural Resources Conservation Service

NEH 645 WS 8.2

WEEKLY SUMMARY OF DENSITY DETERMINATIONS

Project name Rusty Creek Site no. 52-7335-4-104 Location Haley, OK

Contractor Ramp construction Contract no. 11 Report period from 9-15, 20 14

Submitted by J. SMith Date 9-19-14 to 9-19, 20 14

Test no.	Date	Location of sample				Lab or field curve no.	Moisture (%)	Optimum moisture (%)	Moisture range specified (%)	Dry density (lb/ft³)	Maximum dry density (lb/ft³)	Comp. (%)	Percent comp. specified (%)	Comment or corrective action	Tested by
		Location (dam, core, etc.)	Station (X)	Offset (Y)	Elevation (Z)										
21	9/15	Dam	7+00	10´R	916.5	FC 02	13.2	13.0	13.0-17.0	121.2	126.8	95.6	95	Pass	JDS
22	9/17	Dam	8+00	20´L	919.0	FC 02	13.5	13.0	13.0-17.0	123.0	126.8	97.0	95	Pass	JDS
23	9/18	Dam	7+50	15´L	920.0	FC 02	12.0	13.0	13.0-17.0	119.5	126.8	94.2	95	Fail/rework	JDS

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NEH 645 WS 8.2

WEEKLY SUMMARY OF DENSITY DETERMINATIONS

Project name______________________ Site no.____________ Location______________________

Contractor__________________ Contract no.__________________ Report period from__________, 20______

Submitted by______________________ Date__________________ to __________, 20______

Test no.	Date	Location of sample				Lab or field curve no.	Moisture (%)	Optimum moisture (%)	Moisture range specified (%)	Dry density (lb/ft^3)	Maximum dry density (lb/ft^3)	Comp. (%)	Percent comp. specified (%)	Comment or corrective action	Tested by
		Location (dam, core, etc.)	Station (X)	Offset (Y)	Elevation (Z)										

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NEH 645 WS 8.3 Determination of Volume of Compaction Mold

The purpose of Worksheet 8.3 is to determine the volume of the cylindrical molds used in the standard and modified compaction tests (ASTM D698 and D1557). The volume is also needed if the mold is being used in determination of the bulk density of sand used in the sand-cone method for in-place soil density as prescribed in Annex A.2 of ASTM D1556. This document is not a substitute for the actual instructions for determining the volume of the compaction molds found in Annex A.1 of the ASTM D668 or D1557.

The standards specify the nominal dimensions of all compaction molds along with allowable tolerances. Since molds come from different manufacturers of varying quality and repeated use can cause them to become misshapen over time, it is recommended that the volume of the molds be determined before initial use and periodically during use.

There are two procedures described in the ASTM standards, the water-filling method and the linear measurement method. There is also a provision for comparing the results of these two methods. The following information is recorded and calculated on this worksheet.

Water-filling method

Step 1 Record the mass of the mold and glass plates empty. This will include the complete apparatus used to determine the volume in a dry condition.

Step 2 Record the mass of the mold and glass plates full. After filling the mold with water and covering the top with a glass plate, dry the outside of the apparatus and weigh.

Step 3 Compute the mass of the water. [2] – [1]

Step 4 Record the temperature of the water.

Step 5 Determine the volume of water per gram from the included table or another source.

Step 6 Compute the volume of the mold as the mass of the water (in grams) multiplied by the volume of the water per gram. [3] × [5]

Step 7 Repeat the procedure for three trials and determine the average volume (V_w). Verify that this volume is within the specified tolerance of the standard.

Linear measurement method

Step 1 Using a vernier caliper or micrometer (preferred), measure and record to the nearest 0.001 inch the inside diameter of the top of the mold six times at evenly spaced locations around the mold.

Step 2 Repeat for the bottom of mold.

Step 3 Using these twelve measurements, compute the average inside diameter of the mold (d_{avg}). Verify from the standard that this ID is within the specified tolerance.

Step 4 Using a vernier caliper or depth micrometer (preferred), measure and record the height of the inside of the mold at least 3 times equally spaced around the mold.

NEH 645 WS 8.3 Determination of Volume of Compaction Mold—continued

Step 5 Compute the volume of the mold (V_{lm}). Verify that this volume is within the specified tolerance of the standard.

The difference in volume between the two methods should not exceed 0.5 percent of the nominal volume.

If any of the results are not within the specified tolerance, refer to Annex A.1 of the standard to determine if the mold should be replaced.

Sample NEH 645 WS 8.3

U.S. Department of Agriculture
Natural Resources Conservation Service

NEH 645 WS 8.3

DETERMINATION OF VOLUME OF COMPACTION MOLD
ASTM D698 and D1557

Tested by R. Mauldin Office Pearson WSO Date 9-23-15

Volume of mold water-filling method

		Trial 1	Trial 2	Trial 3
1. Mass of mold and glass plates empty	g	5,530	5,530	5,530
2. Mass of mold and glass plates full	g	6,469	6,465	6,470
3. Mass of water = [2] − [1]	g	939	935	940
4. Temperature of water	specify ˚C or ˚F	24 °C	24 °C	24 °C
5. Volume of water per gram (from table below)	ml/g	1.00268	1.00268	1.00268
6. Volume of mold = [3] × [5]	ml	941.5	937.5	942.5
7. Volume of mold (V_w) (average of 3 trials)	ml			940.5

Conversion table–volume of water per gram, based on temperature

Degrees ˚C	Degrees ˚F	Volume of water (ml/g)	Degrees ˚C	Degrees ˚F	Volume of water (ml/g)
12	53.6	1.00048	24	75.2	1.00268
14	57.2	1.00073	26	78.8	1.00320
16	60.8	1.00103	28	82.4	1.00375
18	64.4	1.00138	30	86.0	1.00435
20	68.0	1.00177	32	89.6	1.00497
22	71.6	1.00221			

Note: 453 g = 1 lb: 1 g @ 4 ˚C (39.2 ˚F) = 1 ml

Linear measurement method

	Top diameter of mold (in)	Bottom diameter of mold (in)	Height of mold (in)
1.	3.993	3.992	4.580
2.	3.994	3.994	4.581
3.	3.994	3.995	4.579
4.	3.993	3.993	4.582
5.	3.993	3.992	4.580
6.	3.992	3.995	4.580

Average Diameter d_{avg} = 3.993 (in)

Average Height h_{avg} = 4.580 (in)

Volume $V_{lm} = (16.387 \text{ ml/in}^3) \times (3.14159 \times h_{avg} \times (d_{avg})^2)/4$ = 939.8 (ml)

Note: The difference between the two methods shall not exceed 0.5% of the nominal volume of the mold.

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Natural Resources Conservation Service

NEH 645 WS 8.3

DETERMINATION OF VOLUME OF COMPACTION MOLD
ASTM D698 and D1557

Tested by ______________________________ Office ____________________________ Date ________________________

Volume of mold water-filling method

		Trial 1	Trial 2	Trial 3
1. Mass of mold and glass plates empty ___________________________	g			
2. Mass of mold and glass plates full ______________________________	g			
3. Mass of water = [2] − [1] ____	g			
4. Temperature of water ____________________________	specify ˚C or ˚F			
5. Volume of water per gram (from table below) __________________	ml/g			
6. Volume of mold = [3] × [5] __________________________________	ml			
7. Volume of mold (V_w) (average of 3 trials) ______________________	ml			

Conversion table–volume of water per gram, based on temperature					
Degrees		Volume of water (ml/g)	Degrees		Volume of water (ml/g)
˚C	˚F		C	F	
12	53.6	1.00048	24	75.2	1.00268
14	57.2	1.00073	26	78.8	1.00320
16	60.8	1.00103	28	82.4	1.00375
18	64.4	1.00138	30	86.0	1.00435
20	68.0	1.00177	32	89.6	1.00497
22	71.6	1.00221			

Note: 453 g = 1 lb: 1 g @ 4 ˚C (39.2 ˚F) = 1 ml

Linear measurement method

	Top diameter of mold (in)	Bottom diameter of mold (in)	Height of mold (in)
1.			
2.			
3.			
4.			
5.			
6.			

Average Diameter d_{avg} = ___________ (in)

Average Height h_{avg} = _____________ (in)

Volume $V_{lm} = (16.387 \text{ ml/in}^3) \times (3.14159 \times h_{avg} \text{ x } (d_{avg})^2) /4$ = ___________ (ml)

Note: The difference between the two methods shall not exceed 0.5% of the nominal volume of the mold.

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NEH 645 WS 8.4 Worksheet for Reference Density Compaction Data and Compaction Curve ASTM D698 and D1557

Worksheet 8.4 is a two-page form used to determine a reference maximum dry density and optimum moisture content using the procedures outlined in ASTM D698 (Standard Proctor) and ASTM D1557 (Modified Proctor). The instructions given are no substitute for the complete instructions found in the applicable standard.

The process consists of compacting a soil into a mold of a known volume using a standard compactive effort, determining the moisture content and dry density of the soil at varying moisture contents, and plotting these points on a curve. From the resulting curve, it is possible to determine the maximum dry density and optimum water content of the soil.

ASTM D698 and D1557 are only applicable for soils that have 30 percent or less by mass retained on the three-quarter inch sieve. ASTM D1557, the Modified Proctor, is used when high densities are needed. ASTM D698, the Standard Proctor, is most often specified for NRCS work. Each standard has three methods (A, B, or C); the applicability of each method depends on the soil gradation. For soils that contain more than 30 percent by mass retained on the three-quarter inch sieve, it is common to specify method compaction rather than specify a minimum density that must be achieved. When method compaction is specified it is not necessary to determine the maximum dry density, but ASTM D698 or ASTM D1557, as applicable, may be specified to determine the optimum moisture content.

These tests are performed on the finer fraction of the material by running the sample through the appropriate sieve. If the material contains more than five percent oversized material, an oversized correction must be made in accordance with ASTM D4718. Worksheet 8.13 can be used for this purpose.

Page 1 of 2

Record the predetermined volume of the mold at the bottom of the worksheet in cubic feet. Worksheet 8.3 and Annex A1 of ASTM D698 and ASTM D1557 can be used to accurately determine the volume of the mold.

Compaction data

Step 1 Weigh and record the mass of the cylinder and moist soil.

Step 2 Record the predetermined mass of the empty cylinder.

Step 3 Compute the mass of the moist soil. [1] – [2]

Step 4 Compute the wet density of the soil. [3] ÷ volume of the cylinder

Step 5 Once the moisture content has been determined, compute the dry density of the soil.
([4] × 100) ÷ (100 + [12])

Moisture determination data

Step 6 Enter the container number for the moisture sample.

Step 7 Weigh and record the mass of the container and moist soil.

Step 8 Weigh and record the mass of the container and dry soil.

Step 9 Compute the mass of the moisture. [7] – [8]

NEH 645 WS 8.4 Worksheet for Reference Density Compaction Data and Compaction Curve ASTM D698 and D1557—continued

Step 10 Enter the predetermined mass of the container.

Step 11 Compute the mass of the dry soil. [8] – [10]

Step 12 Compute the moisture content, ([9] ÷ [11]) × 100, once other values have been completed.

Repeat the process at varying moisture contents such that at least two points are above and two points below the optimum moisture content.

Page 2 of 2

Step 1 Complete the heading information. Determine or estimate the specific gravity (G_S) as accurately as possible as it will affect the 100 percent saturation curve.

Step 2 Determine a scale for the X-axis (moisture content) and Y-axis (density) so that the range of moisture and densities will fit within the graph and use most of the allowable space.

Step 3 Plot all of the wet density points and connect the points with a smooth curve.

Step 4 Plot all of the dry density points and connect with a smooth curve.

Step 5 Determine and record the maximum dry density γ_d and optimum moisture content.

Step 6 Compute and plot a 100 percent saturation (zero air voids) curve using the zero air voids curve formula. $w_{sat} = ((\gamma_w \div \gamma_d) - (1 \div G_S)) \times 100$

The points used for the 100 percent compaction curve on the filled out example are:

Using G_S = 2.65:

Density (lb/ft³)	Moisture content (%)
105	21.7
110	19.0
115	16.5
120	14.2

The 100 percent saturation curve is helpful in determining if the dry density curve is completed correctly. The dry density curve should never intersect the 100 percent saturation curve. The optimum moisture is usually about 80 percent of the saturated moisture at the maximum dry density. The wet portion of the Proctor curve should run approximately parallel to the 100 percent saturation curve and be at a moisture content of approximately 90 percent of the 100 percent saturation curve. If any of these self-checks are off, it would be reason to suspect that the value of G_S is incorrect or the curve may be plotted incorrectly.

Useful conversions:

1 lb = 453.6 g

28,317 cm^3 = 1 ft^3

Sample NEH 645 WS 8.4

U.S. Department of Agriculture
Natural Resources Conservation Service

Page 1 of 2

NEH 645 WS 8.4

WORKSHEET FOR REFERENCE DENSITY COMPACTION DATA
ASTM D698 and D1557

Project Rusty Creek Site 11 Sample no. 404-3

Compaction data		Test no.					
		1	2	3	4	5	6
1. Weight of cylinder plus moist soil	lb	8.87	9.22	9.45	9.60	9.61	9.58
2. Weight of cylinder	lb	5.18	5.18	5.18	5.18	5.18	5.18
3. Weight of moist soil = [1] – [2]	lb	3.69	4.04	4.27	4.42	4.43	4.40
4. Wet density = [3] ÷ volume of cylinder	lb/ft^3	110.7	121.2	128.1	132.6	132.9	132.0
5. Dry density = ([4] × 100) ÷ (100 + [12])	lb/ft^3	104.1	111.7	116.1	117.9	116.5	113.8

Moisture determination							
6. Container no.	g	1	3	4	5	6	7
7. Weight of container plus moist soil	g	118.4	136.1	146.7	154.7	149.8	167.4
8. Weight of container plus dry soil	g	113.0	127.5	135.5	140.5	134.5	148.0
9. Weight of moisture = [7] – [8]	g	5.4	8.6	11.2	14.2	15.3	19.4
10. Weight of container	g	27.0	26.0	26.5	27.0	26.0	26.5
11. Weight of dry soil = [8] – [10]	g	86.0	101.5	109.0	113.5	108.5	121.5
12. Moisture content = ([9] ÷ [11]) × 100	%	6.3	8.5	10.3	12.5	14.1	16.0

Volume of cylinder 1/30 ft^3 ASTM Standard D698 ☑ D1557 ☐ Method A

Procedure data: weight of hammer 5.5 lb, drop 12 in, number of lifts 3x25 blows

Completed by J. Smith Date 8/1/14 Computed by J. Smith Date 8/1/14

Checked by D. Walker Date 8/5/14 Recorded by D. Walker Date 8/5/14

Sample NEH 645 WS 8.4—continued

Page 2 of 2

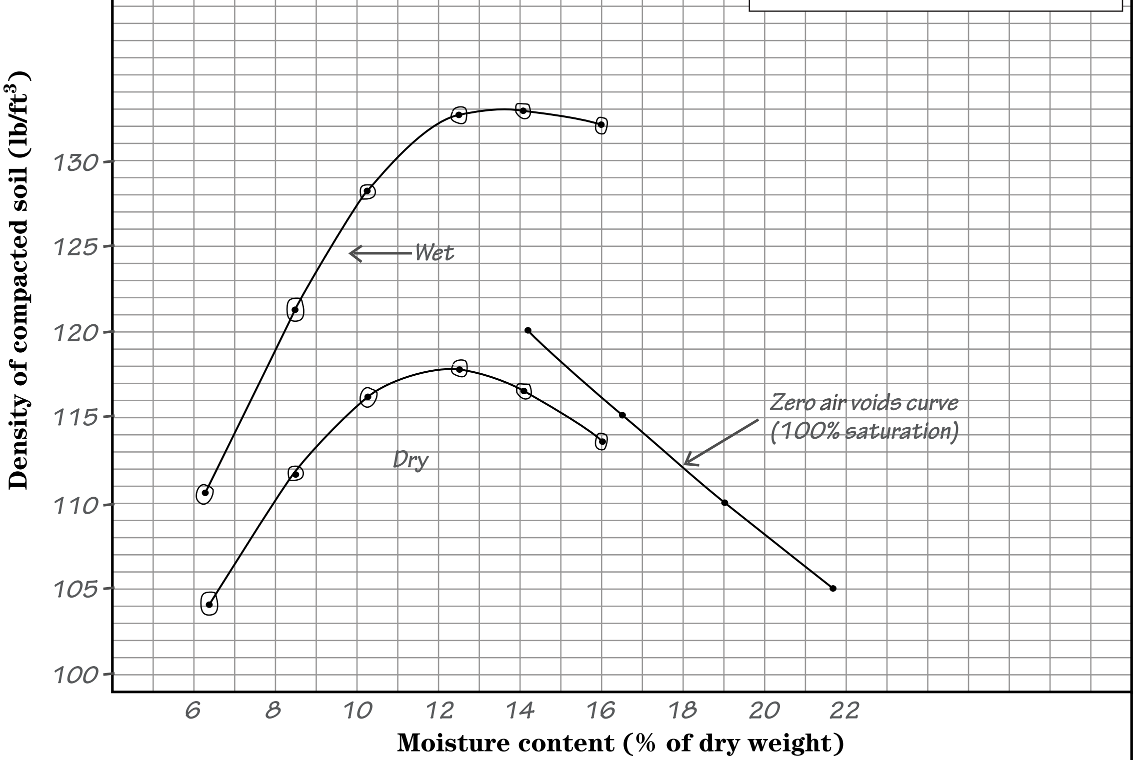
U.S. Department of Agriculture
Natural Resources Conservation Service

NEH 645 WS 8.4

REFERENCE DENSITY COMPACTION CURVE
ASTM D698 and D1557

Project name Rusty Creek Site no. 11 Location Haley, OK
Field sample no. 404-3 Location of material Borrow area C Depth 6.0 – 10.8 ft
Geologic origin Alluvium Tested at Fort Worth SML Approved by R. Jacks Date 8/5/14
Classification SM LL 25 PL 3 Curve no. 3 of 12
Maximun particle size in test ______ Standard (ASTM D-698), method A
Specific gravity (G_s) - No. 4 4.76 Modified (ASTM D-1557), method ______
+ No. 4 2.65

Maximum γ_d 117.9 lb/ft^3
Optimum moisture 12.5 %
Natural moisture ______ %



Remarks ______

Zero air voids curve: $W_{sat}=((\gamma_w/\gamma_d) - (1/G_s)) \times 100$ | γ_w=density of water (62.4 lb/ft^3) | γ_d= a chosen dry density

U.S. Department of Agriculture
Natural Resources Conservation Service

NEH 645 WS 8.4

WORKSHEET FOR REFERENCE DENSITY COMPACTION DATA
ASTM D698 and D1557

Project ________________________ Site ______________ Sample no. ____________

Compaction data	Test no.					
1. Weight of cylinder plus moist soil ____________ lb						
2. Weight of cylinder ________________ lb						
3. Weight of moist soil = [1] – [2] ____________ lb						
4. Wet density = [3] ÷ volume of cylinder ________ lb/ft³						
5. Dry density = ([4] × 100) ÷ (100 + [12]) ________ lb/ft³						

Moisture determination						
6. Container no. ________________ g						
7. Weight of container plus moist soil ____________ g						
8. Weight of container plus dry soil ____________ g						
9. Weight of moisture = [7] – [8] ____________ g						
10. Weight of container ________________ g						
11. Weight of dry soil = [8] – [10] ____________ g						
12. Moisture content = ([9] ÷ [11]) × 100 ________ %						

Volume of cylinder ____________ ft³ ASTM Standard D698 ☐ D1557 ☐ Method ________

Procedure data: weight of hammer ________ lb, drop ________ in, number of lifts ________________

Completed by ____________ Date ________ Computed by ____________ Date ________

Checked by ____________ Date ________ Recorded by ____________ Date ________

Standard (ASTM D-698), method______________________
Modified (ASTM D-1557), method____________________

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NEH 645 WS 8.4

REFERENCE DENSITY COMPACTION CURVE
ASTM D698 and D1557

Project name__________________________ Site no. _________________ Location_____________________

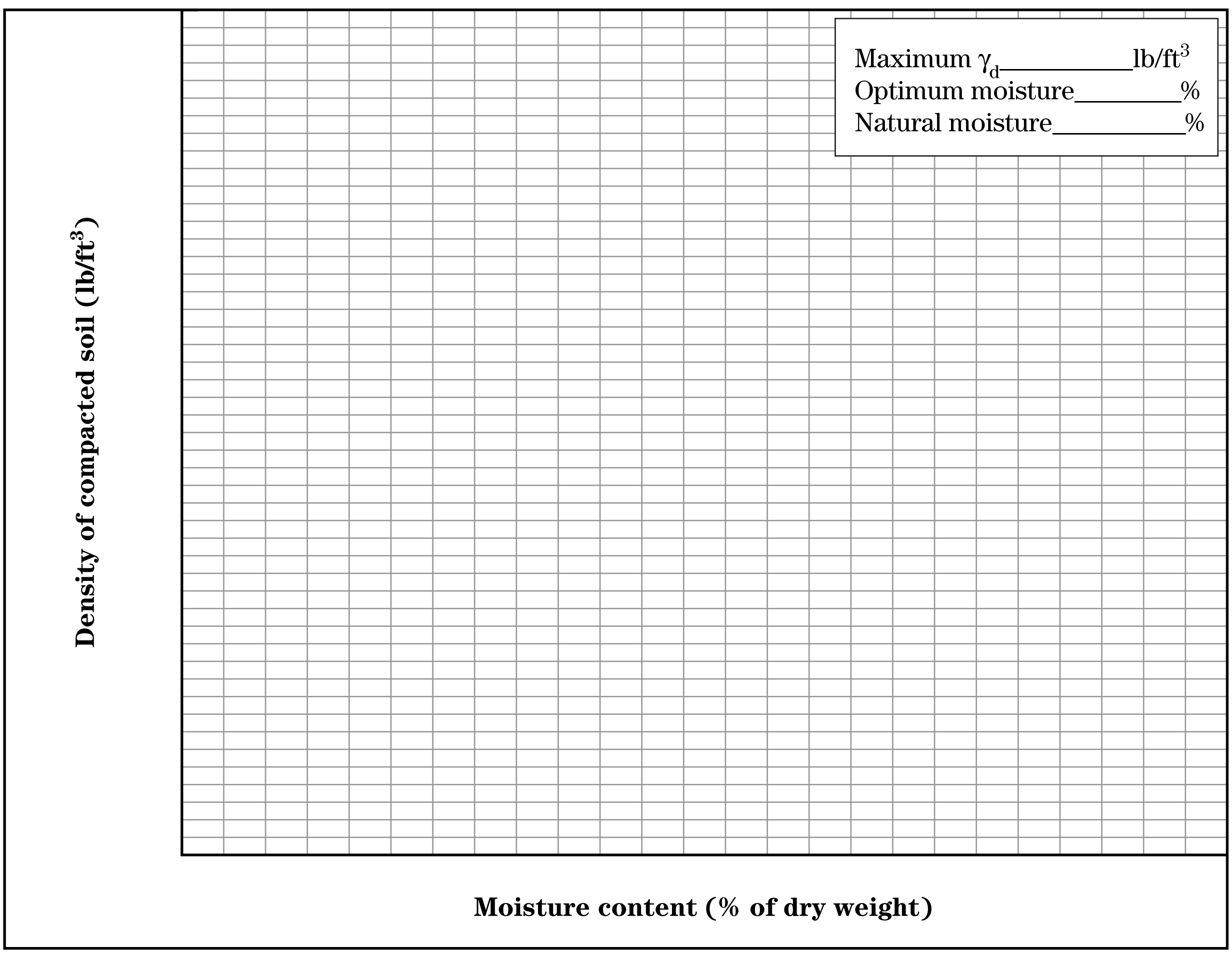
Field sample no.____________ Location of material_________________________ Depth__________________

Geologic origin______________ Tested at__________________ Approved by____________ Date___________

Classification_________________ LL____________ PL___________ Curve no.____________ of_____________

Maximun particle size in test_________________

Specific gravity (G_s) - No. 4__________
+ No. 4__________



Remarks____

____

____

Zero air voids curve: $W_{sat}=((\gamma_w/\gamma_d) - (1/G_s)) \times 100$ | γ_w=density of water (62.4 lb/ft^3) | γ_d= a chosen dry density

NEH 645 WS 8.5 Moisture Correction Determination

Worksheet 8.5 was created as a convenient place for recording the soil moisture from five ASTM standards. This may be helpful in tracking moisture tests that were not part of an associated compaction test or for comparing the results in order to determine a moisture correction.

Most reference moisture tests (i.e. moisture tests used to develop the Proctor curve) are performed using the oven dry method (ASTM D2216). Results obtained from ASTM D2216 are considered to be the most accurate. All other tests approximate the soil moisture content. Field testing using other methods may result in consistent values above or below the oven dry moisture. A correlation between results from other methods and those obtained by ASTM D2216 may be required. This form will allow the user to capture data, make that comparison, and compute a correction.

The following information is recorded or computed on this worksheet:

Step 1 Record the test number, date, Proctor curve number, and location of the test in the appropriate column.

Steps 2–6 apply to ASTM D2216, D4959, and D4643

Step 2 Weigh and record the mass of the moist sample and container (WW).

Step 3 Weigh and record the mass of the dry sample and container (DW).

Step 4 Record the previously determined mass of the container (TW).

Step 5 Compute the moisture content. $w\% = [(WW - DW) \div (DW - TW)] \times 100$

Step 6 Enter the test method used to obtain the moisture content.

- Oven (ASTM D2216)
- Direct heat (ASTM D4959)
- Microwave (ASTM D4643)
- Carbide (ASTM D4944)
- Nuclear (ASTM D6938)

Step 7 Enter the reference moisture and test method. In most cases this will be the oven dry method (ASTM D2216). In some circumstances, a microwave test (ASTM D4643) may be substituted if the oven dry method is unavailable.

Step 8 Compute the moisture correction.
moisture correction = reference moisture – test moisture content.

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Sample NEH 645 WS 8.5

U.S. Department of Agriculture
Natural Resources Conservation Service

NEH 645 WS 8.5

MOISTURE CORRECTION DETERMINATION

Kind of material SM Location Haley, OK Owner Jo Mackenzie
Project name Rusty Creek Site no. 11
Contract no. 52-7335-4-104 Contractor Ramp construction

Test no.	Date of test	Proctor no.	Location of test			WW[1] (g)	DW[1] (g)	TW[1] (g)	Moisture content (%)[2]	Test method[3]	Reference moisture (%)	Reference test method[3]	Moisture correction (%)[4]	Tested by
			Station (X)	Offset (Y)	Elevation (Z)									
104	9/14/14	FC #3	7+00	10'R	916.5	610	573.5	268	12.0	Oven	———	———	———	J. Smith
104	9/14/14	FC #3	7+00	10'R	916.5	610	569.9	269	13.3	Direct	12.0	Oven	-1.3	J. Smith
104	9/14/14	FC #3	7+00	10'R	916.5	———	———	———	12.8	Carbide	12.0	Oven	-0.8	J. Smith
104	9/14/14	FC #3	7+00	10'R	916.5	610	572.9	268	12.2	Microwave	12.0	Oven	-0.2	J. Smith
104	9/14/14	FC #3	7+00	10'R	916.5	———	———	———	13.0	Nuclear	12.0	Oven	-1.0	J.Smith

[1]WW–Weight of moist sample and container DW=Weight of dry sample and container TW=Weight of container
[2][(WW-DW) ÷ (DW-TW)] × 100
[3]Test methods: Oven (ASTM D2216), direct heat (ASTM D4959), microvave (ASTM D4643), carbide (ASTM D4944), or nuclear (ASTM D6938)
[4]Moisture correction = reference moisture - test moisture content

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MOISTURE CORRECTION DETERMINATION

Kind of material________________ Location________________ Owner________________

Project name________________ Site no.________________

Contract no.________________ Contractor________________

Test no.	Date of test	Proctor no.	Location of test			WW[1] (g)	DW[1] (g)	TW[1] (g)	Moisture content (%)[2]	Test method[3]	Reference moisture (%)	Reference test method[3]	Moisture correction (%)[4]	Tested by
			Station (X)	Offset (Y)	Elevation (Z)									

[1] WW–Weight of moist sample and container DW=Weight of dry sample and container TW=Weight of container

[2] [(WW-DW) ÷ (DW-TW)] × 100

[3] Test methods: Oven (ASTM D2216), direct heat (ASTM D4959), microvave (ASTM D4643), carbide (ASTM D4944), or nuclear (ASTM D6938)

[4] Moisture correction = reference moisture - test moisture content

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NEH 645 WS 8.6 Earthfill Construction Report

The Earthfill Construction Report serves as a methodical way to record all relevant information regarding the soil materials, borrow, processing and compaction of earthfill. A detailed account of the earthfill processing information might be helpful in the event of possible disputes or claims and also in training. At any time that additional documentation beyond what is usually recorded in the job diary is desired, Worksheet 8.6 provides guidance and an organized place to record that information.

The following information is recorded (as applicable) on this two-page worksheet:

Description of equipment

Step 1 Enter the borrow location.

Step 2 List the equipment used to excavate borrow and transport it to the fill location.

Step 3 List the equipment used on the fill to process the material prior to compaction. Include equipment for spreading and leveling, raking, disking and adding water.

Step 4 List the compaction equipment. Include the type, model number and any relevant features.

Description of Material Processing and Compaction Operations

Step 5 Enter the borrow location.

Step 6 Enter an in-place density test that represents the processing and compaction operations described.

Step 7 Describe the process being used to excavate borrow and transport it to the fill.

Step 8 Describe the placement and compaction operations by listing the equipment being used, use, sequence of operations, lift thickness, and any other operations that would constitute the completion of one lift.

Description of Materials

Step 9 Enter the borrow location.

Step 10 Enter the Proctor curve associated with this borrow material.

Step 11 Enter an in-place density test that represents the material being described.

Step 12 Enter the location where this earthfill is being placed.

Step 13 Enter the USCS classification for this soil.

Step 14 For rock materials, record the hardness and bulk density.

Step 15 Record an estimated average gradation for the material before and after compaction.

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Sample NEH 645 WS 8.6

U.S. Department of Agriculture
Natural Resources Conservation Service

NEH 645 WS 8.6

EARTHFILL CONSTRUCTION REPORT

Kind of material ___SM___ Location ___Haley, OK___ Owner ___Jo Mackenzie___

Project name ___Rusty Creek___ Site no. ___11___ Completed by ___C. Faye___ Date ___9-23-14___

Contract no. ___52-7335-4-104___ Contractor ___Ramp construction___

Description of Equipment

Borrow source	Equipment for processing and excavating borrow	Equipment for processing on the fill (ranking, grading, disking etc.)	Compaction equipment (type, total weight, average pressure-roller dimension, number and area of tamping feet or tires)
4+00 Grid C	Acme 723 Elevating scraper (2)	Acme J7 dozer (spreading) 36 in disk w/tractor	Acme RR-563 Pad-foot roller 25, 800 lb Drum width 7.0 ft Drum diameter 5.1 ft Centrifugal force low 25,000 lb high 50.000 lb

Description of Material Processing and Compaction Operations

Borrow source	In-place density test no.	Equipment for processing and excavating borrow	Placement and compaction on fill (equipment, number of passes, sequence of operations, lift thickness before and after treatment, etc.)
4+00 Grid C	22	Acme 723 elevating scraper (2)	(1) Spreading w/J7 dozer (9 in) (2) Water wagon- 2 passes (3) Disk- 3 passes (4) Roller-RR-563 4 passes (6 in) (5) Disk-lightly scarity

Sample NEH 645 WS 8.6—continued

U.S. Department of Agriculture
Natural Resources Conservation Service

NEH 645 WS 8.6

Page 2 of 2

DESCRIPTION OF MATERIALS

Borrow source	Proctor curve no.	In-place density test no.	Earthfill location or zone	USCS classification	Gravel and rock		Average gradatation for each borrow group and in-place tests for specific processing and compaction operations	
					Hardness	Bulk density	As dumped on fill, percent passing sieve (maximum size 6 in, 3 in, 1½ in, ¾ in, no. 4)	After compaction; percent passing sieve (maximum size 6 in, 3 in, 1½ ¾ in, no. 4)
4+00 grid C	FC #3	32	8+00 20'L	CH	N/A	N/A	50% Passing no. 4	100% Passing no. 4

U.S. Department of Agriculture
Natural Resources Conservation Service

NEH 645 WS 8.6

EARTHFILL CONSTRUCTION REPORT

Kind of material______________________ Location____________________________ Owner______________________

Project name____________________ Site no.______________ Completed by___________________ Date ______________

Contract no.______________________ Contractor____

Description of Equipment

Borrow source	Equipment for processing and excavating borrow	Equipment for processing on the fill (ranking, grading, disking etc.)	Compaction equipment (type, total weight, average pressure-roller dimension, number and area of tamping feet or tires)

Description of Material Processing and Compaction Operations

Borrow source	In-place density test no.	Equipment for processing and excavating borrow	Placement and compaction on fill (equipment, number of passes, sequence of operations, lift thickness before and after treatment, etc.)

NEH 645 WS 8.6

DESCRIPTION OF MATERIALS

Borrow source	Proctor curve no.	In-place density test no.	Earthfill location or zone	USCS classification	Gravel and rock		Average gradatation for each borrow group and in-place tests for specific processing and compaction operations	
					Hardness	Bulk density	As dumped on fill, percent passing sieve (maximum size 6 in, 3 in, 1½ in, ¾ in, no. 4)	After compaction; percent passing sieve (maximum size 6 in, 3 in, 1½ ¾ in, no. 4)

NEH 645 WS 8.7 Bulk Sand Density Determination and Calibration of Cone and Base Plate for ASTM D1556

The sand-cone test uses a standard apparatus to determine the volume of soil excavated from compacted fill by replacing it with sand of known bulk density. Worksheet 8.7 was developed to provide an organized way to record and compute the information necessary to determine the bulk density of the sand and to calibrate the cone and plate used in the sand-cone moisture-density test.

Two of the variables in this test that change periodically are the bulk density of the sand and the volume of the apparatus. The source of the sand, contamination, and humidity can affect the bulk density of the test sand. It is recommended that the sand bulk density be determined initially, at regular intervals, and when there is a significant change in humidity.

The sand-cone apparatus (cone and base plate) will contain a volume of sand that is not part of the volume of soil removed. This must be subtracted from the total to determine the test volume. This value will be different for each apparatus and can change over time through use of the equipment and changes in the bulk density of the sand. This calibration should be completed each time there is a change in the bulk density of the sand.

ASTM D1556, Annex A1 (Calibration of Sand Cone Apparatus) and A2 (Calibration of Density Sand), describe these procedures in detail. These instructions are no substitute for the full text of the standard. Refer to ASTM D1556 for a complete description of the procedures.

Bulk Density of Sand (Method A)

This is the preferred method.

Step 1 Enter the predetermined volume of the mold (or container) used. If a Proctor mold is used, worksheet 8.3 can be used to determine the volume of the mold.

Step 2 Record the initial mass of the jar (usually with cone attached) and sand.

Step 3 Record the final mass of the jar and sand.

Step 4 Compute the mass of the sand retained in the cone, plate, and mold. [2] – [3]

Step 5 Enter the predetermined mass of the sand retained in the cone and plate.

Step 6 Compute the mass of the sand retained in the mold. [4] – [5]

Step 7 Compute the bulk density of the sand. [6] ÷ [1]

Complete this test three times and determine the average. The maximum variation between any one test and the average should not exceed one percent.

Bulk Density of Sand (Method B)

(Note: A sample worksheet is not provided for Method B.)

Step 1 Enter the predetermined volume of the mold.

Step 2 Record the mass of the mold empty.

NEH 645 WS 8.7 Bulk Sand Density Determination and Calibration of Cone and Base Plate for ASTM D1556—continued

Step 3 Record the mass of the mold filled with sand.

Step 4 Compute the mass of the sand in the mold. [2] – [3]

Step 5 Compute the bulk density of the sand. [4] ÷ [1]

Complete this test three times and determine the average. The maximum variation between any one test and the average should not exceed one percent.

Weight of sand in cone and plate

Step 1 Weigh and record the initial mass of the jar and sand.

Step 2 Weigh and record the final mass of the jar and sand.

Step 3 Compute the mass of the sand required to fill the cone and base plate. [1] – [2]

Complete this test three times and determine the average. The maximum variation between any one test and the average should not exceed one percent. The final value represents the mass of sand that will be subtracted during subsequent ASTM D1556 moisture-density tests.

Useful conversions:

1 lb = 453.6 g
28,317 cm^3 = 1 ft^3

Sample NEH 645 WS 8.7

U.S. Department of Agriculture
Natural Resources Conservation Service

Page 1 of 2

NEH 645 WS 8.7

BULK SAND DENSITY DETERMINATION AND CALIBRATION OF CONE AND BASE PLATE FOR ASTM D1556

Project name Pine River Watershed #2 Location Pine Mountain, GA
Contractor Martin Const. Contract no. 12-13-108 Test no. 1
Material source Soil Test Co. Tested by R. White Date 4/10/15

Bulk density of sand (Method A)

	Trial 1	Trial 2	Trial 3	Avg.
1. Volume of mold, (predetermined) ______ ft^3	0.075	0.075	0.075	
2. Initial weight of jar + sand ______ lb	16.49	16.31	16.61	
3. Final weight of jar + sand ______ lb	4.82	4.72	5.00	
4. Weight of sand in cone, plate & mold [2] – [3] ____ lb	11.67	11.59	11.61	
5. Weight of sand in cone & plate (predetermined) ___ lb	4.24	4.24	4.24	
6. Weight of sand in mold [4] – [5] ______ lb/ft^3	7.43	7.35	7.37	
7. Bulk density of sand [6] ÷ [1] ______ lb/ft^3	99.1	98.0	98.3	98.4

	Trial 1	Trial 2	Trial 3
Percent difference from average	0.7	0.4	0.1

% Difference from avg. = [(avg. of 3 trials – Trial #___) / avg. of 3 trials] × 100
(Trials should not exceed 1% difference from the average.)

Weight of sand in cone & plate

	Trial 1	Trial 2	Trial 3	Avg.
1. Initial weight of jar + sand ______ lb	17.20	12.96	8.73	
2. Final weight of jar + sand ______ lb	12.96	8.73	4.48	
3. Weight of sand in cone and plate [1] – [2] ______ lb	4.24	4.23	4.25	4.24

	Trial 1	Trial 2	Trial 3
Percent difference from average	0	0.2	0.2

% Difference from avg. = [(avg. of 3 trials – Trial #___) / avg. of 3 trials] × 100
(Trials should not exceed 1% difference from the average.)

Sample NEH 645 WS 8.7—continued

U.S. Department of Agriculture
Natural Resources Conservation Service

NEH 645 WS 8.7

BULK SAND DENSITY DETERMINATION AND CALIBRATION OF CONE AND BASE PLATE FOR ASTM D1556

Project name ______________________ Location ______________________

Contractor ________________ Contract no. ________________ Test no. ________________

Material source ________________ Tested by ________________ Date ________________

Bulk density of sand (Method B)

	Trial 1	Trial 2	Trial 3	Avg.
1. Volume of mold, (predetermined) ________ ft^3				
2. Weight of mold ________ lb				
3. Weight of sand & mold ________ lb				
4. Weight of sand in mold [3] – [2] ________ lb				
5. Bulk density of sand [4] ÷ [1] ________ lb/ft^3				

	Trial 1	Trial 2	Trial 3
Percent difference from average			

% Difference from avg. = [(avg. of 3 trials – Trial #___) / avg. of 3 trials] × 100
(Trials should not exceed 1% difference from the average.)

NEH 645 WS 8.7

BULK SAND DENSITY DETERMINATION AND CALIBRATION OF CONE AND BASE PLATE FOR ASTM D1556

Project name ______________________ Location ______________________

Contractor ______________________ Contract no. ______________________ Test no. ______________________

Material source ______________________ Tested by ______________________ Date ______________________

Bulk density of sand (Method A)

	Trial 1	Trial 2	Trial 3	Avg.
1. Volume of mold, (predetermined) ______________ ft^3				
2. Initial weight of jar + sand ______________ lb				
3. Final weight of jar + sand ______________ lb				
4. Weight of sand in cone, plate & mold [2] – [3] ____ lb				
5. Weight of sand in cone & plate (predetermined) ___ lb				
6. Weight of sand in mold [4] – [5] ______________ lb/ft^3				
7. Bulk density of sand [6] ÷ [1] ______________ lb/ft^3				
	Trial 1	Trial 2	Trial 3	
Percent difference from average				

% Difference from avg. = [(avg. of 3 trials – Trial #___) / avg. of 3 trials] × 100
(Trials should not exceed 1% difference from the average.)

Weight of Sand in Cone & Plate

	Trial 1	Trial 2	Trial 3	Avg.
1. Initial weight of jar + sand ______________ lb				
2. Final weight of jar + sand ______________ lb				
3. Weight of sand in cone and plate [1] – [2] ________ lb				
	Trial 1	Trial 2	Trial 3	
Percent difference from average				

% Difference from avg. = [(avg. of 3 trials – Trial #___) / avg. of 3 trials] × 100
(Trials should not exceed 1% difference from the average.)

NEH 645 WS 8.7

BULK SAND DENSITY DETERMINATION AND CALIBRATION OF CONE AND BASE PLATE FOR ASTM D1556

Project name ________________________ Location ________________________

Contractor ____________________ Contract no. ________________ Test no. ______________

Material source ________________ Tested by ________________ Date ______________

Bulk density of sand (Method B)

	Trial 1	Trial 2	Trial 3	Avg.
1. Volume of mold, (predetermined) ____________ ft^3				
2. Weight of mold ____________ lb				
3. Weight of sand & mold ____________ lb				
4. Weight of sand in mold [3] – [2] ____________ lb				
5. Bulk density of sand [4] ÷ [1] ____________ lb/ft^3				

	Trial 1	Trial 2	Trial 3
Percent difference from average			

% Difference from avg. = [(avg. of 3 trials – Trial #___) / avg. of 3 trials] × 100
(Trials should not exceed 1% difference from the average.)

NEH 645 WS 8.8 In-Place Moisture-Density Determination: Sand-Cone Method ASTM D1556

The sand-cone method of moisture-density determination is described in ASTM D1556. These instructions are no substitute for the complete description in the standard. The sand-cone method is one of several procedures for determining the in-place density of soils. The rationale of most of these methods is the same. An amount of soil is excavated and saved in an air-tight container so that the mass of the soil and the moisture content can be determined. The remaining variable is the volume that soil occupied. In the sand-cone method, this volume is determined by replacing the soil with a sand of known bulk density using a standard apparatus and standard procedures.

Worksheet 8.8 consists of two pages. The first page allows entry of the location information, the specification requirements and the test results for four separate tests. The test data is recorded and results computed on the second page.

Page 1 of 2

Step 1 Enter the test number, date, location of the test, location and depth from which borrow (i.e. material being tested) was taken, and USCS material classification.

Step 2 Enter the size of the sand cone used for this test.

Step 3 Enter the test number and date for each of the tests conducted.

Step 4 Copy the required percent moisture range and percent compaction from the contract provisions.

Step 5 Upon completion of the test, return to this page to input the test results: percent moisture from the test, the dry density from the test, the laboratory or field curve number applicable for this soil, the maximum dry density from the proctor curve, and the percent compaction determined.

Step 6 Indicate in the remarks any unusual conditions of note and actions taken if a test fails.

Page 2 of 2

Volume determination

Record the test number in the appropriate column. This should correspond with a test number from page 1.

Step 1 Enter the predetermined bulk density of the sand used for this test. The bulk density of the sand must be computed initially and any time there is an appreciable change in humidity. The procedure is found in Annex A2 of ASTM D1556. Worksheet 8.7 can be used to determine bulk density of the sand.

Step 2 Weigh and record the initial mass of the sand, cone, and container.

Step 3 Weigh and record the final mass of the sand, cone, and container.

Step 4 Compute the mass of the sand in the mold, plate, and cone. [2] – [3]

NEH 645 WS 8.8 In-Place Moisture-Density Determination: Sand-Cone Method ASTM D1556—continued

Step 5 Enter the predetermined mass of the sand in the plate and cone. The procedure for obtaining this value is found in Annex A1 of ASTM D1556. Worksheet 8.7 can also be used to determine this value. It should be determined for each apparatus used, at regular intervals and any time the bulk density of the sand changes.

Step 6 Compute the mass of the sand in the hole. [4] – [5]

Step 7 Compute the volume of the hole. [6] ÷ [1]

Moisture Determination

Enter the container number for the moisture sample in the appropriate column and check the box indicating how the moisture sample was dried.

Step 8 Weigh and record the mass of the moist sample and container.

Step 9 Weigh and record the mass of the dry sample and container.

Step 10 Compute the mass of the moisture. [8] – [9]

Step 11 Enter the predetermined mass of the container.

Step 12 Compute the mass of the dry sample. [9] – [11]

Step 13 Compute the moisture content. ([10] ÷ [12]) × 100

Step 14 Enter the correction factor for ignition if direct heat is being used. Determine a correction factor for microwave drying.

Step 15 Compute the corrected moisture content. [13] – [14]

Density Determination

Enter the container number for the density sample. This contains all of the material excavated from the hole where the density test was conducted.

Step 16 Weigh and record the mass of the moist sample excavated from the test hole plus its container.

Step 17 Enter the predetermined mass of the container.

Step 18 Compute the mass of the moist sample. [16] – [17]

Step 19 Compute the wet density. [18] ÷ [7]

Step 20 Compute the dry density. [19] ÷ (1 + ([15] ÷ 100))

Step 21 Enter the maximum dry density from the compaction curve.

Step 22 Compute the percent compaction. ([20] ÷ [21]) × 100

Sample NEH 645 WS 8.8

U.S. Department of Agriculture
Natural Resources Conservation Service

Page 1 of 2

NEH 645 WS 8.8

IN-PLACE MOISTURE-DENSITY DETERMINATION: SAND CONE METHOD ASTM D1556

Location Faye, TX   Site no. 14B

Project name Cameron Creek

Contract no. 52-7335-7-140   Contractor Greasy Creek Const.

Tested by R. Smith   Computed by R. Smith   Checked by M. White

Test no.	Date	Location of test			Borrow source, location, and depth	USCS field classification ASTM D2487
		Station (X)	Offset (Y)	Elevation (Z)		
5	8/29/14	3+50	L 10 ft	1,201.5	7+00 Grid A 5-7 ft	℄

Size of sand cone 6 in

Test no.	Date	Spec. requirements		Test results				
		Moisture (%)	Compaction (%)	Moisture (%)	Dry density (lb/ft^3)	Curve no.	Maximum dry density (lb/ft^3)	Compaction (%)
5	8/29/14	-1+3 (16.1-20.1)	95	18.1	102.6	FC 4	105.5	97.2

Remarks

Sample NEH 645 WS 8.8—continued

U.S. Department of Agriculture
Natural Resources Conservation Service

Page 2 of 2

NEH 645 WS 8.8

IN-PLACE MOISTURE-DENSITY DETERMINATION: SAND CONE METHOD ASTM D1556

Volume determination		Test no.			
		5			
1. Bulk density of sand (predetermined)	lb/ft^3	98.5			
2. Initial weight of sand, cone, and container	lb	16.70			
3. Final weight of sand, cone, and container	lb	4.80			
4. Weight of sand in hole, plate, and cone = [2] – [3]	lb	11.90			
5. Weight of sand in plate plus cone (predetermined)	lb	4.24			
6. Weight of sand in hole = [4] – [5]	lb	7.66			
7. Volume of hole = [6] ÷ [1]	ft^3	0.078			

Moisture determination		Container no.			
		3			
Sample tested using: direct heat ____ oven ___ microwave ✔					
8. Weight of moist sample and container	g	401.3			
9. Weight of dry sample and container	g	354.1			
10. Weight of moisture = [8] – [9]	g	47.2			
11. Weight of container	g	93.1			
12. Weight of dry sample = [9] – [11]	g	261.0			
13. Moisture content = ([10] ÷ [12]) × 100	%	18.1			
14. Correction	%	—			
15. Corrected moisture content = [13] – [14]	%	18.1			

Density determination		Container no.			
		1			
16. Weight of moist sample plus container	lb	10.18			
17. Weight of container	lb	0.73			
18. Weight of moist sample= [16] – [17]	lb	9.45			
19. Wet density = [18] ÷ [7]	lb/ft^3	121.2			
20. Dry density = [19] ÷ (1 + ([15] ÷ 100))	lb/ft^3	102.6			
21. Maximum dry density from compaction curve	lb/ft^3	105.5			
22. Actual % compaction ([20] ÷ [21]) × 100	%	97.2			

NEH 645 WS 8.8

IN-PLACE MOISTURE-DENSITY DETERMINATION: SAND CONE METHOD ASTM D1556

Location ______________________________ Site no. ______________

Project name ____

Contract no. ______________ Contractor ______________________

Tested by ____________ Computed by ____________ Checked by ____________

Test no.	Date	Location of test			Borrow source, location, and depth	USCS field classification ASTM D2487
		Station (X)	Offset (Y)	Elevation (Z)		

Size of sand cone ______________________

Test no.	Date	Spec. requirements		Test results				
		Moisture (%)	Compaction (%)	Moisture (%)	Dry density (lb/ft^3)	Curve no.	Maximum dry density (lb/ft^3)	Compaction (%)

Remarks ____

NEH 645 WS 8.8

IN-PLACE MOISTURE-DENSITY DETERMINATION: SAND CONE METHOD ASTM D1556

Volume determination	Test no.			
1. Bulk density of sand (predetermined)________ lb/ft^3				
2. Initial weight of sand, cone, and container________ lb				
3. Final weight of sand, cone, and container________ lb				
4. Weight of sand in hole, plate, and cone = [2] – [3]________ lb				
5. Weight of sand in plate plus cone (predetermined)________ lb				
6. Weight of sand in hole = [4] – [5] ________ lb				
7. Volume of hole = [6] ÷ [1] ________ ft^3				

Moisture determination	Container no.			
Sample tested using: direct heat ____ oven ___ microwave ___				
8. Weight of moist sample and container ________ g				
9. Weight of dry sample and container ________ g				
10. Weight of moisture = [8] – [9] ________ g				
11. Weight of container ________ g				
12. Weight of dry sample = [9] – [11] ________ g				
13. Moisture content = ([10] ÷ [12]) × 100 ________ %				
14. Correction ________ %				
15. Corrected moisture content = [13] – [14] ________ %				

Density determination	Container no.			
16. Weight of moist sample plus container ________ lb				
17. Weight of container ________ lb				
18. Weight of moist sample= [16] – [17] ________ lb				
19. Wet density = [18] ÷ [7] ________ lb/ft^3				
20. Dry density = [19] ÷ (1 + ([15] ÷ 100)) ________ lb/ft^3				
21. Maximum dry density from compaction curve ________ lb/ft^3				
22. Actual % compaction ([20] ÷ [21]) × 100 ________ %				

NEH 645 WS 8.9 In-Place Moisture-Density Determination: Rubber Balloon Method ASTM D2167

The rubber balloon method of moisture-density determination is described in ASTM D2167. These instructions are no substitute for the complete description in the standard. The rubber balloon method is one of several procedures for determining the in-place density of soils. The rationale of most of these methods is the same. An amount of soil is excavated and saved in an air-tight container so that the mass of the soil and the moisture content can be determined. The remaining variable is the volume that soil occupied. In the rubber balloon method, this volume is determined by inflating a rubber balloon with water into the voided area and measuring the amount of water required to inflate the balloon. The test is conducted using a standard apparatus and standard procedures.

Worksheet 8.9 consists of two pages. The first page allows entry of the location information, the specification requirements and the test results for four separate tests. The second page is where information is recorded about the test and compute the necessary values.

Page 1 of 2

Step 1 Enter the test number, date, location of the test, location and depth from which borrow (i.e. material being tested) was taken, and USCS material classification.

Step 2 Again record the test number and date.

Step 3 Copy the required percent moisture range and percent compaction from the specifications.

Step 4 Upon completion of the test, return to this page to input the test results: percent moisture from the test, dry density from the test, laboratory or field Proctor curve number applicable for this soil, maximum dry density from the Proctor curve, and percent compaction determined.

Step 5 Indicate in the remarks any unusual conditions of note and actions taken if a test is shown to fail.

Page 2 of 2

Volume Determination

Record the test number in the appropriate column. This should correspond with a test number from page 1.

Step 1 Record the final reading from the volume indicator.

Step 2 Record the initial reading from the volume indicator.

Step 3 Compute the volume of the hole. [1] – [2]

Moisture Determination

Enter the container number for your moisture sample in the appropriate column and check the box indicating how the moisture sample was dried.

Step 4 Weigh and record the mass of the moist sample and container.

Step 5 Weigh and record the mass of the dry sample and container.

NEH 645 WS 8.9 In-Place Moisture-Density Determination: Rubber Balloon Method ASTM D2167—continued

Step 6 Compute the mass of the moisture. [4] – [5]

Step 7 Enter the predetermined mass of the container.

Step 8 Compute the mass of the dry sample. [5] – [7]

Step 9 Compute the moisture content. ([6] ÷ [8]) × 100

Step 10 Enter the correction factor for ignition if using direct heat. Determine a correction factor for microwave drying.

Step 11 Compute the corrected moisture content. [9] – [10]

Density Determination

Enter the container number for your density sample. This contains all of the material excavated from the hole where the density test is being conducted.

Step 12 Weigh and record the mass of the moist sample excavated from the test hole plus the container.

Step 13 Enter the predetermined mass of the container.

Step 14 Compute the mass of the moist sample. [12] – [13]

Step 15 Compute the wet density. [14] ÷ [3]

Step 16 Compute the dry density. [15] ÷ (1 + ([11] ÷ 100))

Step 17 Enter the maximum dry density from the compaction curve.

Step 18 Compute the percent compaction. ([16] ÷ [17]) × 100

Sample NEH 645 WS 8.9

U.S. Department of Agriculture
Natural Resources Conservation Service

Page 1 of 2

NEH 645 WS 8.9

IN-PLACE MOISTURE-DENSITY DETERMINATION: RUBBER BALLOON METHOD ASTM D2167

Location West Hollow, WV Site no. 3

Project name Rooty Creek Watershed

Contract no. 210-108-007 Contractor McCoy Const. Co.

Tested by R. Miller Computed by R. Miller Checked by M. Hunter

Test no.	Date	Location of test			Borrow source, location, and depth	USCS Material classification
		Station (X)	Offset (Y)	Elevation (Z)		
3	5/2/15	5+50	℄	1,186.5	Area #1 5-8 ft	ML

Test no.	Date	Spec. requirements		Test results				
		Moisture (%)	Compaction (%)	Moisture (%)	Dry density (lb/ft^3)	Curve no.	Maximum dry density (lb/ft^3)	Compaction (%)
3	5/2/15	±2 (17-21)	95	18.9	101.9	FC# 5	109.4	93.1

Remarks

Sample NEH 645 WS 8.9—continued

U.S. Department of Agriculture
Natural Resources Conservation Service

Page 2 of 2

NEH 645 WS 8.9

IN-PLACE MOISTURE-DENSITY DETERMINATION: TEST DATA FOR THE RUBBER BALLOON METHOD ASTM D2167

Volume Determination		Test No.			
		3			
1. Final reading	ft^3	0.0520			
2. Initial reading	ft^3	0.0124			
3. Volume of hole = [1] – [2]	ft^3	0.0396			

Moisture Determination		Container No.			
		6			
Sample tested using: direct heat ___ oven ___ microwave ✔					
4. Weight of moist sample and container	g	259.64			
5. Weight of dry sample and container	g	221.52			
6. Weight of moisture = [4] – [5]	g	38.12			
7. Weight of container	g	20.21			
8. Weight of dry sample = [5] – [7]	g	201.31			
9. Moisture content = ([6] ÷ [8]) 100	%	18.9			
10. Correction	%	—			
11. Corrected moisture content = [9] – [10]	%	18.9			

Density Determination		Container No.			
		2			
12. Weight of moist sample plus container	lb	5.25			
13. Weight of container	lb	0.45			
14. Weight of moist sample = [12] – [13]	lb	4.80			
15. Wet density = [14] ÷ [3]	lb/ft^3	121.2			
16. Dry density = [15] ÷ (1 + ([11] ÷ 100))	lb/ft^3	101.9			
17. Maximum dry density from compaction curve	lb/ft^3	109.4			
18. Actual % compaction ([16] ÷ [17]) × 100	%	93.1			

NEH 645 WS 8.9

IN-PLACE MOISTURE-DENSITY DETERMINATION: RUBBER BALLOON METHOD ASTM D2167

Location ______________________________ Site no. ____________

Project name ____

Contract no. ______________ Contractor ____________________________

Tested by ____________ Computed by ____________ Checked by ____________

Test no.	Date	Location of test			Borrow source, location, and depth	USCS Material classification
		Station (X)	Offset (Y)	Elevation (Z)		

Test no.	Date	Spec. requirements		Test results				
		Moisture (%)	Compaction (%)	Moisture (%)	Dry density (lb/ft^3)	Curve no.	Maximum dry density (lb/ft^3)	Compaction (%)

Remarks ____
____
____
____

NEH 645 WS 8.9

IN-PLACE MOISTURE-DENSITY DETERMINATION: TEST DATA FOR THE RUBBER BALLOON METHOD ASTM D2167

Volume Determination	Test No.			
1. Final reading ______ ft^3				
2. Initial reading ______ ft^3				
3. Volume of hole = [1] – [2] ______ ft^3				

Moisture Determination	Container No.			
Sample tested using: direct heat ____ oven ___ microwave ___				
4. Weight of moist sample and container ______ g				
5. Weight of dry sample and container ______ g				
6. Weight of moisture = [4] – [5] ______ g				
7. Weight of container ______ g				
8. Weight of dry sample = [5] – [7] ______ g				
9. Moisture content = ([6] ÷ [8]) 100 ______ %				
10. Correction ______ %				
11. Corrected moisture content = [9] – [10] ______ %				

Density Determination	Container No.			
12. Weight of moist sample plus container ______ lb				
13. Weight of container ______ lb				
14. Weight of moist sample = [12] – [13] ______ lb				
15. Wet density = [14] ÷ [3] ______ lb/ft^3				
16. Dry density = [15] ÷ (1 + ([11] ÷ 100)) ______ lb/ft^3				
17. Maximum dry density from compaction curve ______ lb/ft^3				
18. Actual % compaction ([16] ÷ [17]) × 100 ______ %				

NEH 645 WS 8.10 In-Place Moisture-Density Determination: Calibrated Cylinder Method ASTM D2937

The drive-cylinder method of moisture-density determination is described in ASTM D2937. These instructions are no substitute for the complete description in the standard. The drive-cylinder method is one of several procedures for determining the in-place density of soils. The rationale of most of these methods is the same. An amount of soil is excavated and saved in an air-tight container so that the mass of the soil and the moisture content can be determined. The remaining variable is the volume that soil occupied. In the drive-cylinder method, this volume has been predetermined as the volume of the calibrated cylinder that is driven into the soil and trimmed flush on each end. The volume of soil tested is thereby equal to the inside volume of the cylinder.

This is the most straight-forward of the mechanical moisture-density tests. Its shortcoming is that it is not appropriate for organic soils that compress easily, soils with appreciable amounts of gravel and low plasticity, or soils that are not retained in the cylinder once it has been extracted. This method almost always results in density values that are slightly higher than values obtained from other methods. This is because driving the cylinder into the fill tends to densify the soil nearest the cylinder.

Worksheet 8.8 consists of two pages. The first page allows entry of the location information, specification requirements, and test results for four separate tests. The second page is used to record information about the test and compute necessary values.

Page 1 of 2

Step 1 Enter the test number, date, location of the test, location and depth from which test sample was taken, and the USCS material classification.

Step 2 Enter the size of the sand cone used for this test.

Step 3 Again enter the test number and date.

Step 4 Copy the required percent moisture range and compaction from the contract provisions.

Step 5 Upon completion of the test, return to this page to input the test results: percent moisture from the test, dry density from the test, laboratory or field curve number applicable for this soil, maximum dry density from the Proctor curve and percent compaction determined.

Step 6 Indicate in the remarks any unusual conditions of note and actions taken if a test is shown to fail.

Page 2 of 2

Volume Determination

Record the test number in the appropriate column. This should correspond with a test number from page 1.

Step 1 Enter the predetermined volume of the cylinder. The procedure for determining the cylinder volume is found in Annex A1 of ASTM D2937.

NEH 645 WS 8.10 In-Place Moisture-Density Determination: Calibrated Cylinder Method ASTM D2937—continued

Moisture Determination

Enter the container number for the moisture sample in the appropriate column and check the box indicating how the moisture sample was dried.

Step 2 Weigh and record the mass of the moist sample and container.

Step 3 Weigh and record the mass of the dry sample and container.

Step 4 Compute the mass of the moisture. [2] – [3]

Step 5 Enter the predetermined mass of the container.

Step 6 Compute the mass of the dry sample. [3] – [5]

Step 7 Compute the moisture content ([4] ÷ [6]) × 100

Step 8 Enter the correction factor for ignition if using direct heat. Determine a correction factor for microwave drying.

Step 9 Compute the corrected moisture content. [7] – [8]

Density Determination

Enter the number of the calibrated cylinder used.

Step 10 Weigh and record the mass of the moist sample and the cylinder

Step 11 Enter the predetermined mass of the cylinder.

Step 12 Compute the mass of the moist sample. [10] – [11]

Step 13 Compute the wet density. [12] ÷ [1]

Step 14 Compute the dry density. [13] ÷ (1 + ([9] ÷ 100))

Step 15 Enter the maximum dry density from the compaction curve.

Step 16 Compute the percent compaction. ([14] ÷ [15]) × 100

Sample NEH 645 WS 8.10

U.S. Department of Agriculture
Natural Resources Conservation Service

Page 1 of 2

NEH 645 WS 8.10

IN-PLACE MOISTURE-DENSITY DETERMINATION: CALIBRATED CYLINDER METHOD TEST RECORD ASTM D2937

Location French Town, WV Site no. 3

Project name Middle Fork Watershed

Contract no. 12-10-400 Contractor Reed Const.

Tested by M. Hunter Computed by B. Dillard Checked by F. Sams

Test no.	Date	Location of test			Borrow source, location, and depth	USCS Material classification
		Station (X)	Offset (Y)	Elevation (Z)		
5	4/10/14	2+80	R 15 ft	1,160.0	Area #2 3–5 ft	MH

Test no.	Date	Spec. requirements		Test results				
		Moisture (%)	Compaction (%)	Moisture (%)	Dry density (lb/ft^3)	Curve no.	Maximum dry density (lb/ft^3)	Compaction (%)
5	4/10/14	-3+1 (14–18)	95	20.0	90.2	4	98.8	91.3

Remarks

Sample NEH 645 WS 8.10—continued

U.S. Department of Agriculture
Natural Resources Conservation Service

Page 2 of 2

NEH 645 WS 8.10

IN-PLACE MOISTURE-DENSITY DETERMINATION: CALIBRATED CYLINDER METHOD TEST DATA ASTM D2937

Volume determination	Test no.			
	5			
1. Volume of cylinder (volume of hole) ________________ ft^3	0.042			

Moisture determination	Container no.			
	3			
Sample tested using: direct heat ✔ oven ___ microwave ___				
2. Weight of moist sample plus container ______________ g	124.0			
3. Weight of dry sample plus container ________________ g	105.2			
4. Weight of moisture = [2] – [3] ____________________ g	18.8			
5. Weight of container _____________________________ g	13.9			
6. Weight of dry sample = [3] – [5] __________________ g	91.3			
7. Moisture content = ([4] ÷ [6]) ×100 ________________ %	20.6			
8. Correction ___________________________________ %	–0.6			
9. Corrected moisture content = [7] – [8] ______________ %	20.0			

Density determination	Cylinder no.			
	3			
10. Weight of moist sample plus cylinder ______________ lb	5.75			
11. Weight of cylinder ______________________________ lb	1.20			
12. Weight of moist sample = [10] – [11] ______________ lb	4.55			
13. Wet density = [12] ÷ [1] _________________________ lb/ft^3	108.3			
14. Dry density = [13] ÷ (1 + ([9] ÷ 100)) ______________ lb/ft^3	90.2			
15. Maximum dry density from compaction curve _______ lb/ft^3	98.8			
16. Actual % compaction ([14] ÷ [15]) ×100 ____________%	91.3			

NEH 645 WS 8.10

IN-PLACE MOISTURE-DENSITY DETERMINATION: CALIBRATED CYLINDER METHOD TEST RECORD ASTM D2937

Location ____________________ Site no. ____________

Project name ______________________________

Contract no. ____________ Contractor ____________________

Tested by __________ Computed by __________ Checked by __________

Test no.	Date	Location of test			Borrow source, location, and depth	USCS Material classification
		Station (X)	Offset (Y)	Elevation (Z)		

Test no.	Date	Spec. requirements		Test results				
		Moisture (%)	Compaction (%)	Moisture (%)	Dry density (lb/ft^3)	Curve no.	Maximum dry density (lb/ft^3)	Compaction (%)

Remarks ______________________________

NEH 645 WS 8.10

IN-PLACE MOISTURE-DENSITY DETERMINATION: CALIBRATED CYLINDER METHOD TEST DATA ASTM D2937

Volume determination	Test no.			
1. Volume of cylinder (volume of hole) ________________ ft^3				

Moisture determination	Container no.			
Sample tested using: direct heat ____ oven ___ microwave ___				
2. Weight of moist sample plus container _______________ g				
3. Weight of dry sample plus container ________________ g				
4. Weight of moisture = [2] – [3] ____________________ g				
5. Weight of container _____________________________ g				
6. Weight of dry sample = [3] – [5] __________________ g				
7. Moisture content = ([4] ÷ [6]) ×100 ________________ %				
8. Correction ____________________________________ %				
9. Corrected moisture content = [7] – [8] ______________ %				

Density determination	Cylinder no.			
10. Weight of moist sample plus cylinder _______________ lb				
11. Weight of cylinder ______________________________ lb				
12. Weight of moist sample = [10] – [11] ______________ lb				
13. Wet density = [12] ÷ [1] ________________________ lb/ft^3				
14. Dry density = [13] ÷ (1 + ([9] ÷ 100)) ______________ lb/ft^3				
15. Maximum dry density from compaction curve _______ lb/ft^3				
16. Actual % compaction ([14] ÷ [15]) ×100 ____________%				

NEH 645 WS 8.11 Nuclear Compaction Test Data – ASTM D6938

Worksheet 8.11 was created as a convenient place to record moisture-density test results conducted using the nuclear moisture-density gauge according to ASTM D6938. This worksheet allows the entry of multiple tests.

The following information is recorded on the worksheet:

- Test number
- Date
- Location of the test—location, station, offset, and elevation
- Testing mode and depth of the nuclear gauge
- Soil type
- Gauge values of wet density (lb/ft^3) and moisture content (%)
- Moisture correction for the gauge—Nuclear gauges measure moisture by measuring hydrogen atoms in the soil. It is assumed that every hydrogen atom is part of a water molecule, therefore hydrogen atoms that are not part of a water molecule will contribute to an artificially high reading. There are some soils where hydrogen atoms are masked. Therefore, the moisture values for all nuclear gauge moisture readings must be corrected either internally (in the gauge) or externally.
- Dry density, which may be read directly if the gauge does the moisture correction or computed manually if the moisture correction is done separately

Specification Requirements and Results

- Number of the laboratory or field Proctor curve associated with this test
- Maximum dry density from the Proctor curve
- Compaction requirement from the construction specifications
- Required dry density which is computed by multiplying the maximum dry density by the compaction requirement
- Optimum moisture from the compaction curve
- Required moisture limits (usually relative to the optimum moisture) from the construction specifications
- Actual percent compaction which is computed by dividing the measured dry density by the maximum dry density
- Result of the test (pass or fail)
- Name of the individual completing the test

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Sample NEH 645 WS 8.11

U.S. Department of Agriculture
Natural Resources Conservation Service

NEH 645 WS 8.11

NUCLEAR COMPATION TEST DATA FOR ASTM D6938

Project name________________

Site no.____________________

Location___________________

Contract no.________________

Gauge no.__________________

Test number		3			
Date		5/13/14			
Location		Embankment			
Station (X)		8+50			
Offset (Y)		30' Left			
Elevation (Z)		631.0			
Testing mode		60 sec			
Testing depth		8"			
Soil type		SM			
Wet density (lb/ft^3)		127.4			
Moisture (%)		15.2			
Moisture correction (%)		1.2			
Corrected moisture (%)		14.0			
Dry density (lb/ft^3)		111.7			

Specification Requirements and Results

Lab or field curve no.		Field Curve #2			
Maximum dry density (lb/ft^3)		118.0			
Compaction requirement (%)		95%			
Required dry density (lb/ft^3)		112.1			
Optimum moisture (%)		12.9			
Required moisture limits (%)		Opt to +4			
Actual percent compaction (lb/ft^3)		94.7			
Test result		Fail - Retest			
Tested by		J. Smith			

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U.S. Department of Agriculture
Natural Resources Conservation Service

NEH 645 WS 8.11

NUCLEAR COMPATION TEST DATA FOR ASTM D6938

Project name__________________

Site no.____________________

Location____________________

Contract no.________________

Gauge no.__________________

Test number					
Date					
Location					
Station (X)					
Offset (Y)					
Elevation (Z)					
Testing mode					
Testing depth					
Soil type					
Wet density (lb/ft^3)					
Moisture (%)					
Moisture correction (%)					
Corrected moisture (%)					
Dry density (lb/ft^3)					

Specification Requirements and Results

Lab or field curve no.					
Maximum dry density (lb/ft^3)					
Compaction requirement (%)					
Required dry density (lb/ft^3)					
Optimum moisture (%)					
Required moisture limits (%)					
Actual percent compaction (lb/ft^3)					
Test result					
Tested by					

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NEH 645 WS 8.12 In-Place Moisture-Density Determination: Template and Plastic Liner Method ASTM D5030

The Template and Plastic Liner Method (also called the Water Replacement Method in a Test Pit) of moisture-density determination is described in ASTM D5030. These instructions are no substitute for the complete description in the standard. The Template and Plastic Liner Method is one of several procedures for determining the in-place density of soils. The rationale of most of these methods is the same. An amount of soil is excavated and saved in an air-tight container so that the mass of the soil and the moisture content can be determined. The remaining variable is the volume that soil occupied. In the Template and Plastic Liner Method, this volume is determined by excavating a pit and determining the amount of water required to fill it using standard procedures described in ASTM D5030.

Worksheet 8.12 consists of two pages. The first page allows entry of the location information, the specification requirements and the test results for three separate tests. On the second page record information about the test and compute the necessary values.

Page 1 of 2

Step 1 Enter the test number, date, location of the test, location and depth from which the test sample was taken, and USCS material classification.

Step 2 Enter the size of the template used for this test.

Step 3 Again enter the test number and date.

Step 4 Copy the required percent moisture range and percent compaction from the contract provisions.

Step 5 Upon completion of the test, return to this page to input the test results: percent moisture from the test, dry density from the test, laboratory or field curve number applicable for this soil, maximum dry density from the Proctor curve and percent compaction determined.

Step 6 Indicate in the remarks any unusual conditions of note and actions taken if a test is shown to fail.

Page 2 of 2

Volume Determination

Record the test number in the appropriate column. This should correspond with a test number from page 1.

Step 1 Weigh and record the mass of the water and container before filling the template.

Step 2 Weigh and record the mass of the water and container after filling the template.

Step 3 Compute the mass of the water required to fill the template. [1] – [2]

Step 4 Weigh and record the mass of the water and container before filling the template and hole.

Step 5 Weigh and record the mass of the water and container after filling the template and hole.

NEH 645 WS 8.12 In-Place Moisture-Density Determination: Template and Plastic Liner Method ASTM D5030—continued

Step 6 Compute the mass of the water required to fill the template and hole. [4] – [5]

Step 7 Compute the mass of the water required to fill the hole. [6] – [3]

Step 8 Compute the volume of the hole [7] ÷ 62.4

Moisture Determination

Enter the container number for the moisture sample in the appropriate column and check the box indicating how the moisture sample was dried.

Step 9 Weigh and record the mass of the moist sample and container.

Step 10 Weigh and record the mass of the dry sample and container.

Step 11 Compute the mass of the moisture. [9] – [10]

Step 12 Enter the predetermined mass of the container.

Step 13 Compute the mass of the moist sample. [9] – [12]

Step 14 Compute the mass of the dry sample. [10] – [12]

Step 15 Compute the moisture content. ([11] ÷ [14]) × 100

Step 16 Enter the correction factor for ignition if using direct heat. Determine a correction factor for microwave drying.

Step 17 Compute the corrected moisture content. [15] – [16]

Density Determination

Enter the container number for your density sample. This contains all of the material excavated from the hole from where the test sample is obtained.

Step 18 Enter the total mass of the soil removed from the hole.

Step 19 Compute the moist density. [18] ÷ [8]

Step 20 Compute the dry density. [19] ÷ (1 + ([17] ÷ 100)).

Step 21 Enter the maximum dry density from the compaction Proctor curve.

Step 22 Compute the percent compaction. ([20] ÷ [21]) × 100

Sample NEH 645 WS 8.12

U.S. Department of Agriculture
Natural Resources Conservation Service

Page 1 of 2

NEH 645 WS 8.12

IN-PLACE MOISTURE-DENSITY DETERMINATION: TEMPLATE & PLASTIC LINER METHOD ASTM D5030

Location Haley, OK Site no. 11

Project name Cameron Creek

Contract no. 52-7335-4-104 Contractor Mack Construction Co.

Tested by J. Smith Computed by J. Smith Checked by J. Pullen

Test no.	Date	Location of test			Borrow source, location, and depth	USCS Material classification
		Station (X)	Offset (Y)	Elevation (Z)		
1	5/6/14	10+00	30' L	820.5	Area #1	℄

Size of template ______

Test no.	Date	Specified requirements		Test results				
		Moisture range (%)	Compaction (%)	Moisture (%)	Dry density (lb/ft^3)	Curve no.	Maximum dry density (lb/ft^3)	Compaction (%)
1	5/6/14	-2+2 (19-23)	95%	20.0	103.3	FC# 3	107.5	96.1

Remarks: ______

Sample NEH 645 WS 8.12—continued

U.S. Department of Agriculture
Natural Resources Conservation Service

Page 2 of 2

NEH 645 WS 8.12

IN-PLACE MOISTURE-DENSITY DETERMINATION: TEMPLATE & PLASTIC LINER METHOD ASTM D5030

Volume Determination		Test No.		
		1		
1. Weight of water plus container before filling template	lb	4,052		
2. Weight of water plus container after filling template	lb	3,856		
3. Weight of water required to fill template = [1] – [2]	lb	196		
4. Weight of water plus container before filling template and hole	lb	3,856		
5. Weight of water plus container after filling template and hole	lb	2,107		
6. Weight of water to fill template and hole = [4] – [5]	lb	1,749		
7. Net weight of water to fill hole = [6] – [3]	lb	1,553		
8. Volume of hole = [7] ÷ 62.4	ft^3	24.9		

Moisture Determination		Container No.		
		13		
Sample tested using: direct heat ____ oven ✓ microwave ____				
9. Weight of moist sample and container	g	250.0		
10. Weight of dry sample and container	g	210.5		
11. Weight of moisture = [9] – [10]	g	39.5		
12. Weight of container	g	20		
13. Weight of wet sample = [9] – [12]	g	230		
14. Weight of dry sample = [10] – [12]	g	190.5		
15. Moisture content = ([11] ÷ [14]) × 100	%	20.7		
16. Correction	%	0		
17. Corrected moisture content = [15] – [16]	%	20.7		

Density Determination		Test No.		
		1		
18. Total weight of soil removed from the hole	lb	3,105		
19. Total wet density = [18] ÷ [8]	lb/ft^3	124.7		
20. Total dry density = [19] ÷ (1 + ([17] ÷ 100))	lb/ft^3	103.3		
21. Maximum dry density from compaction curve	lb/ft^3	107.5		
22. Actual % compaction ([20] ÷ [21]) × 100	%	96.1		

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NEH 645 WS 8.12

IN-PLACE MOISTURE-DENSITY DETERMINATION: TEMPLATE & PLASTIC LINER METHOD ASTM D5030

Location ______________________________ Site no.______________

Project name ______________________________

Contract no. ______________ Contractor ______________________________

Tested by ______________ Computed by ______________ Checked by ______________

Test no.	Date	Location of test			Borrow source, location, and depth	USCS Material classification
		Station (X)	Offset (Y)	Elevation (Z)		

Size of template______________________________

Test no.	Date	Specified requirements		Test results				
		Moisture range (%)	Compaction (%)	Moisture (%)	Dry density (lb/ft^3)	Curve no.	Maximum dry density (lb/ft^3)	Compaction (%)

Remarks: ______________________________

EH 645 WS 8.12

IN-PLACE MOISTURE-DENSITY DETERMINATION: TEMPLATE & PLASTIC LINER METHOD ASTM D5030

Volume Determination		Test No.		
. Weight of water plus container before filling template ____________	lb			
. Weight of water plus container after filling template ______________	lb			
. Weight of water required to fill template = [1] – [2] ______________	lb			
. Weight of water plus container before filling template and hole _____	lb			
. Weight of water plus container after filling template and hole ______	lb			
. Weight of water to fill template and hole = [4] – [5] ______________	lb			
. Net weight of water to fill hole = [6] – [3] _______________________	lb			
. Volume of hole = [7] ÷ 62.4 ________________________________	ft^3			

Moisture Determination		Container No.		
ample tested using: direct heat ____ oven ____ microwave ____				
. Weight of moist sample and container _______________________	g			
0. Weight of dry sample and container ________________________	g			
1. Weight of moisture = [9] – [10] ____________________________	g			
2. Weight of container ____	g			
3. Weight of wet sample = [9] – [12] ___________________________	g			
4. Weight of dry sample = [10] – [12] __________________________	g			
5. Moisture content = ([11] ÷ [14]) × 100 _______________________	%			
6. Correction ____	%			
7. Corrected moisture content = [15] – [16] ____________________	%			

Density Determination		Test No.		
8. Total weight of soil removed from the hole __________________				
9. Total wet density = [18] ÷ [8] ______________________________	lb/ft^3			
0. Total dry density = [19] ÷ (1 + ([17] ÷ 100)) __________________	lb/ft^3			
1. Maximum dry density from compaction curve _________________	lb/ft^3			
2. Actual % compaction ([20] ÷ [21]) × 100 ____________________	%			

NEH 645 WS 8.13 Correction of Unit Weight and Water Content for Soils Containing Oversize Particles ASTM D4718

Worksheet 8.13 follows the procedures outlined in ASTM D4718 to correct the field test dry density and moisture content to equivalent values with the oversized material removed. It is intended to be used in conjunction with an appropriate moisture-density test and attached to those forms.

Laboratory tests from ASTM D698 and D1557 require that the material being tested be processed through a sieve (No. 4, 3/8 in. or ¾ in.). Oversized material generally increases the dry density and decreases the water content of a particular soil. These standards state that field tests of soils that contain appreciable amounts (more than 5%) of oversized material be corrected using the procedures in ASTM D4718. The standards also state the maximum percentage of oversized material allowed.

The following items shall be completed:

Mark the check box indicating the sieve size used to remove the oversized material (No. 4, 3/8 in or ¾ in)

Finer Fraction

Step 1 Weigh and record the mass of the moist finer material and container.

Step 2 Weigh and record the mass of the dry finer material and container.

Step 3 Compute the mass of the moisture in the finer material. M_{WF} = [1] – [2]

Step 4 Enter the mass of the container (predetermined).

Step 5 Compute the mass of the dry material. M_{DF} = [2] – [4]

Coarse Fraction

Step 6 Weigh and record the mass of the moist oversized material and container.

Step 7 Weigh and record the mass of the dry oversized material and container.

Step 8 Compute the mass of the moisture in the oversized material. M_{WC} = [6] – [7]

Step 9 Enter the mass of the container (predetermined).

Step 10 Compute the mass of the dry oversized material. M_{DC} = [7] – [9]

Step 11 Compute the water content of the oversized material as a decimal. w_c = [8] ÷ [10]

Percent Oversize Determination

Step 12 Compute the percentage of the finer fraction. P_F = 100 × [5] ÷ ([5] + [10])

Step 13 Compute the percentage of the coarse fraction. P_C = 100 × [10] ÷ ([5] + [10])

NEH 645 WS 8.13 Correction of Unit Weight and Water Content for Soils Containing Oversize Particles ASTM D4718—continued

Corrected Moisture Content

Step 14 Enter the moisture content of the field test as a decimal.

Step 15 Compute the corrected moisture content for the finer fraction.
$w_F = ((100 \times [14]) - ([11] \times [13])) \div [12]$

Corrected Dry Unit Weight

Step 16 Enter the dry unit weight (lb/ft^3) from the field test.

Step 17 Enter the specific gravity (determined by ASTM C127 or assumed).

Step 18 Compute the corrected dry unit weight of the finer fraction
$\gamma_F = ([16] \times [17] \times 62.4 \times [12]) \div ((100 \times [17] \times 62.4) - ([16] \times [13]))$

These computed values for corrected moisture content for the finer fraction (w_F) and corrected dry unit weight of the finer fraction (γ_F) can be compared to the appropriate compaction curve to determine if the test passes.

Sample NEH 645 WS 8.13

U.S. Department of Agriculture
Natural Resources Conservation Service

NEH 645 WS 8.13

CORRECTION OF UNIT WEIGHT AND WATER CONTENT FOR SOILS CONTAINING OVERSIZE PARTICLES
ASTM D4718

Location: Haynie, OK   Site no.: 12B

Project name: Tipton Creek

Contract no.: 52-7335-4-11   Contractor: Ace Construction

Tested by: R. Miller   Computed by: D. Finley   Checked by: R. Miller

Oversize fraction based on the following sieve size: No. 4 ☑ 3/8 in. ☐ 3/4 in. ☐

		Test no.			
		1			
Finer fraction		Container no.			
		3			
1. Mass of moist finer material and container	lb	15.15			
2. Mass of dry finer material and container	lb	13.2			
3. Mass of moisture in finer material: M_{WF} = [1] – [2]	lb	1.95			
4. Mass of container	lb	1.01			
5. Mass of dry finer material: M_{DF} = [2] – [4]	lb	12.19			
Course fraction		Container no.			
		1			
6. Mass of moist oversize material and container	lb	5.98			
7. Mass of dry oversize material and container	lb	5.74			
8. Mass of moisture in oversize material: M_{WC} = [6] – [7]	lb	0.24			
9. Mass of container	lb	1.11			
10. Mass of dry oversize material: M_{DC} = [7] – [9]	lb	4.63			
11. Water content of oversize material (as a decimal): w_C = [8] ÷ [10]		0.0518			
Percent oversize determination					
12. Percent finer fraction P_F = 100 × [5] ÷ ([5] + [10])	%	72.5			
13. Percent oversize fraction P_C = 100 × [10] ÷ ([5] + [10])	%	27.5			
Corrected moisture content					
14. Field moisture test (as a decimal)		0.167			
15. Corrected moisture content of finer fraction: w_F= ((100 × [14]) – ([11] × [13])) ÷ [12]		0.211			
Corrected dry unit weight					
16. Field dry unit weight	lb/ft^3	122.0			
17. Specific gravity of oversize fraction		2.35			
18. Corrected dry unit weight of finer fraction: γ_F = ([16] × [17] × 62.4 × [12]) ÷ ((100 × [17] × 62.4) – ([16] × [13]))	lb/ft^3	114.7			

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Natural Resources Conservation Service

NEH 645 WS 8.13

CORRECTION OF UNIT WEIGHT AND WATER CONTENT FOR SOILS CONTAINING OVERSIZE PARTICLES
ASTM D4718

Location ______________________ Site no.______________

Project name ______________________________________

Contract no. ______________ Contractor ______________________

Tested by __________ Computed by ___________ Checked by ____________

Oversize fraction based on the following sieve size: No. 4 ☐ 3/8 in. ☐ 3/4 in. ☐

	Test no.			
	Container no.			
Finer fraction				
1. Mass of moist finer material and container ______ lb				
2. Mass of dry finer material and container ______ lb				
3. Mass of moisture in finer material: M_{WF} = [1] – [2] ______ lb				
4. Mass of container ______ lb				
5. Mass of dry finer material: M_{DF} = [2] – [4] ______ lb				
	Container no.			
Course fraction				
6. Mass of moist oversize material and container ______ lb				
7. Mass of dry oversize material and container ______ lb				
8. Mass of moisture in oversize material: M_{WC} = [6] – [7] ______ lb				
9. Mass of container ______ lb				
10. Mass of dry oversize material: M_{DC} = [7] – [9] ______ lb				
11. Water content of oversize material (as a decimal): w_C = [8] ÷ [10] ______				
Percent oversize determination				
12. Percent finer fraction P_F = 100 × [5] ÷ ([5] + [10]) ______ %				
13. Percent oversize fraction P_C = 100 × [10] ÷ ([5] + [10]) ______ %				
Corrected moisture content				
14. Field moisture test (as a decimal) ______				
15. Corrected moisture content of finer fraction: w_F = ((100 × [14]) – ([11] × [13])) ÷ [12] ______				
Corrected dry unit weight				
16. Field dry unit weight ______ lb/ft^3				
17. Specific gravity of oversize fraction ______				
18. Corrected dry unit weight of finer fraction: γ_F = ([16] × [17] × 62.4 × [12]) ÷ ((100 × [17] × 62.4) – ([16] × [13])) ___ lb/ft^3				

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NEH 645 WS 9.1 Granular Material Application Rate

Whenever granular materials such as cement, pozzolan, lime, bentonite, or dispersants are broadcast onto the surface to be mixed with the soil on the ground, the inspector must assure that the materials are evenly distributed at the proper application rate. WS 9.1 may be used to verify and document the application rate.

The example given on page B–9.1–2 is for determining the application of cement being applied for incorporation into a 6-inch-thick compacted lift. For this example assume the rate was specified to be a minimum of 6.0 percent of the dry weight of compacted soil-cement mixture. The maximum dry density of the mixture was determined in the laboratory per ASTM D558 to be 133.9 lb/ft^3. The specification called for the mixture to be placed at a minimum dry density equal to 95 percent of the maximum dry density of the mixture (i.e., 127.2 lb/ft^3). The process for using this worksheet to determine the actual field application rate is as follows:

1. convert the application rate from percent of the dry weight of compacted soil-cement mixture to pounds per square foot of surface area,
2. place a tarpaulin of known weight in three locations in the path of cement distribution,
3. record the horizontal location of each tarp either by baseline and offset distance or by rectangular coordinates,
4. record the elevation of the surface of the lift at each tarp location,
5. after the distribution is made, carefully pick up each tarp preventing the loss of cement from the tarp,
6. weigh each tarp and cement,
7. subtract the weight of the tarp from the weight of the tarp and cement,
8. divide this value by the area of the tarp to yield the measured application rate in terms of lb/ft^2,
9. compare each measured application rate to the specified application rate,
10. comment if the measured rate is less than the specified rate and include the reason for the low rate and action taken to remedy problems.

The example given on page B–9.1–3 is for determining the application of soda ash being applied for incorporation into a 6 inch thick compacted lift. The process for using this worksheet to determine the actual field application rate is as follows:

1. convert the application rate from pounds per 100 square feet of surface per inch of lift depth to pounds per square foot of surface area,
2. place a tarpaulin of known weight in three locations in the path of soda ash distribution,
3. record the location of each tarp in terms of baseline and offset distance or rectangular coordinates,
4. record the elevation of the surface of the lift at each tarp location,
5. after the distribution is made carefully pick up each tarp preventing the loss of soda ash from the tarp,
6. weigh each tarp and soda ash,
7. subtract the weight of the tarp from the weight of the tarp and soda ash,
8. divided this value by the area of the tarp to yield the measured application rate in terms of lb/ft^2,
9. compare each measured application rate to the specified application rate,
10. comment if the measured rate is less than the specified rate and include the reason for the low rate and action taken to remedy problems.

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Sample NEH 645 WS 9.1

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NEH 645 WS 9.1 GRANULAR MATERIAL APPLICATION RATE

Site or owner Jerry Hernandez Structure Ag. Waste lagoon
Report no. 1 of 3 Date 4-1-05 Inspector B. Johnson
Placement no. or location Lift 1 of 2 in bottom and sides of lagoon
Weather Cloudy, cool Temp 49°F to 55°F
Source of amendments and type or class Soda ash from FMC
USCS class CL Proctor curve #1

Specified Application Rate

a.	Specified dry density of soil-amendment moisture=	—	lb/ft^3
b.	Specified amendment application rate=	—	%
c.	Specified amendment application rate=a–(a/(1+b/100))=	—	lb/ft^3
d.	Application rate per ft^2 of surface per inch of lift thickness=c/12=	0.025	$lb/ft^2/in$
e.	Thickness of lift into which the amendment will be incorporated=	6	in
f.	Specified application rate per ft^2=d x e=	0.15	lb/ft^2

Measured Application Rate

	Sample #1	Sample #2	Sample #3	Average
Station (x)	1,150	1,180	1,205	
Offset left(L) or right (R) of centerline (y)	155	180	210	
Elevation (z)	592.0	592.0	598.0	
Wt of tarpaulin + amendment (lb-oz)	2-2	2-1	2-2	
Wt. of tarpaulin (lb-oz)	0-12	0-12	0-12	
Wt. of amendment (lb-oz)	1-6	1-5	1-6	
Wt. of amendment (lb)	1.375	1.313	1.375	1.354
Area of tarpaulin (ft^2)	9	9	9	9
Wt. of amendment/area of tarpaulin (lb/ft^2)	0.153	0.146	0.153	0.151

Comments

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Sample NEH 645 WS 9.1

U.S. Department of Agriculture
Natural Resources Conservation Service

NEH 645 WS 9.1

GRANULAR MATERIAL APPLICATION RATE

Site or owner Oak Creek Site 3 Structure Wave Berm

Report no. 3 of 2 Date 4-1-05 Inspector B. Johnson

Placement no. or location Elev. 591.5 to 592.0, Sta. 6+25 to 14+25

Weather Cloudy, cool Temp 49°F to 55°F

Source of amendments and type or class Type 1 Portland Cement from Lehigh

USCS class SC Proctor curve #1

Specified Application Rate		
a. Specified dry density of soil-amendment moisture=	127.2	lb/ft^3
b. Specified amendment application rate=	6.0	%
c. Specified amendment application rate=a–(a/(1+b/100))=	7.2	lb/ft^3
d. Application rate per ft^2 of surface per inch of lift thickness=c/12=	0.60	lb/ft^2/in
e. Thickness of lift into which the amendment will be incorporated=	6	in
f. Specified application rate per ft^2=d x e=	3.6	lb/ft^2

Measured Application Rate

	Sample #1	Sample #2	Sample #3	Average
Station (x)	6+50	7+00	7+50	
Offset left(L) or right (R) of centerline (y)	47'R	43'R	45'R	
Elevation (z)	592.0	592.0	592.0	
Wt of tarpaulin + amendment (lb-oz)	34-14	34-8	33-10	
Wt. of tarpaulin (lb-oz)	0-12	0-12	0-12	
Wt. of amendment (lb-oz)	34-2	33-12	32-14	
Wt. of amendment (lb)	34.1	33.8	32.9	33.6
Area of tarpaulin (ft^2)	9	9	9	9
Wt. of amendment/area of tarpaulin (lb/ft^2)	3.79	3.76	3.66	3.74

Comments

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U.S. Department of Agriculture
Natural Resources Conservation Service

NEH 645 WS 9.1

GRANULAR MATERIAL APPLICATION RATE

Site or owner ______________________ Structure ______________________

Report no. ________ of __________ Date______________ Inspector ______________________

Placement no. or location ____

Weather ______________________ Temp ____________ to ____________

Source of amendments and type or class ______________________________________

USCS class ______________________ Proctor curve ______________________

Specified Application Rate	
a. Specified dry density of soil-amendment moisture=	________ lb/ft^3
b. Specified amendment application rate=	________ %
c. Specified amendment application rate=a–(a/(1+b/100)=	________ lb/ft^3
d. Application rate per ft^2 of surface per inch of lift thickness=c/12=	________ $lb/ft^2/in$
e. Thickness of lift into which the amendment will be incorporated=	________ in
f. Specified application rate per ft^2=d x e=	________ lb/ft^2

Measured Application Rate				
	Sample #1	Sample #2	Sample #3	Average
Station (x)				
Offset left (L) or right (R) of centerline (y)				
Elevation (z)				
Wt of tarpaulin + amendment (lb-oz)				
Wt. of tarpaulin (lb-oz)				
Wt. of amendment (lb-oz)				
Wt. of amendment (lb)				
Area of tarpaulin (ft^{2})				
Wt. of amendment/area of tarpaulin (lb/ft^{2})				

Comments ____

____

____

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NEH 645 WS 13.1 Record of Aggregate Moisture

Aggregate moisture should be monitored and documented at least once each production shift and whenever a change in the moisture is suspected.

On WS 13.1, note that the fine aggregate sampled on October 30 was sampled by two different test methods with different results. The first test method, ASTM D4944, appeared to measure mostly surface moisture. The second test method, ASTM D4959, measured surface and absorbed moisture. Always note observations such as this in the comments section.

When sampling aggregate, note the time when sampling is begun and the time when sampling ceases. This will allow correlation with the plant record pertaining to the mix produced from the aggregates sampled.

Obtain several samples. Record all test results and strike through any values that are unreasonable or markedly different from other results of tests from the same set of samples. Average the test results from the remaining values in each set of samples.

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Sample NEH 645 WS 13.1

U. S. Department of Agriculture
Natural Resources Conservation Service

NEH 645 WS 13.1

RECORD OF AGGREGATE MOISTURE

Watershed Pine Creek **Site No.** 3 **Structure** Aux. Spillway **Report No.** 3 of 28

Inspector R.. Rangel

Coarse Aggregate #1 Redland crushed 1" NMSA **Fine Aggregate #1** Redland silica sand

Coarse Aggregate #2 Lakeside Pit #2 **Fine Aggregate #2** ______

Date	Time Sampled		Aggregate Tested	Specific Location Tested	Test Method	Test Results						Average
	Start	End				Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	
4/30/05	1000	1100	FA #1	Stockpile *	D4944	2.0	2.0	2.2	2.1			2.1
4/30/05	1000	1100	FA #1	Stockpile *	D4959	2.5	2.5	2.7	2.6			2.6
5/1/05	0815	0830	CA #1	End of belt #1	D4959	2.4	2.6	2.5				2.5
5/1/05	0830	0845	CA #2	End of belt #2	D4959	2.5	2.4	2.5				2.5
5/1/05	0845	0900	FA #1	End of belt #3	D4959	2.3	2.2	2.4				2.3
5/2/05	0815	0830	CA #1	End of belt #1	D4959	2.5	2.6	2.6				2.6
5/2/05	0830	0845	CA #2	End of belt #2	D4959	~~2.2~~	2.7	2.7	2.6			2.7
5/2/05	0915	0930	FA #1	End of belt #3	D4959	2.1	2.1	2.2	2.1			2.1
5/3/05	0800	0815	CA #1	End of belt #1	D4959	~~2.2~~	2.7	2.7	2.8			2.7
5/3/05	0815	0830	CA #2	End of belt #2	D4959	2.7	~~2.3~~	2.8	2.8			2.8
5/3/05	0845	0900	FA #1	End of belt #3	D4959	2.2	2.3	2.3	2.4			2.3

Comments:
*FA was taken at various locations where material was being removed by front end loader. Speedy moisture meter appears to be measuring free water only. Tests on 4/30 were made from the same sample, but the oven dry sample test results show approximately 0.5 percent more moisture than the speedy. A calibration curve will be developed for the Speedy.

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NEH 645 WS 13.1

RECORD OF AGGREGATE MOISTURE

Watershed ____________ **Site No.** ___ **Structure** ____________ **Report No.** ____ ________

Inspector ________________________

Coarse Aggregate #1 ____________________ **Fine Aggregate #1** ______________

Coarse Aggregate #2 ____________________ **Fine Aggregate #2** ______________

Date	Time Sampled		Aggregate Tested	Specific Location Tested	Test Method	Test Results						Average
	Start	End				Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	

Comments:

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NEH 645 WS 13.2 Field Mix Evaluation

Plants that produce RCC also produce a plant record listing the weight of individual ingredients being mixed at any time during production. The inspector must ensure that the mix being produced in the field conforms to the approved Job Mix. The Field Mix Evaluation uses information obtained from the Job Mix submittal and plant records to evaluate the mix being produced in the field (field mix). Three questions about the field mix are answered by the completion of the Field Mix Evaluation:

- Is the field mix proportioned within the tolerances specified in Spec 36?
- What is the *percent moisture* (%M) of the field mix?
- What is the theoretical air-free density (TAFD) of the field mix?

Enter the applicable units (pounds or tons) in the space provided in the top left corner of the table. Use the units reported by the plant. The values in the example are in tons.

Line 1
Record the quantities of each mix ingredient on line 1, columns 1 through 7 and column 9. The sum of the figures in columns 1 through 7 is computed and placed in column 8. In the example, the quantities are summed as follows:

$$25.99+45.23+59.25+5.76+6.49+4.50=147.22 \text{ tons}$$

Column 9
Column 9 contains information about the admixture. The example shows 570 ounces of admixture were added to the mix. For a liquid admixture, this equals approximately 37 pounds of liquid, which is included in the quantity for Water + Admix in line 1, column 5. If the plant record does not include the admixture in the quantity of water added to the mix, add the quantity of admixture to the quantity of water reported by the plant and place this sum in line 1, column 5.

Line 2, columns 1 through 4
The value for aggregate field moisture is obtained from the Record of Aggregate Moisture and placed in line 2, columns 1 through 4. For coarse aggregate #1 (CA #1) the value of 2.5 percent is obtained from the Record of Aggregate Moisture and recorded on line 2, column 1.

Line 3, columns 1 through 4
Use the field moisture from line 2 to compute the weight of dry aggregate. For example, the Dry Quantity of CA #1 is computed as follows:

$$\text{Dry Quantity}=\frac{25.99}{1.025}=25.36 \text{ tons}$$

Line 2, column 5
The difference between the quantity in line 1, columns 1 through 4 and the dry quantity in line 3, columns 1 through 4 equals the aggregate moisture. For CA #1, the aggregate moisture is computed as follows:

$$25.99-25.36=0.63 \text{ tons}$$

The sum of the aggregate moisture is entered in line 2, column 5. In the example, this value is computed as follows:

$$\text{Field Moisture}=0.63+1.10+1.33=3.06 \text{ tons}$$

NEH 645 WS 13.2 Field Mix Evaluation—continued

Line 3, column 5
The total amount of moisture in the mix is determined by adding the value in line 1, column 5 to that in line 2, column 5 as follows:

$$5.76 + 3.06 = 8.82 \text{ tons}$$

Place this value in line 3, column 5.

Line 4, columns 1 through 4
Some of the moisture in the mix is absorbed by the aggregates. The amount of moisture that an aggregate will absorb is termed "*absorption*." Aggregate absorption is determined in the laboratory and reported as a percentage of the dry weight of the aggregate. Spec 36 requires aggregate absorption to be reported on the Job Mix submittal for each aggregate used in the mix. Obtain the absorption from the Job Mix submittal and record the values for each aggregate in line 4, columns 1 through 4, as applicable. In the example, in line 4, column 1, 2.0 percent is recorded as the absorption of CA #1.

Line 5, columns 1 through 4
The *saturated surface-dry (SSD)* quantity is the weight of the aggregates plus the moisture absorbed into the aggregates. Compute the SSD quantity for each aggregate using the value for absorption from line 4. The SSD quantity of CA #1 is computed as follows:

$$\text{SSD Quantity} = 25.36 \times 1.02 = 25.87 \text{ tons}$$

Place the value for SSD quantity of each aggregate in the appropriate column on line 5.

Line 4, column 5
The amount of moisture absorbed by each aggregate is computed by subtracting the dry quantity in line 3, columns 1 through 4 from the SSD quantity in line 5, columns 1 through 4. For example, the amount of moisture absorbed by CA #1 is computed as follows:

$$25.87 - 25.36 = 0.51 \text{ tons}$$

The total aggregate absorption is computed as follows:

$$\text{Total Absorption} = 0.51 + 0.93 + 0.29 = 1.73 \text{ tons}$$

Enter the total absorption on line 4, column 5.

Line 5, column 5
The difference between the total amount of moisture in the mix and the total absorption is termed the "*free water*." The free water is the moisture that is available (free) to mix with the cementitious materials and other fine particles to form the paste. In the example, the free water is computed as follows:

$$\text{free water} = 8.82 - 1.73 = 7.09 \text{ tons}$$

Enter the free water on line 5, column 5.

NEH 645 WS 13.2 Field Mix Evaluation—continued

Line 5
Copy the quantities of cement and pozzolan from line 1, columns 6 and 7 to line 5, columns 6 and 7. The sum of the values on line 5, columns 1 through 7 equals the total weight of the mix as follows:

$$25.87 + 45.06 + 58.21 + 7.09 + 6.49 + 4.50 = 147.22 \text{ tons}$$

This value is placed on line 5, column 8 and must equal the previous total located on line 1, column 8. If these values are not equal, a computation error has occurred that must be corrected before proceeding.

Line 6, columns 1 through 7
Line 6 contains the quantity of each ingredient as a percentage of the total mix quantity. The values in line 6, columns 1 through 7 are computed by dividing the values in line 5 by the total quantity of the mix on line 5, column 8 and multiplying by 100. For example, the percentage of CA #1 is computed as follows:

$$\left(\frac{25.87}{147.22}\right) \times 100 = 17.57\%$$

Line 6, column 9
Copy the quantity of admixture added to the mix from line 1, column 9.

Line 7, columns 1 through 7
From the Job Mix, record the specified percentage of each aggregate, water + admixture, cement, and pozzolan.

Line 7, column 9
Record the quantity of admixture specified in the Job Mix on line 7, column 9. This value may be shown on the Job Mix in ounces or milliliters per cubic yard of mix. If so, it must be multiplied by the number of cubic yards in the batch being evaluated to convert to ounces or milliliters per batch.

Line 8
Compute and record the percent difference between the values in lines 6 and 7. For example, line 6, column 1 shows 17.57 percent of the mix is CA #1. The Job Mix specified that 17.43 percent of the mix be CA #1, as shown in line 7, column 1. The percent difference is computed as follows:

$$\left[\left(\frac{(17.57 - 17.43)}{17.43}\right) \times 100\right] = +0.80\%$$

Line 9
Line 9 lists the tolerances in proportioning allowed by Spec 36. The values in line 8 must be within these specified tolerances; otherwise, mix proportioning adjustments must be made so that the mix being produced in the field is proportioned within the specified tolerances.

Line 10
Copy the quantities from line 5 to line 10. The values in line 10 must be in pounds. Make the conversion, if applicable. For example, the quantity of CA #1 on line 5 is 25.87 tons. The value recorded on line 10, column 1 is computed as follows:

NEH 645 WS 13.2 Field Mix Evaluation—continued

$$25.87 \text{ tons} \times 2000 \text{ lb/ton} = 51{,}740 \text{ lb}$$

The sum of values in line 10, columns 1 through 7 equals the total weight of the mix in pounds as follows:

$$51{,}740 + 90{,}120 + 116{,}420 + 14{,}180 + 12{,}980 + 9{,}000 = 294{,}440 \text{ lb}$$

Record this value on line 10, column 8.

Line 11

Obtain from the Job Mix the SSD relative density of each of the ingredients, and record them on line 11, columns 1 through 7. (Note: Relative density is the ratio of the weight of a specific absolute volume of material to the weight of an equal volume of distilled water. It is synonymous with the term "specific gravity" and is sometimes reported on Job Mix submittals as specific gravity, or abbreviated G_s). The aggregate relative densities recorded here are for aggregates in the saturated surface dry (SSD) condition. Aggregate relative density should be listed on the Job Mix for aggregates in the SSD condition. If the relative density listed on the Job Mix submittal has not been adjusted for SSD, make the adjustment. For example, if the relative density of CA #1 in the dry condition is 2.60 and the absorption is 2.0 percent, the SSD relative density is computed as follows:

$$2.60 \times 1.02 = 2.65$$

Line 12

Compute and record the *absolute volume* of each mix ingredient on line 12, columns 1 through 7. The absolute volume computation is made by dividing the values in line 10, columns 1 through 7 by the product of values in line 11, columns 1 through 7 and the unit weight of water. For example, the *absolute volume* of CA #1 is computed as follows:

$$\text{Absolute Volume} = \frac{51{,}740}{(2.65 \times 62.4)} = 312.89 \text{ ft}^3$$

Compute, as follows, the sum of the absolute volumes of each ingredient and place in line, 12 column 8:

$$312.89 + 538.89 + 704.04 + 227.24 + 66.04 + 51.15 = 1{,}900.25 \text{ ft}^3$$

The %M and TAFD computations are made at the bottom of the worksheet. %M is computed by dividing the total weight of dry materials in the mix by the total moisture in the mix. In the example, the %M is computed as follows:

$$\%M = \left[\frac{8.82}{(147.22 - 8.82)}\right] \times 100 = 6.4\%$$

TAFD is computed by dividing the total weight of all ingredients in the mix by the absolute volume of all ingredients in the mix as follows:

$$\text{TAFD} = \frac{294{,}440 \text{ lb}}{1{,}900.25 \text{ ft}^3} = 155.0 \text{ lb/ft}^3$$

Sample NEH 645 WS 13.2

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NEH 645 WS 13.2 — **FIELD MIX EVALUATION**

Watershed Pine Creek **Site No.** 3 **Structure** Aux. Spillway **Report No.** 3 **of** 28 **Date** 4/1/05
Placement No. or Location Test Section **Inspector** R. Rangel
Time of operation 0800 **to** 1130 **Weather** Cloudy, cool **Temp** 49 °F **to** 55 °F
RCC Temp 53 °F **to** 55 °F **Plant brand** ARAN 280 **Plant type** Continuous flow through pug mill
Mix Number PC3 200/100 **Cement Source and Type** Lehigh Type I **Pozzolan Source and Class** Monex Class F
Admixture Source and Type MB ASTM C494 Type D
Coarse Aggregate #1 Redland crushed 1" NMSA **Fine Aggregate #1** Redland manufactured sand
Coarse Aggregate #2 Lakeside Pit #2 **Fine Aggregate #2**

	Column →	1	2	3	4	5	6	7	8	9
Line	Unless Otherwise Indicated Units = ____ tons	CA #1	CA #2	FA #1	FA #2	Water + Admix	Cement	Pozzolan	Total	*Admixture (__oz__)
1	Quantity	25.99	45.23	59.25		5.76	6.49	4.50	147.22	570
2	Field Moisture	2.5 %	2.5 %	2.3 %	%	3.06				
3	Dry Quantity	25.36	44.13	57.92		8.82				
4	Absorption	2.0 %	2.1 %	0.5 %	%	1.73				
5	SSD Quantity	25.87	45.06	58.21		7.09	6.49	4.50	147.22	
6	Proportions (%)	17.57	30.61	39.54		4.82	4.41	3.06	**100**	570
7	Job Mix (%)	17.43	31.07	39.30		4.73	4.37	3.10	**100**	563
8	Difference ± (%)	+0.80	1.48	+0.61		+1.90	+0.92	1.29		+1.24
9	Tolerance (%)	± 3	± 3	± 3	± 3	± 2	± 2	± 2		± 3
10	SSD Quantity (lbs)	51,740	90,120	116,420		14,180	12,980	9,000	294,440	
11	SSD Relative Density	2.65	2.68	2.65		1.0	3.15	2.82		
12	Absolute Volume (ft^3)	312.89	538.89	704.04		227.24	66.04	51.15	1,900.25	

$$\%M = \left[\frac{8.82}{(147.22 - 8.82)}\right] \times 100 = 6.4\% \qquad TAFD = \frac{294{,}440\ lb}{1{,}900.25\ ft^3} = 155.0\ lb/ft^3$$

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NEH 645 WS 13.2

FIELD MIX EVALUATION

Watershed ____________________ Site No. ___ Structure ____________________ Report No. ___ of ___ Date __________
Placement No. or Location ____ Inspector ______________________________
Time of operation ____________ to ____________ Weather ____________________ Temp ________ to ________
RCC Temp ________ to ________ Plant brand ________________________ Plant type ______________________________
Mix Number ____________ Cement Source and Type ____________ Pozzolan Source and Class ____________
Admixture Source and Type ______________________________________
Coarse Aggregate #1 ______________________________________ Fine Aggregate #1 ______________________________
Coarse Aggregate #2 ______________________________________ Fine Aggregate #2 ______________________________

	Column →	1	2	3	4	5	6	7	8	9
Line	Unless Otherwise Indicated Units = ____ tons	CA #1	CA #2	FA #1	FA #2	Water + Admix	Cement	Pozzolan	Total	*Admixture (__oz__)
1	Quantity									
2	Field Moisture	%	%	%	%					
3	Dry Quantity									
4	Absorption	%	%	%	%					
5	SSD Quantity									
6	Proportions (%)								100	
7	Job Mix (%)								100	
8	Difference ± (%)									
9	Tolerance (%)	± 3	± 3	± 3	± 3	± 2	± 2	± 2		± 3
10	SSD Quantity (lbs)									
11	SSD Relative Density									
12	Absolute Volume (ft^3)									

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NEH 645 WS 13.3 Apparent Maximum Density (AMD) Determination

An AMD determination must be made for each gauge employed for the purpose of documenting compliance with density specifications. The three-step process of determining the AMD should be recorded on the worksheet. Refer to NEH 645.1301(c), Test section, for a detailed explanation of this three-step process.

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Sample NEH 645 WS 13.3

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NEH 645 WS 13.3

APPARENT MAXIMUM DENSITY (AMD) DETERMINATION

Watershed Pine **Site No.** 3 **Structure** Aux. Spillway

Date 4/1/05 **Inspector** R. Rangel

Placement No. or Location Test Section

Time of operation 0800 **to** 1130 **Weather** Cloudy, cool

Temp 49 °F **to** 55 °F **RCC Temp** 53 °F **to** 55 °F

Mix Number PC3 200/100 **TAFD** 155.0 pcf

Roller make and model Dynapac CA511D

Step 1: Compact and test two passes beyond the point density ceases to increase.

Number of Roller Passes	Wet Density @ 12-inch depth (pcf)	
	#1 – Gauge 00103	#2 – Gauge 02103
2	148.2	148.1
3	148.7	148.5
4	149.1	149.0
5	149.5	149.5
6	149.5	149.4
7	149.4	149.4
8	149.1	149.0

Step 2: Verify that density varies no more than 2 percent from bottom to top of the 12-inch lift.

Nuclear Probe Depth (inches)	Wet Density (pcf)			
	#1 – Gauge 00103	#2 – Gauge 02103	Max. and Min.	
2	150.2	150.5	150.2	150.5
4	150.1	150.1		
6	149.9	150.1		
8	149.9	150.0		
10	149.7	149.8		
12	149.5	149.5	149.5	149.5
		Max. – Min. =	0.7	1.0
		Percent Variation = [(Max. – Min.) ÷ Max.] × 100 =	0.5%	0.7%
		Allowable Percent Variation =	2%	

Step 3: Compute the AMD.

Location	Wet Density @ 10-inch depth (pcf)			
	Gauge 00103	Gauge 02103	values ≥ 0.96TAFD Gauge 00103	values ≥ 0.96TAFD Gauge 02103
1	152.4	152.1	152.4	152.1
2	152.4	152.5	152.4	152.5
3	152.6	152.8	152.6	152.8
4	152.7	152.3	152.7	152.3
5		152.6		152.6
6	152.4	152.9	152.4	152.9
		Average Density =	152.5	152.6
		0.98TAFD =	151.9	

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Natural Resources Conservation Service

NEH 645 WS 13.3

APPARENT MAXIMUM DENSITY (AMD) DETERMINATION

Watershed ____________________ **Site No.** ____ **Structure** ____________________

Date __________ **Inspector** ________________________________

Placement No. or Location ____

Time of operation ________ **to** _________ **Weather** ____________________________

Temp _________ **to** _________ **RCC Temp** _________ **to** _________

Mix Number _________________________ **TAFD** _______________

Roller make and model ____

Step 1: Compact and test two passes beyond the point density ceases to increase.		
Number of Roller Passes	Wet Density @ 12-inch depth (pcf)	
	#1 – Gauge _______	#2 – Gauge _______
2		
3		
4		
5		
6		
7		
8		

Step 2: Verify that density varies no more than 2 percent from bottom to top of the 12-inch lift.				
Nuclear Probe Depth (inches)	Wet Density (pcf)			
	#1 – Gauge _______	#2 – Gauge _______	Max. and Min.	
2				
4				
6				
8				
10				
12				
		Max. – Min. =		
		Percent Variation = [(Max. – Min.) ÷ Max.] × 100 =		
		Allowable Percent Variation =	2%	

Step 3: Compute the AMD.				
Location	Wet Density @ 10-inch depth (pcf)			
	Gauge ______	Gauge ______	values $\geq$ 0.96TAFD	
			Gauge ______	Gauge ______
1				
2				
3				
4				
5				
6				
		Average Density =		
		0.98TAFD =		
		Average Density $\geq$ 0.98TAFD?	Yes or No	Yes or No
		AMD =		

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NEH 645 WS 13.4 RCC Lift Summary

WS 13.4, RCC Lift Summary, is used to document placement of one RCC lift including the condition of the lift and edge joints and the treatment of those joints at the time they are covered with RCC or conventional concrete. The worksheet is also used to document moisture and density test results, the location of the tests including lift elevation, and the compactor used to compact the lift being tested.

Draw a sketch in the space provided above the table. Include items such as:

- coordinates or stations and offsets relative to the centerline of the structure that pinpoint the location of the sketched area
- embankment contact locations
- edge joint locations
- locations where temperature of the lift surface was measured and the average surface temperature (AST) as defined in Spec 36
- the time when RCC was spread over the surface
- the time when compaction was completed
- locations of moisture and density tests
- areas where there were problems with the mix
- repair areas

The joints in the example are labeled A, B, C, D, and E. A is located from approximate Station 5+70 to the end of the wall. RCC placement began over A at 8:08 a.m. RCC compaction was completed over A by 8:28 a.m. A moisture/density test was made at the location identified by the "+" and labeled "1." RCC spreading over B was completed at 8:30 a.m., apparently placed and spread while the RCC over A was being compacted.

Information to be recorded in the table includes details about the lift and RCC compaction. Spec 36 requires the RCC surface temperature to be measured each hour the lift surface is exposed. The time of joint exposure (TE) and the average temperature of the surface (AST) are recorded for each area. The product of these values equals the joint maturity. Two hours was recorded for the TE for area A. The AST for area A was recorded as 69 °F. The joint maturity is computed as follows:

$$\text{Joint maturity} = 2 \times 69 = 138\ ^\circ\text{F-hr}$$

Spec 36 defines three joint conditions (fresh joint, intermediate joint, and cold joint). One of three treatment methods defined in Spec 36 (treatment methods I, II, or III) is typically chosen by the design engineer based on the joint condition. Area A has a joint condition of "fresh." Treatment method I is recorded as the method of treatment employed to treat area A.

The moisture and density of the RCC compacted with the CA511D compactor was tested at the location identified on the sketch by "+" and labeled "1." In addition to being identified on the sketch, the test location is further defined in the table as being at Station 5+85, 176 feet left of the centerline of the structure. (Note: Unless otherwise noted, it is normal convention for the left side of the structure to be on the left when facing downstream in the direction of ascending station numbers.) A density of 149.4 pounds per cubic foot was tested with Gauge No. 00103 at a probe depth of 12 inches. 5.9 percent moisture was measured at the same location.

Include, in the comment section, any problems or relevant issues, such as a description of any repairs, which warrant additional explanation.

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Sample NEH 645 WS 13.4

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Natural Resources Conservation Service

NEH 645 WS 13.4

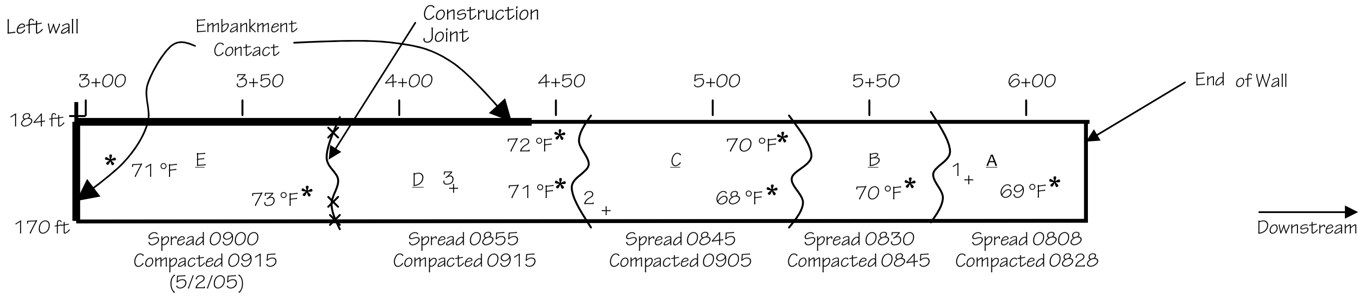
RCC LIFT SUMMARY

Watershed Pine Creek **Site No.** 3 **Structure** Aux. Spillway **Report No.** 3 **of** 28 **Date** 5/1/05

Placement No. or Location Elev. to 730.1 to 731.1 **Mix Number** PC 200/1003 **Inspector** R. Rangel

Weather Cloudy, cool **Temp** 51 °F **to** 56 °F **Mix Temp** 65 °F **to** 73 °F

Lift Diagram Left wall



Area	A	B	C	D	E
TE (h)	2	2	2	2	17
AST (°F)	69	70	71	72	73
Joint Maturity (°F-h)	138	140	142	144	1241
Joint Condition	fresh	fresh	fresh	fresh	intermediate
Treatment Method	I	I	I	I	III
Test No.	1		2	3	
Compactor	CA511D		3410	CA511D	
Station	5+85		4+65	4+20	
Offset (ft)	L176		L171	L175	
Gauge No.	00103		00103	00103	
Moisture Content (%)	5.9		5.9	5.9	
Wet Density (lb/ft³)	149.4		148.3	149.6	
Probe Depth (in)	12		12	6	

Comments:

A problem with mix uniformity was observed during placement in Area E. A portion of the mix was removed/wasted after being deposited. Edge of remaining RCC trimmed to a 1:1 slope. Production ceased for the day. Problem was with a leaky valve dumping too much water into the mix. Problem was fixed. Production resumed on 5-2-05. Construction joint and lift joint kept moist. Construction joint and lift joint treated with Treatment Method III.

Test No. 2 was made of RCC compacted in 6-inch lifts.

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NEH 645 WS 13.4

RCC LIFT SUMMARY

Watershed ______________ Site No. ___ Structure ______________ Report No. ____ of ____ Date ________

Placement No. or Location ______________ Mix Number Inspector ______________

Weather ______________ Temp ________ to ________ Mix Temp ________ to ________

Lift Diagram

Area	A	B	C	D	E	Comments:
TE (h)						
AST (°F)						
Joint Maturity (°F-hr)						
Joint Condition						
Treatment Method						
Test No.						
Compactor						
Station						
Offset (ft)						
Gauge No.						
Moisture Content (%)						
Wet Density (lb/ft^3)						
Probe Depth (in)						

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NEH 645 WS 13.5 In-place RCC Density and Moisture Test Results

WS 13.5, In-place Density and Moisture Test Results, is used to record density and moisture test results.

Even though some information will be duplicated by using both the RCC Lift Summary and In-place Density and Moisture Test Results worksheets, a more comprehensive set of data will be provided by completing both forms.

The test location can be identified by x, y, z—coordinates or by station, offset, and elevation. The stations given in the example entries refer to the centerline station of the RCC structure. The offset (e.g., L176 ft) gives the distance to the left or right of the centerline of the RCC structure. The "L" indicates the test location is to the left of the centerline and the number 176 is the distance left of the centerline. (Note: Unless otherwise noted it is normal convention for the left side of the structure to be on the left when facing downstream in the direction of ascending station numbers.) The elevation given for the test location is the elevation of the surface upon which the nuclear gauge sits to make the test.

All nuclear gauges are identified by a number and this number should be recorded to document which gauge was used to run the test. The nuclear gauge probe is lowered into the RCC and locked at a specific depth to run the test. This depth must be recorded.

The first line in the example shows a test was made on the 1st of May at a location 176 feet left of RCC structure centerline station 4+20. Gauge number 00103 measured the wet density of the RCC to be 159.1 pounds per cubic foot with the probe set at 12 inches. The moisture was measured to be 5.8 percent. The first line also documents that the density of the 12-inch lift was attained with 10 passes of the Hamm 3410 compactor (compactor B). Furthermore, a foot note was provided that directs the reader to the Comments section of the worksheet, where it is noted that a switch was made to compactor A.

Always list corrective actions in the comment area provided at the bottom of the page and document problems and corrective actions in the job diary as appropriate.

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Sample NEH 645 WS 13.5

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NEH 645 WS 13.5

IN-PLACE RCC DENSITY AND MOISTURE TEST RESULTS

Watershed Pine Creek **Site No.** 3 **Structure** Auxiliary Spillway

Sheet No. 3 **of** 28 **Year** 2005 **Inspector** R. Rangel

Mix Number PC3-200/100 **Specified Wet Density (lb/ft³)** 149.3 **Job Mix Moisture (%)** 5.9

Compactor	Make	Model
A	Dynapac	CA511D
B	Hamm	3410
C	Wacker	RD 2700100

Date Tested	Test Location			Gauge No.	Test Depth (in)	Wet Density (lb/ft³)	Moisture (%)	Compactor	Passes	Lift Thickness (in)	Comment or Corrective Action Taken
	Station (X)	Offset (Y)	Elev. (Z)								
5/1	4+20	L176 ft	731.1	00103	12	146.1	5.8	B	10	12	1
5/1	4+20	L176 ft	731.1	00103	12	149.4	5.9	A	6	12	
5/1	4+65	L171 ft	731.1	00103	12	146.7	6.0	B	10	12	2
5/1	4+65	L171 ft	731.1	00103	6	148.3	5.8	B	6	6	
5/1	5+40	L174 ft	731.1	00103	12	149.5	5.9	A	6	12	
5/1	5+40	L174 ft	731.1	00103	10	149.7	5.9	A	6	12	
5/1	5+40	L174 ft	731.1	00103	8	150.1	5.9	A	6	12	
5/1	5+40	L174 ft	731.1	00103	6	150.5	5.9	A	6	12	
5/1	5+40	L174 ft	731.1	00103	4	150.9	5.9	A	6	12	
5/1	5+85	L176 ft	731.1	00103	12	149.6	5.9	A	6	12	
5/2	4+40	R173 ft	732.1	00103	10	149.7	5.9	A	6	12	
5/2	5+10	R176 ft	732.1	00103	10	149.6	5.9	A	6	12	
5/2	5+50	R180 ft	732.1	00103	10	149.8	5.9	A	6	12	3
5/2	5+50	R180 ft	732.1	00111	10	149.6	5.1	A	6	12	3
5/2	5+60	R176 ft	732.1	00103	10	149.9	5.9	A	6	12	3
5/2	5+60	R176 ft	732.1	00111	10	149.7	5.1	A	6	12	3

Comments:
1. Switched to Compactor A
2. Thinned lift from 12 to 6 inches when using Compactor B
3. Measurements taken in same holes with different gauges to compare gauges. Density is relatively close, but moisture varies quite a bit between gauges. Moisture correction dialed into Gauge 00103, but no correction dialed into Gauge 00111. Will determine moisture correction for Gauge 00111 prior to further use.

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NEH 645 WS 13.5

IN-PLACE RCC DENSITY AND MOISTURE TEST RESULTS

Watershed ____________________ **Site No.** _______ **Structure** ____________________

Sheet No. ____ **of** _____ **Year** _________ **Inspector** ____________________

Mix Number _______________ **Specified Wet Density (lb/ft³)** __________ **Job Mix Moisture (%)** ____

Compactor	Make	Model
A		
B		
C		

Date Tested	Test Location			Gauge No.	Test Depth (in)	Wet Density (lb/ft³)	Moisture (%)	Compactor	Passes	Lift Thickness (in)	Comment or Corrective Action Taken
	Station (X)	Offset (Y)	Elev. (Z)								

Comments:

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NEH 645 WS 13.6 RCC Compressive Strength Test Results

WS 13.6, RCC Compressive Strength Test Results, is used to record information about RCC compressive strength test specimens.

The example shows the results from three groups of specimens. Groups 11 and 12 each contained 12 cylinders. The specimens in groups 11 and 12 were 6-inch nominal diameter cylinders made on 5/1/05 and 5/2/05, respectively. Two cylinders from each group were tested and are reported in the example. Group 3, made on 5/2/05, was a group of four 6-inch nominal diameter cores. Results from two of the four cores are reported in the example.

The cylinders were weighed immediately after being made to obtain their wet weight. The ends of the cores were sawed and weighed at the time of testing. Specimen volumes were determined at the time of compression strength testing.

RCC cylinders generally have a slightly larger diameter than conventional concrete test specimens because compaction results in expansion of the plastic specimen mold. Thus, the volume will be slightly higher than the volume of the empty mold. The diameter of core specimens can also vary. Accurate diameter measurements are made by measuring the circumference with a "PI tape," which yields a direct reading of the diameter to within 0.001 inch. The diameter used to compute the volume of core or molded cylinder specimens should be the average of the bottom, middle, and top diameters. The diameter of specimen number 1 from group 11 was measured near the bottom, middle, and top to be 6.009, 6.014, and 6.015 inches. The average diameter is computed as follows:

$$\frac{(6.009+6.014+6.015)}{3} = 6.013 \text{ in}$$

The cross-sectional area of specimen number 1 from group 11 is computed as follows:

$$\pi \times \frac{6.0132}{4} = 28.397 \text{ in}^2$$

The length of specimen number 1 from group 11 was measured to be 11.94 inches. The volume of the specimen is computed as follows:

$$11.94 \times \frac{28.397}{1728} = 0.1962 \text{ ft}^3$$

Density values are computed by dividing the weight of cores or cylinders by their volume. The density of specimen number 1 from group 11 is computed as follows:

$$\text{Density} = \frac{29.35 \text{ lb}}{0.1962 \text{ ft}^3} = 149.6 \text{ lb/ft}^3$$

The average density of specimen numbers 1 and 2 is computed as follows:

$$\text{Average Density} = 149.6 + 149.3 = 149.5 \text{ lb/ft}^3$$

Accurate compression testing requires the load placed on the specimen to be evenly distributed across the top and bottom of the specimen. Since the top and bottom of specimens are rarely smooth, they are capped with sulfur which is bonded to the top and bottom of the specimen or capped with a high density rubber which is not bonded to the specimen. The type of caps used, bonded or unbonded, should be reported.

NEH 645 WS 13.6 RCC Compressive Strength Test Results—continued

L/D is the ratio of the length to the diameter of the specimen. It is not uncommon for cores to have an L/D less than or equal to 1.75. ASTM C39 and C42 require a correction be made to the measured compressive strength if the L/D is less than or equal to 1.75. Correction factors taken from C39 and C42 are as follows:

L/D	Correction factor
1.75	0.98
1.50	0.96
1.25	0.93
1.00	0.87

Use interpolation to determine correction factors for L/D values given in the table.

Specimen number 1 from group 3 had an L/D of 1.67. The correction factor for this specimen is between 0.96 and 0.98. The following relationship can be employed to compute the correction factor:

$$\frac{1.75-1.67}{1.75-1.50}=\frac{0.98-x}{0.98-0.96}$$

Solve for the correction factor (x) as follows:

$$x=0.98-\left(\frac{0.08\times 0.02}{0.25}\right)\approx 0.97$$

The compressive strength of specimen number 1 from group 3 tested to be 1,920 pounds per square inch. The corrected compressive strength is computed as follows:

$$1920\times 0.97=1862\ \text{lb/in}^2$$

ASTM C39 requires compressive strength be reported to the nearest 10 pounds per square inch. Thus, in the example, the corrected compressive strength of specimen number 1 from group 3 was reported as 1,860 pounds per square inch.

ASTM C39 contains a schematic of six fracture patterns (type 1 through type 6). The number corresponding to the type of fracture should be documented. Also, note the presence of large air voids, evidence of segregation, whether fractures pass predominantly around or through coarse aggregate particles, and any other observations related to strength values attained. In the example, specimen number 12 from group 12 had a tested compressive strength of 1,410 pounds per square inch, whereas specimen number 11 made and tested on the same dates had a much higher strength (2,230 lb/in^2). A comment was made in the comments section of the worksheet explaining that poor compaction was indicated by gravel with little paste at an approximated depth of 8 inches. The comment infers the low strength was a result of poor compaction.

Spec 36 requires that three cylinders or two cores be tested for compressive strength at each age specified. The average of three cylinders or two cores made from the same mix and tested on the same day represents

NEH 645 WS 13.6 RCC Compressive Strength Test Results—continued

the mix strength at a specific age. If one compression test value is significantly lower than that of the other specimen(s), only the higher values should be used to determine the average density. If the cause of the low strength value can be determined, it should be noted as mentioned above for specimen number 12 from group 12. The strength of this specimen was recorded and then lined through to denote that it was not used to compute the average strength.

The last line of the table in the RCC Compressive Strength Test Results worksheet is used to record the average compressive strength from results of two or more tests made from the same specimen group tested on 5/15/05. For example, specimens 1, 2, and 3 were in specimen group 11 and were tested on 5/15/05. Their compressive strengths are averaged as follows:

$$1580 + 1620 + 1550 = 1580 \text{ lb/ft}^2$$

This value is recorded on the last line in one of the columns containing the 5/15/05 test results from a group 11 specimen.

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Sample NEH 645 WS 13.6

U.S. Department of Agriculture
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NEH 645 WS 13.6

RCC COMPRESSIVE STRENGTH TEST RESULTS

Watershed Pine Creek **Site No.** 3 **Structure** Aux. Spillway

Report No. 3 **of** 28 **Mix Number** PC3-200/100 **Inspector** R. Rangel

Specimen Number	1	**2**	**3**	**10**	**11**	**12**	**1**	**2**	
Specimen Group	11	11	11	12	12	12	3	3	
Number in Group	12	12	12	12	12	12	4	4	
Date Made	5/1/05	5/1/05	5/1/05	5/2/05	5/2/05	5/2/05	5/2/05	5/2/05	
Sample Standard	C1435	C1435	C1435	C1435	C1435	C1435	C42	C42	
L × D (in) (nominal)	12x 6	12x 6	12x 6	12x6	12x6	12x6	10x6	11x6	
Weight (lb)	29.35	29.39	29.42	29.39	29.36	28.80	24.46	26.91	
Curing Method	Wet	Wet	Wet	Wet	Wet	Wet	In-place	In-place	
Curing Period (d)	14	14	14	14	14	14	14	14	
Date Tested	5/15/05	5/15/05	5/15/05	5/30/07	5/30/07	5/30/07	5/30/07	5/30/07	
Age Tested (d)	14	14	14	28	28	28	28	28	
Test Standard	C39	C39	C39	C39	C39	C39	C39	C39	
Volume (ft^3)	0.1962	0.1966	0.1965	0.1966	0.1963	0.1967	0.1645	0.1807	
Density (lb/ft^3)	149.6	149.3	149.7	149.5	149.6	146.4	148.7	148.9	
Average Density (lb/ft^3)			149.5			149.5		148.8	
Caps (B = bonded or U = unbonded)	U	U	U	U	U	U	B	B	
L/D	2	2	2	2	2	2	1.67	1.83	
Strength (psi)	1580	1620	1550	2260	2200	1410	1920	1780	
Type of Fracture	1	1	1	2	2	*4	5	5	
Correction Factor							0.97		
Corrected Strength (psi)	1580	1620	1550	2260	2200	~~1410~~	1860	1780	
Average Strength (psi)			1580			2230		2750	

Comments: *Poor compaction indicated by mostly gravel with little paste at approximate depth of 8 inches from top of cylinder.
Cylinders were weighed at the time of molding. Cores were weighed at the time of testing.

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NEH 645 WS 13.6

RCC COMPRESSIVE STRENGTH TEST RESULTS

Watershed ______________________ Site No. __________ Structure ______________________________

Report No. _____ of _____ Mix Number ______________ Inspector ___________________________

Specimen Number		2	3	10	11	12	1	2	
Specimen Group									
Number in Group									
Date Made									
Sample Standard									
L × D (in) (nominal)									
Weight (lb)									
Curing Method									
Curing Period (d)									
Date Tested									
Age Tested (d)									
Test Standard									
Volume (ft^3)									
Density (lb/ft^3)									
Average Density (lb/ft^3)									
Caps (B = bonded or U = unbonded)									
L/D									
Strength (psi)									
Type of Fracture									
Correction Factor									
Corrected Strength (psi)									
Average Strength (psi)									

Comments: